GE MOBILE RADIO

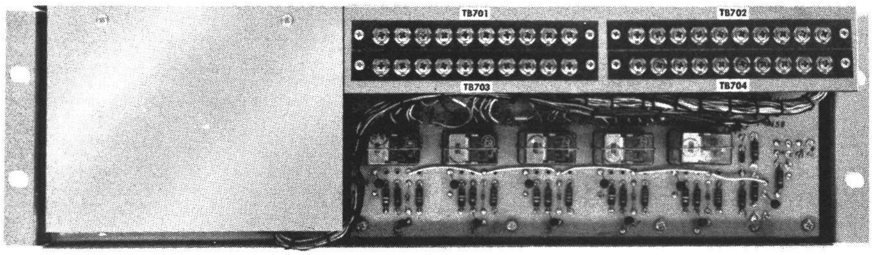
# MAINTENANCE MANUAL

## FIVE-FUNCTION DIGITAL DECODER PANEL

## MODELS 4EJ18C10-12 (Options 7742, 7743 & 7744)

Maintenance Manual LBI-4046C

DF-5036




EJ-18-C

## SPECIFICATIONS *

| Model Number | Tone Input | MASTR Professional Option Number |
|---|---|---|
| 4EJ18C10 | 590 Hz | 7742 |
| 4EJ18C11 | 1500 Hz | 7743 |
| 4EJ18C12 | 2805 Hz | 7744 |

| | |
|---|---|
| Pulsing Speed | 8 to 16 PPS (10 PPS Nominal) |
| Input Impedance | 3000 ohms minimum |
| Audio Sensitivity | |
| 590 & 1500 Hz | .02 to 6.0 volts at 10 dB SINAD |
| 2805 Hz | .02 to 6.0 volts at 14 dB SINAD |
| Input Power (no relays operated) | 12.6 volts DC at 140 milliamperes (add 20 milliamperes per operated relay) |
| Relay Contact Rating | 1 ampere at 24 volts, resistive<br>1/2-ampere at 115 volts, resistive |
| Relay Contacts Available | 1 form-A, 1 form-B and 1 form-C per function wired to terminal boards |
| Dimensions (H x W) | 5-1/4" x 19" |
| Temperature Range | -30°C to +60°C |

## OPTIONS

| Description | Option Number |
|---|---|
| 117-Volt AC Power Supply | 7776 |
| 1 Relay (19A122344-G1 | 7777 |
| 2 Relays(19A122344-G1 | 7778 |
| 3 Relays (19A122344-G1) | 7779 |

* These specifications are intended primarily for the use of the serviceman. Refer to the appropriate Specification Sheet for the complete specifications.

GENERAL ELECTRIC

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**WARNING**

No one should be permitted to handle any portion of the equipment that is supplied with voltage; or RF power; or to connect any external apparatus to the units while the units are supplied with power. KEEP AWAY FROM LIVE CIRCUITS.

# DESCRIPTION

General Electric Five-Function Digital Decoder Panel Models 4EJ18C10-12 are activated by coded tones to provide up to five control functions. The decoder panel consists of a digital decoder assembly and a five-function relay board mounted on a single three rack-unit, 19-inch panel.

The decoder assembly responds to a tone that is interrupted by a telephone-type dial to form a series of pulses corresponding to the digit dialed. The decoder output activates a selected relay on the relay board to perform the desired switching.

The standard panel is shipped from the factory equipped with the Function 1 and Function 5 relays. Optional plug-in relays are available for Functions 2, 3 and 4.

The decoder panel is designed for use with virtually any local, local/remote or remote station, and may also be mounted on auxiliary equipment racks,used in consoles or other equipment. When used with MASTR Professional Series stations, the panel is supplied by the 12.6-volt regulator on the station power supply. An optional 117-volt AC power supply is available for other applications.

# PRELIMINARY ADJUSTMENT

## CODE SETTING

Before placing the decoder panel into operation, new code assignments and code settings must be made. The decoder is normally shipped from the factory set for the following codes:

- Function 1 : 5-9-5
- Function 2 : 5-9-6
- Function 3 : 5-9-7
- Function 4 : 5-9-8
- Function 5 : 5-9-9

Complete instructions for setting new two-digit or three-digit codes are contained in the Code Setting Procedure listed in the Table of Contents. Instructions are also provided for setting a one digit function code (normally assigned as a relay drop out code).

## RELAY OPERATION

### CONTACT SELECTION

The standard decoder panel provides one set of form A, one set of form B and one set of form C contacts per function that are wired to terminal boards on the panel for controlling external circuits. However, each relay has three sets of form C contacts that may be used. The contacts available at the terminal boards may be changed to fit the requirements of specific applications by changing the connections to the relay contact jacks.

### RELAY STRAPPING

As a result of the flexibility designed into the decoder panel, the relays may be strapped for many different methods of operation. Three of the more common methods are described in the following text. Strapping instructions for the three methods are contained in the Relay Strapping Procedure listed in the Table of Contents.

#### Multiple Lock-Up

The standard panel is shipped from the factory strapped for multiple lock-up operation. Dialing the Function 1 code locks up the Function 1 relay. When the optional relays are used, the Function 1 through Function 4 relays may be locked up individually and in any sequence. Dialing the Function 5 code momentarily energizes the Function 5 relay (for approximately four seconds), releasing all locked-up relays.

#### Exclusive Lock-Up

When strapped for this method of operation, the Function 1 through Function 5 relays may be operated individually and in any sequence. However, the operation of any relay releases any previously-operated relay so that only one relay may be locked up at a time.

#### Sequential Drop-Out

When strapped for this method of operation, the Function 1 through Function 4 relays may be operated individually and in any sequence. However, the locking path of the lower numbered relays is connected through the normally-closed contacts of the higher numbered relays. Operating a higher numbered relay releases any lower numbered relay that is locked up, so that only one relay may be locked up at a time.

Any relay that has been released may be energized for approximately four seconds by dialing the appropriate code.

CUSTOMER-SUPPLIED RELAYS

The standard relays (GE Part No. 5491595-P14) supplied with the decoder panel have a contact rating of one ampere resistive at 24 volts, or 1/2-ampere resistive at 115 volts. In applications requiring relays with a larger current capacity, the relays shown in the following chart may be substituted for the standard relays.

| Contact Rating | Similiar To Allied Control Company |
|---|---|
| 2 amperes resistive | TS154-CCCC-12V |
| 5 amperes resistive | TF154-CCCC-12V |

The relays listed in the chart require more current than the standard relays shipped with the decoder panel. For example, the 5-ampere relay has a 185-ohm winding and requires approximately 70 milliamperes, as compared with the 520-ohm winding of the standard relay which requires approximately 20 milli-amperes. Therefore, care must be exercised not to exceed the capacity of the 12.6-volt regulator. In applications where the current drain is critical, the use of external relays is recommended, or the optional AC power supply may be used to power the decoder panel.

For applications requiring a magnetic latching relay, a relay similiar to Allied Control Company T351-CCCC-2/12 may be used. The relay contacts are rated at one ampere at 29-volts DC. When the magnetic latching relay is used, the panel must be strapped according to the manufacturer's instructions for operating the relay.

## LOGIC CIRCUITS

This section contains a detailed description of all of the logic circuits used in the decoder. It is suggested that the serviceman study the following information carefully, as a good understanding of the basic decoder circuitry is essential for servicing the decoder.

### SOLID STATE SWITCHES

An ideal switch has infinite resistance when open and zero resistance when closed. The transistor and semiconductor diode can be made to approach these conditions while operating at a much higher rate than conventional switches. Logic circuits are primarily switching devices which are either in a state of full conduction (saturated) or turned off. These devices can be switched from one state to the other as rapidly as required by the circuit function.

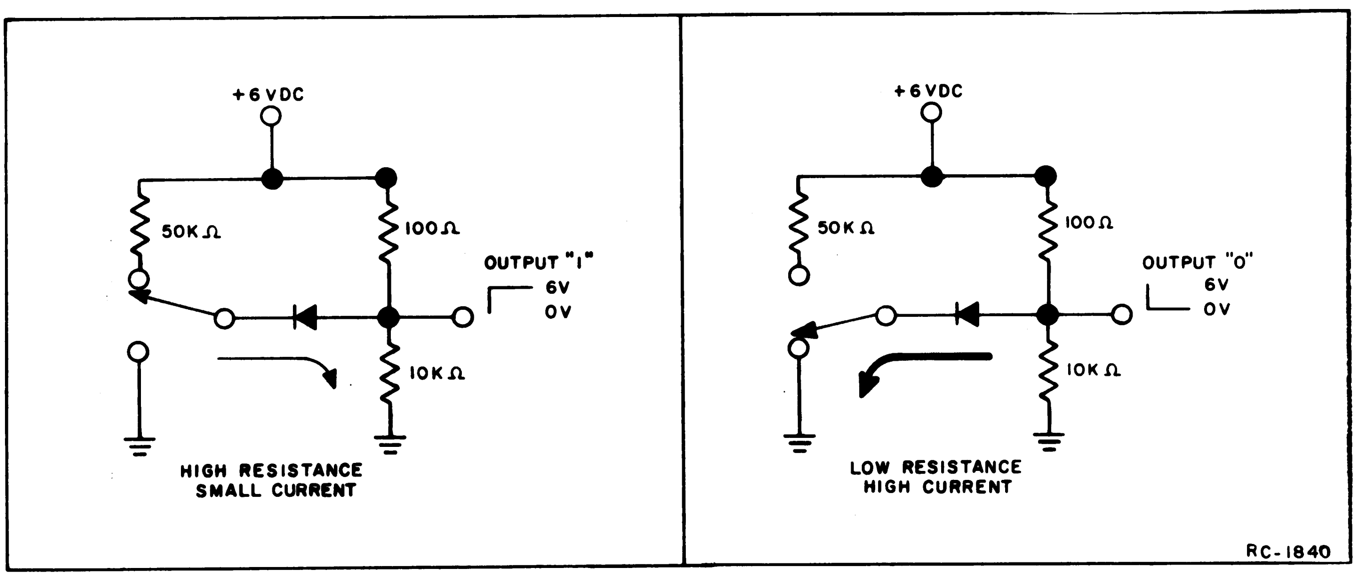



Figure 1 - Diode Switching Circuit

DIODE SWITCH (Figure 1)

A semiconductor diode presents maximum resistance to the circuit when the diode is reversed biased or there is no difference of potential between the cathode or anode. Applying a negative potential to the cathode of the diode (with respect to the anode), of a positive potential (with respect to the cathode) to the anode of sufficient amplitude to overcome the series resistance of the diode, forward biases the diode causing it to conduct. The diode now switches from maximum to minimum resistance.

The resulting current flow in the diode circuit increases from near zero to the maximum value allowed by the amplitude of the switching voltage and the series resistance of the circuit.

TRANSISTOR SWITCH & INVERTER (Figure 2)

The high value of "off" resistance and the low value of "on" resistance make the transistor invaluable for switching applications. When no base current is applied to the transistor switch shown in Figure 2, and the collector has the proper voltage applied, the open-circuit resistance of the transistor approaches several megohms. If sufficient base current is suddenly applied to drive the transistor into saturation (turned ON), the collector-emitter resistance will drop to as low as 1.0 ohm. Voltage across the transistor under these conditions may be only a few tenths of a volt.

The transistor stage shown in Figure 2 can also be used as an inverter for reversing the polarity of the input signal. A positive signal applied to the base-emitter junction will cause the collector voltage to drop from +6 volts to near ground potential.

GATING CIRCUITS

Formal logic requires that a statement be either true or false; no other condition can exist for the statement. A logic circuit is basically a switch or gate that is either closed or open; no other condition can exist for the circuit. By logical arrangement of these gating circuits, electrical functions can be performed in a pre-determined sequence by opening or closing the gates at the proper time.

A single-pole, single-throw switch is equivalent to a binary device with only two possible operating conditions: either open or closed. If point "C" of Figure 3 is to be made equal to potential V, switches A and B must be closed. It can then be said that A and B = C. If switches A and B are considered as gates, then potential V is said to be gated to "C" when both gates are closed. By representing the closed state of a switch or gate as "1" and the open state of a switch or gate as "0", then all possible conditions for the AND gate are shown in the Truth Table in Figure 3.

In Figure 4, if point "C" is to be made equal to potential V, either switch A or B (or both) may be closed. It can then be said A or B = C. All possible conditions for the OR gate are shown in the Truth Table in Figure 4.

DIODE GATING CIRCUITS

In gating circuits, the desired state of the gate may be represented by either "0" or "1". In this section, "1" will be used to represent a positive potential (approximately +6 volts) and "0" will be used to represent a low potential (near zero volts).

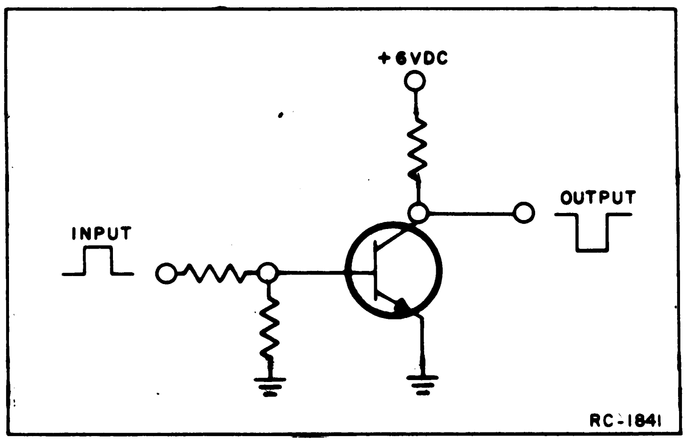



Figure 2 - Transistor Switching Circuit

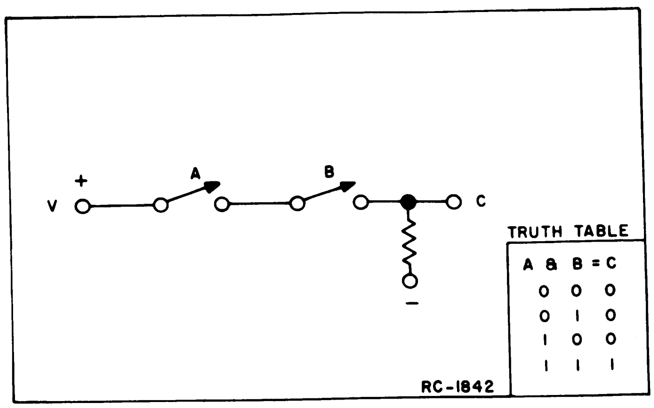



Figure 3 - Simple AND Gate

## Logic Symbols

The use of logic symbols in this manual provides a simple method of showing the function of complicated logic circuits without drawing each diode, resistor and transistor in the circuit. The individual symbols can be tied together to form a logic diagram of a complete unit (decoder, encoder, etc.). Logic symbols of circuits used in the decoder are shown in the following simplified diagrams.

## AND Gate

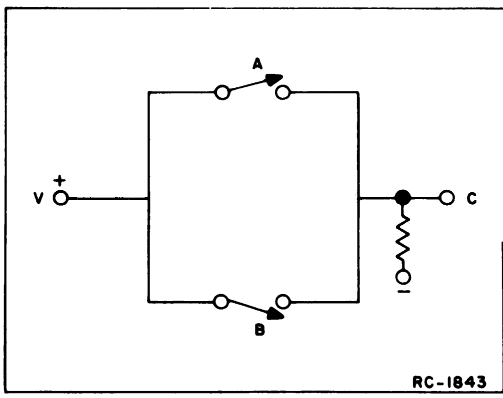
A simple diode AND gate is shown in Figure 5. The same conditions exist in this circuit as in the switch gate of Figure 3. Application of a positive potential to the diodes at all inputs will result in a positive potential at the output. This represents the "1" state of the gate. Application of a positive potential to one or two terminals will result in no potential developed, representing the "O" state of the gate.

## OR Gate

A simple diode OR gate is shown in Figure 6. The same conditions exist in this circuit as the switch gate of Figure 4. Application of a positive potential at any of the inputs will result in an output of the same polarity, representing the "1" state.

## NAND Gate

The basic logic circuitry used in the decoder is the NAND gate (NOT-AND). A NAND gate is simply an AND gate with a transistor inverter (NOT) stage added (see Figure 7).




TRUTH TABLE

| A | B | C |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

(A OR B = C)

Figure 4 - Simple OR Gate

Applying a positive potential to inputs A and B back biases diodes CR1 and CR2, permitting inverter Q1 to conduct. When conducting, the collector of Q1 drops to near ground potential.

Additional buffer or amplifier stages are usually added to the NAND gate to provide better isolation and increased gain. These additional stages are connected so that the logical output of the inverter is not changed.

NAND gates may also be used to provide the OR function. Assume that inputs A and B are all at a positive potential. Grounding either A or B turns off the inverter, so that the output (C) rises to approximately 6 volts.

## Flip-Flops

Two NAND gates connected as shown in Figure 8 will provide the same logic functions as the conventional flip-flop (bistable multivibrator).

Assume that a positive potential is applied to all inputs. Momentarily grounding the cathode of CR4, CR5 or CR6 turns off Q2, causing its collector voltage to rise to approximately +6 volts. This turns on Q1, causing its collector voltage to drop to near ground potential, keeping Q2 turned off. The flip-flop will remain in this state until either CR1, CR2 or CR3 are grounded.

Usually, two or more of the flip-flops are connected in a "master-slave" configuration (one flip-flop driving the other) for additional flexibility. Terminal identification for the flip-flop is shown in Figure 9A. However, the flip-flops used in the decoder are actually connected as shown in Figure 9B, with external connections from input terminal 3 to output terminal 9, and from input terminal 12 to output terminal 6. This leaves terminal 2 as the input terminal or "trigger". A flip-flop connected in this manner (J-K connected) will change state each time a negative-going pulse is applied to the trigger (terminal 2).

Terminal 10 of the flip-flop is the reset terminal. Applying a negative-going pulse to the reset terminal shifts the output of the flip-flop to a "1" at terminal 6 and a "O" at terminal 9, even when a pulse is being applied to the trigger.

## Counters

Two or more flip-flops may be connected to form a counter. The counter circuit in Figure 10 uses three flip-flops for counting up to eight pulses.

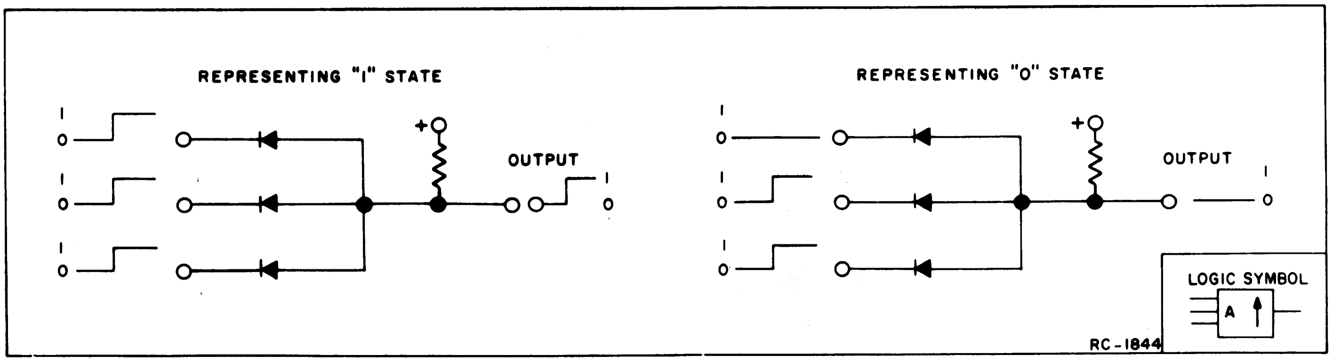



Figure 5 - Diode AND Gate

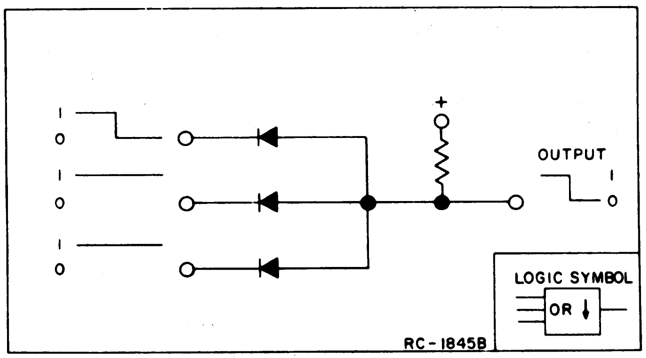



Figure 6 - Diode OR Gate

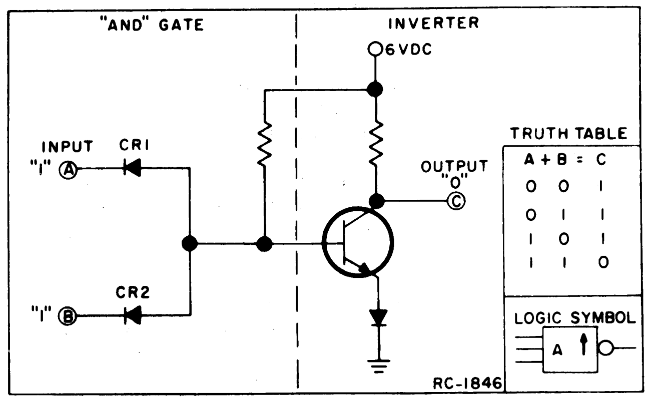



Figure 7 - Simplified NAND Gate

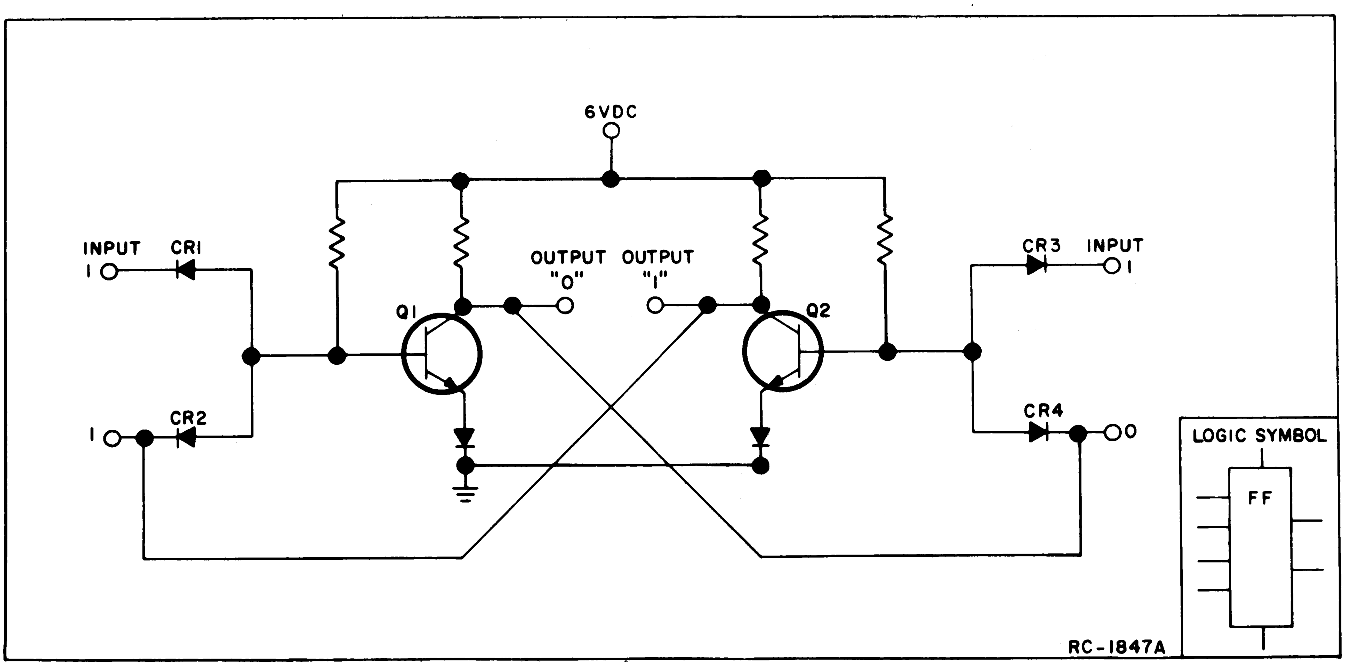



Figure 8 - NAND Gate Flip-Flop

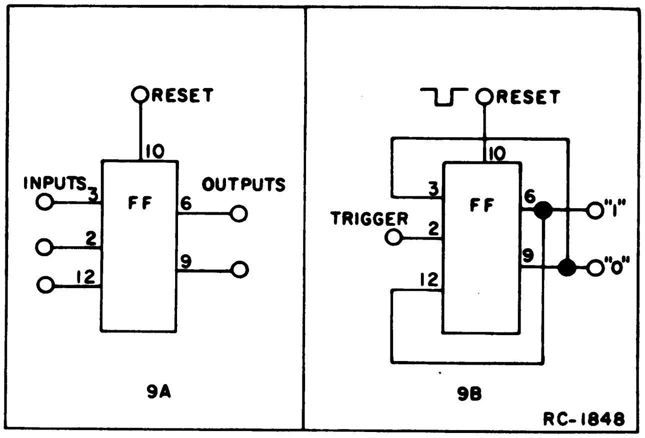



Figure 9 - Flip-Flop Terminal Identification

A reset pulse switches all three flip-flops to a "1" at terminal 6 (and a "O" at terminal 9). The first negative-going pulse applied to the trigger of A switches all of the flip-flops to the "O" state at terminal 6. The second pulse switches A back to the "1" state at terminal 6 while B and C do not change state.

Applying the third pulse switches terminal 6 of A back to a "O". This switches terminal 6 of B to a "1", which does not change the state of C. The application of four more pulses to the trigger of A will shift the outputs at terminal 6 of A, B and C as shown in the truth table in Figure 10. Note that each flip-flop changes state only when the preceeding flip-flop goes from a "1" to a "O".

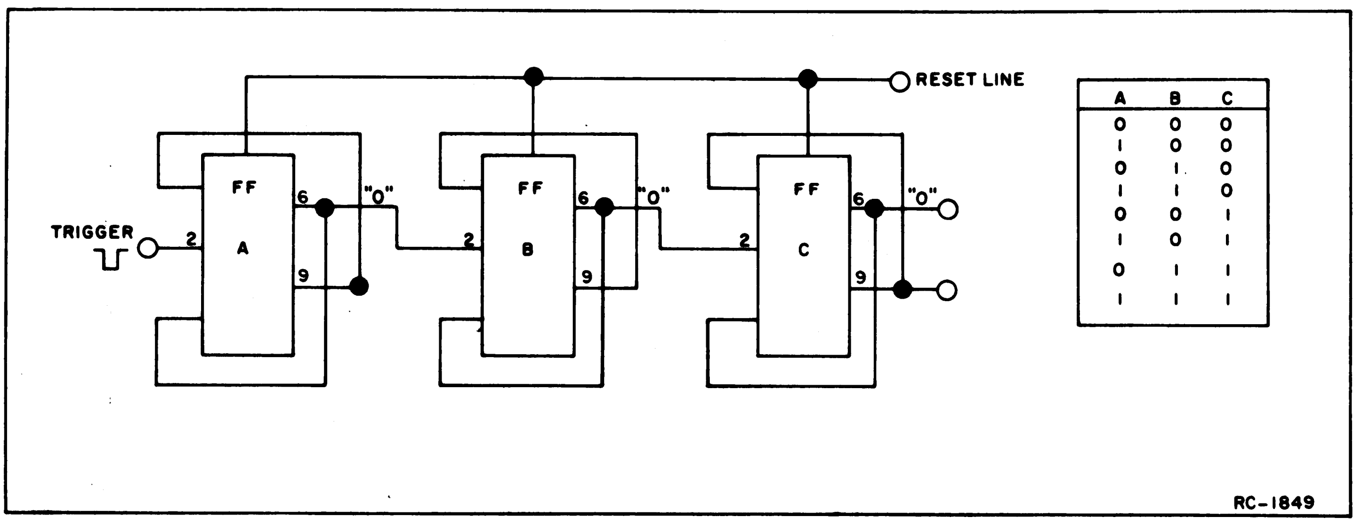
A NAND gate diode matrix connected to the outputs of the counter flip-flops is used to detect a unique set of outputs. In effect, the counter and matrix provides a simple method of recognizing (decoding) a correctly coded input signal. A simplified bit counter and digit counter with a decode matrix are shown in Figure 11.

The digit counter is triggered by a pulse for each digit dialed, while the bit counter is triggered by a pulse for each interruption in the coded tone. The matrix is shown connected for a code of 3 - 2 - 2.

Assume that this code is being dialed at the encoder. Tone applied to the decoder at the start of dialing resets all of the flip-flops to a "1" at terminal 6. The first pulse of the dialed code applied to the counters switches all of the flip-flops to "O" at terminal 6.

In the digit counter, terminal 9 of flip-flops A and B are now positive. This back biases diodes CR1 and CR2, removing the ground on input 4 of NAND gate 1. As terminal 6 of A and B is "O", CR3 and CR6 are forward biased, grounding input 4 of NAND gates 2 and 3. This disables gates 2 and 3 while the first digit is counted.

In the bit counter, the second and third pulses switch terminal 6 of flip-flop C to a "1" and back to a "O". The "O" at the trigger of D switches its output to a 1, while E remains an "O". Terminal 9 of C and E are now positive, removing the ground on inputs 1 and 3 of NAND gate 1. Terminal 6 of D is positive, removing the ground on input 2 of NAND gate 1. All positive inputs activates the NAND gate and its output goes negative. This negative output activates the OR gate and its output goes positive. The positive OR gate output prevents the reset circuit from resetting the counters so that they remain ready for the next digit in the code.




| A | B | C |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 0 |
| 0 | 0 | 1 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 1 |

Figure 10 - Simplified Counter

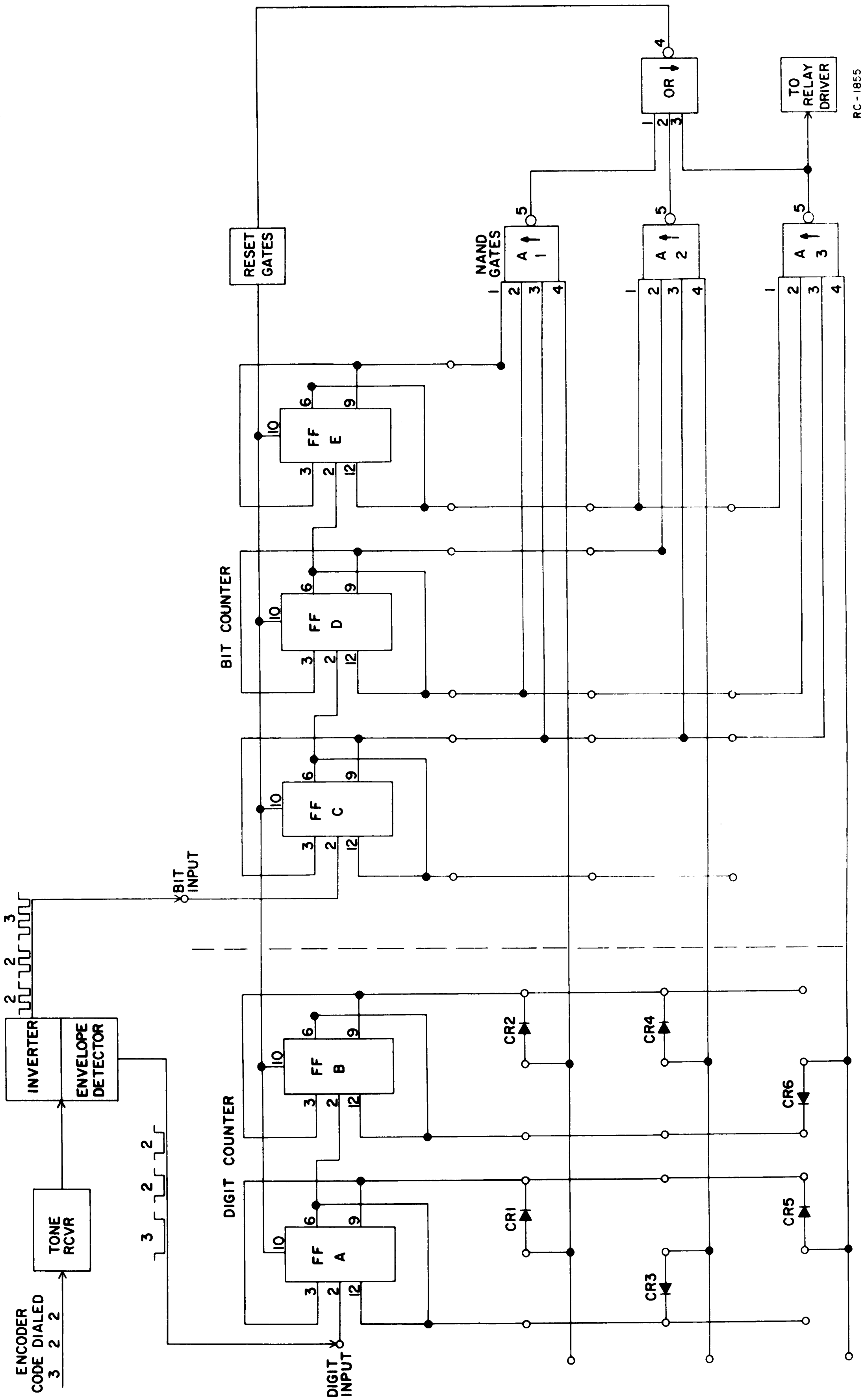



Figure 11 - Simplified Counter and Matrix

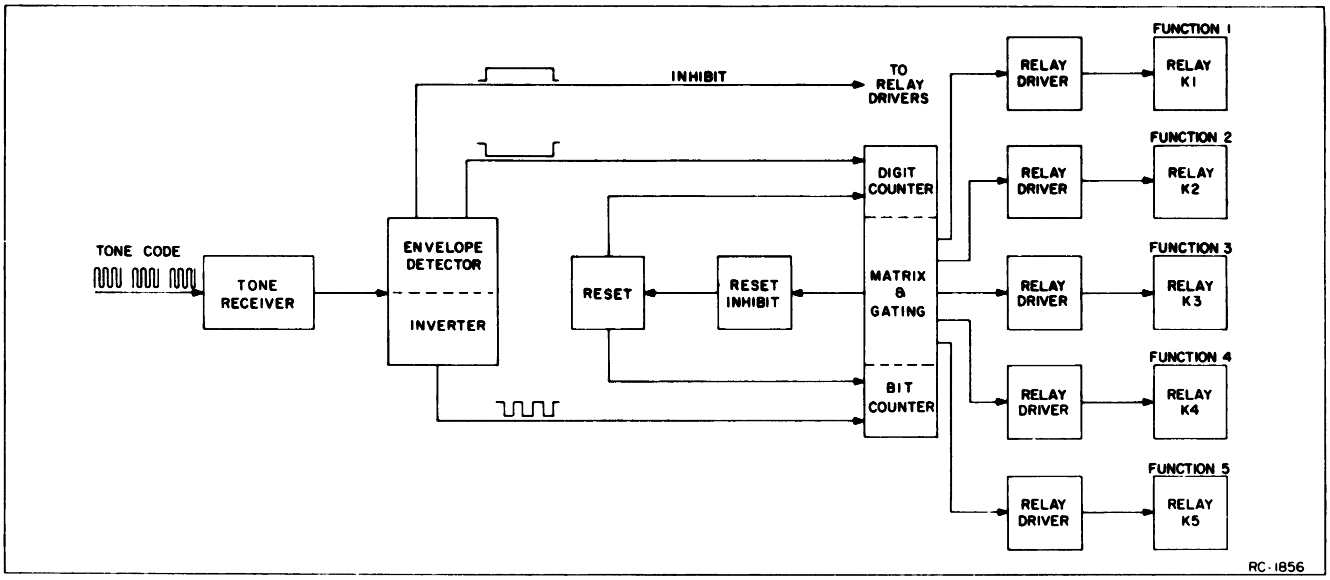



Figure 12 - Decoder Block Diagram

In the digit counter, applying the second digit of the code switches flip-flop A to a "1" at terminal 6 while B remains a "0". This reverse biases CR3 and CR4, removing the ground to input 4 of NAND gate 2. The two pulses applied to the bit counter switch flip-flop C from "0" to "1", and from "1" to "0". The "0" at the trigger of D switches its output from "1" to "0", which switches E to "1". Now all of the inputs to NAND gate 2 are positive, activating the gate. This again activates the OR gate, so that its output goes positive to prevent resetting.

Applying the last digit of the code switches digit counter flip-flop A to "0" and B to "1". This reverse biases CR5 and CR6, removing the ground to input 4 of NAND gate 3. The two pulses applied to the bit counter shifts terminal 6 of flip-flop C from "0" to "1" and from "1" to "0". The "0" output switches D from "0" to "1", and output of E remains a "1". This activates NAND gate 3 and the OR gate to prevent resetting. The negative-going output of the NAND gate also is applied to the Function 1 relay driver on the relay board, energizing the Function 1 relay.

When the tone is removed from the decoder for over 150 milliseconds, the counters reset the remain in the reset condition until tone is applied to the decoder.

## CIRCUIT ANALYSIS

References to symbol numbers mentioned in the following text may be found on the applicable Schematic Diagram, Outline Diagram and Parts List (see Table of Contents).

### DECODER ASSEMBLY

Decoder Assembly A702 consists of a tone receiver board, a pulse routing board and a counter board. A 117-volt AC power supply is added for station applications.

The decoder is fully transistorized, using both discrete components and Integrated Circuit Modules (IC's) for increased reliability. Typical schematic and logic diagrams of the IC's used in the decoder are listed in the Table of Contents.

### TONE RECEIVER

Three different tone receiver boards are available for use in the decoder, depending on the system frequency. The operating frequency of each board is as follows:

- A1701-590 Hz
- A1702-1500 Hz
- A1703-2805 Hz

Each tone receiver board consists of an amplifier-limiter, a tuned circuit, a detector and regulator, and an output switch.

A coded tone from the mobile or station receiver is coupled through DC blocking capacitor C12 to amplifier-limiters Q1 and Q2. A negative feedback path from the collector of Q1 to diode limiters CR3 and CR4 limits the signal applied to the base of Q2. Diodes CR1 and CR2 provide large-signal protection for Q1. The output of Q2 is applied to a tuned circuit consisting of C5/C6, C7/C8/C9 and L1/L2.

When an incorrect tone (or no tone) is applied to the tuned circuit, diode CR5 is forward biased by current through L1/L2. With CR5 conducting, detector Q3 is turned off. This allows diode CR6 to conduct, keeping output switch Q5 turned off.

Applying the correct tone to the tuned circuit increases the impedance of L1/L2, removing the bias on CR5. The diode now conducts only on the positive half-cycles of tone, and is cut off (reverse biased) on the negative half cycles. When a negative half cycle turns CR5 off, Q3 turns on. Turning on Q3 turns off CR6, which forward biases CR7 and CR8 and turns on out put switch Q5. When a positive half cycle turns CR5 on (and Q3 off), C10 starts discharging through R17 and R18, keeping CR6 off and Q5 on. The output of Q5 is a positive pulse for each interruption in the tone code. Q4 acts as a regulator, keeping the emitter voltage of Q3 constant over the temperature range.

In some applications, it may be necessary to drive the decoder from a high impedance source (such as volume high). The tone receiver input impedance may be raised to approximately 50,000 ohms by changing the value of R1 and R2 (on the tone receiver board) to 24,000 ohms. This raises the minimum tone input required from 20 millivolts to 100 millivolts.

## PULSE ROUTING BOARD

The pulse routing board contains the 6-volt regulator, inverters, envelope detector, tone-off reset and reset stages. Multiple input Integrated Circuits, (IC's) are used for the inverters, envelope detectors and reset circuits. Discrete transistors are used for the regulator, tone-off reset stage, and in the envelope detector.

Figure 13 contains a complete set of decoder timing waveforms. It is recommended that these waveforms be used in conjunction with the circuit analysis for a better understanding of the decoder circuitry.

### 6-Volt Regulator

Operating voltage for the decoder is supplied by the 6-volt regulator. +13 volts from the station power supply is applied to the zener diode-emitter follower regulator (CR8 and Q2). The +6-volt, 250-milliamp output is taken from the emitter of Q2.

### 1st Inverter

The output of the tone receiver board is connected to input terminal 1 of the 1st inverter (IC12).

When no tone is applied to the decoder, the output of the tone receiver board is high (positive) and the output of the inverter is low (zero). When tone is first applied the inverter output goes positive. The positive-going pulses (one for each interruption in the tone) from the tone receiver are changed to negative-going pulses by the inverter. These negative-going pulses are applied to the trigger of the first flip-flop in the bit counter.

The inverter output is also applied to the input of the envelope detector and the tone-off reset circuits.

### Envelope Detector

With no tone applied, the zero inverter output is applied to terminal 1 of the envelope detector OR gate, resulting in a positive output.

When tone is first applied to the decoder, the inverter output goes positive. This positive potential is applied to terminal 1 of the OR gate, and also turns on Q1 so that its collector drops to zero. This keeps the OR gate output positive for as long as Q1 conducts. Q1 conducts until C1 is fully charged, and then turns off. This causes the OR gate output to drop to zero.

The first negative-going pulse in the pulse train from the inverter switches the OR gate output to positive, and also causes C1 to rapidly discharge through CR1 and CR2. The trailing edge of the first pulse (now positive-going) turns on Q1, keeping the OR gate output positive. This cycle is repeated until the end of the digit pulse train and results in a positive pulse envelope. The positive output of the envelope detector performs two functions. For one function, the output is inverted by IC13 and the negative-going pulse is applied to the trigger of the first flip-flop in the digit counter. For the second function, the positive inhibit pulse is applied to the relay driver circuits on the relay board. The inhibit pulse prevents the relays with a lower code number from energizing while the counters are counting a higher number code.

### Tone-Off Reset

When tone is first applied, the positive inverter output of the first inverter turns on Q6, and also charges C9 through CR14. Turning on Q6 turns off normally-on transistor Q7 so that its collector goes positive.

The negative-going digit pulses applied to the tone-off reset circuit causes C9 to discharge through R20 and the base-emitter junction of Q6, which keeps Q6 on.

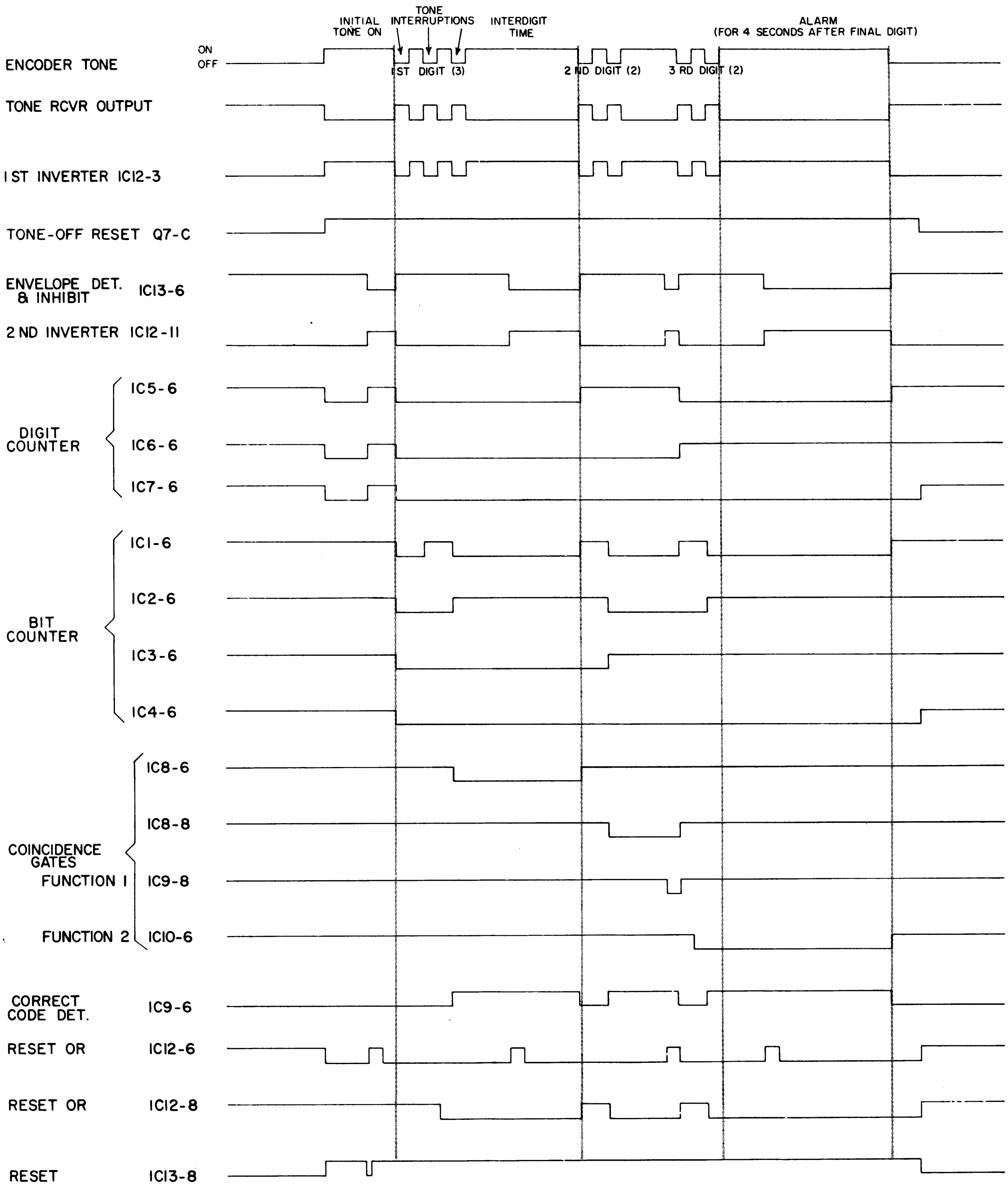



Figure 13 - Decoder Timing Waveforms

RC-1857A

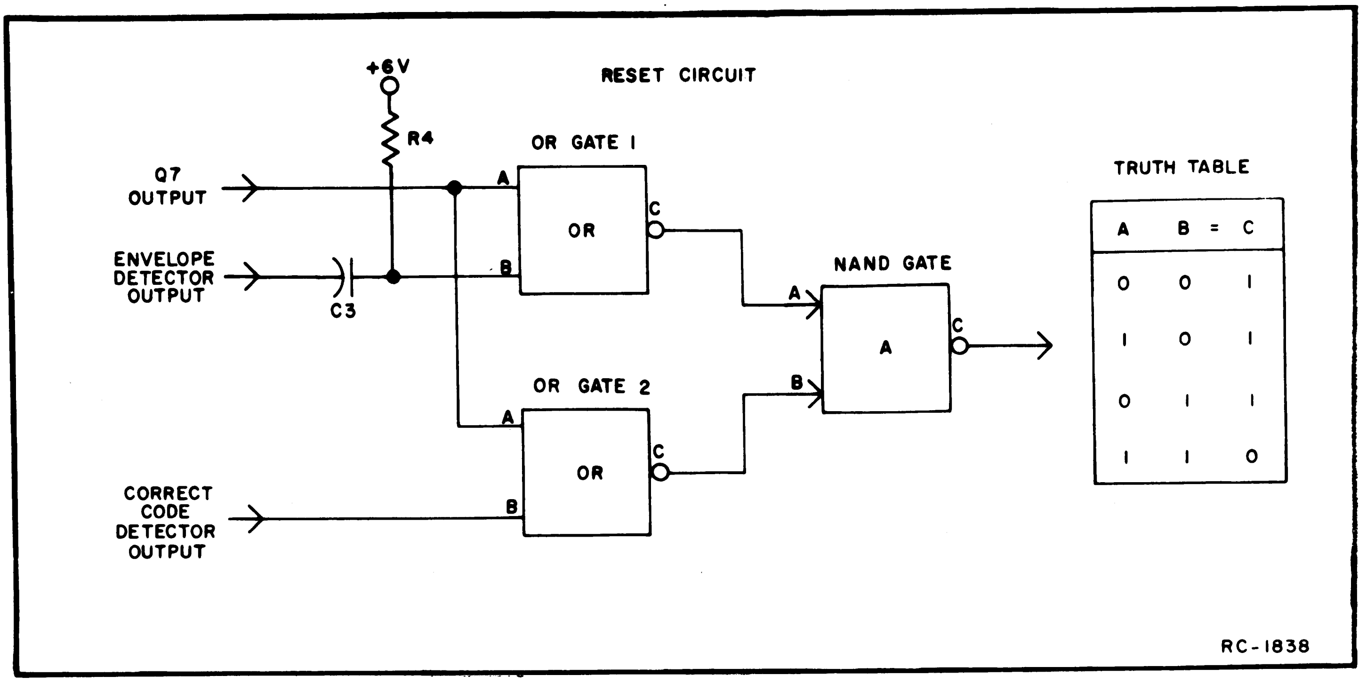



Figure 14 - Reset Circuit

The output of Q7 remains positive until tone is removed from the decoder and C9 discharges. The output of Q7 is applied to the reset circuit.

Reset

The reset circuit consists of two NAND gates utilized as negative OR gates (IC12) driving a NAND gate (IC13). A simplified reset circuit and the truth table for all of the gates is shown in Figure 14. When both OR gate outputs are positive, the NAND gate output goes negative, resetting the counter flip-flops.

With no tone applied to the decoder, input A to each OR gate is at "0", holding the NAND gate in the reset condition.

When tone is applied, the positive output of Q7 keeps terminal A of both OR gates positive. Terminal B of the first OR gate is kept positive through R4, and the output of OR gate is "0". In the second OR gate, terminal A is positive and terminal B is held at "0" by the correct code detector so that the second OR gate output is positive. The zero and positive inputs to the NAND gate keep its output high, preveting the counters from resetting.

At the end of the first digit, a negative pulse from the envelope detector is coupled through C3 to terminal 4 of the OR gate, causing its output to go positive momentarily. At the same time, if a correct code has been applied to the counters, the output of correct code detector (OR gate) goes positive and is applied to terminal B of the second OR gate. Now, the output of the first reset OR gate is positive, and the second OR gate is zero, keeping the NAND gate output positive (no reset).

If an incorrect code is dialed, the correct code detector output remains at zero and both OR gate outputs go positive at the end of the incorrect digit. This switches the NAND gate output to zero, resetting the counters.

COUNTER BOARD

The counter board consists of 11 IC's in the counters and gating circuits. The digit counter consists of three master-slave flip-flops (IC5, IC6 and IC7) whose outputs are connected to the coincidence gates through a discrete diode matrix. The bit counter consists of four master-slave flip-flops (IC1, IC2, IC3 and IC4) whose outputs are connected to the coincidence gate inputs by screws located in the various holes in the counter board. The screws are positioned in holes 1 through 8 on lines A through G according to the code setting information as listed in the Table of Contents.

The decoder Schematic Diagram is shown strapped (by dotted lines in the matrix) for the actual codes set at the factory (5-9-5 for Function 1 through 5-9-9 for Function 5). The Truth Table on the Schematic Diagram shows all possible states of the flip-flop outputs (at terminal 6) while counting.

Assume that the Function 1 code (5-9-5) is dialed at the encoder. When the first digit is received at the decoder, one pulse is applied to the digit counter and five pulses are applied to the bit counter.

The pulse applied to the digit counter switches all of the flip-flops from the reset condition (all "1"s at terminal 6) to a "0" at terminal 6 and a "1" at terminal 9. This back biases diodes CR1, CR2 and CR3, removing the ground on terminal 3 of NAND coincidence gate "A".

The five pulses applied to the bit counter sequentially switches the flip-flop outputs at terminal 6 from the reset condition (all "1"s at terminal 6) at a "0" - "0" - "1" - "0" as shown on line 5 of the Truth Table. Now all of the inputs to coincidence gate "A" are positive, and its output goes to ground. The ground activates the correct code detector OR gate, and its output goes positive. The positive output (reset inhibit) is applied to the reset circuit to prevent the counters from resetting.

When the second digit (9) is applied to the decoder, another pulse is applied to the digit counter and nine pulses are applied to the bit counter.

The pulse applied to the digit counter switches the flip-flops to a "1" - "0" - "1" at terminal 6. This back biases CR4, CR5 and CR6, removing the ground on terminal 11 of coincidence gate "B".

The nine pulses applied to the bit counter switches the flip-flop outputs at terminal 6 to a "1" - "0" - "1" - "1" as shown on line 14 of the Truth Table. Now all of the inputs to coincidence gate "B" are positive, and its output goes to ground. This activates the correct code detector and its output goes positive. The positive reset inhibit is applied to the reset circuit to prevent the counters from resetting.

Applying the third digit (5) to the decoder applies one more pulse to the digit counter and 5 more pulses to the bit counter.

The pulse applied to the digit counter switches the flip-flops to "0" - "1" - "0" at terminal 6. This back biases CR7, CR8 and CR9, removing the ground on terminal 11 of coincidence gate "C".

The five pulses applied to the bit counter switches the flip-flops to "0" - "1" - "0" - "0" at terminal 6 as shown on line 3 of the Truth Table. Note that after the counter counts 16 bits, it recycles (i.e., starts counting over again from the first link on the Truth Table. Now all of the inputs to coincidence gate "C" are positive. The output of the coincidence gate goes to ground, activating the correct code detector. The ground is also applied to the base of relay driver Q1 on the relay board, which energizes the Function 1 relay (K1).

Dialing the Function 2 code (5-9-6) activates coincidence gates "A", "B" and "D" in that order, causing the Function 2 relay to be energized. The remaining relays are energized by dialing the proper code to activate coincidence gates "A" and "B", and then gates "E", "F" or "G".

## RELAY BOARD

Standard relay board consists of five relay driver circuits, five relay sockets, two relays (for Functions 1 and 5), and a lockup-release circuit. Optional relays are available for Functions 2, 3 and 4.

The relay board is shipped from the factory strapped so that the Function 1 through Function 4 relays (K1-K4) will operate individually and in any sequence. The operated relays will remain locked up until the Function 5 relay (K5) is operated.

Each relay provides one set of form A, one set of form B and one set of form C contacts that are connected by the panel wiring harness to terminals on TB701 through TB704. However, as the standard relays have three sets of form C contacts available, the standard contact configuration may be changed as desired by simply changing the wiring connections to the relay contact jacks.

### RELAY DRIVERS

Relay driver transistors Q1 through Q10 are controlled by coincidence gates "C" through "G" on the decoder counter board, with the output of gates "C" through "G" connected to the base of transistors Q1 through Q5 respectively. Because all of the driver circuits operate in the same manner, only the Function 1 and Function 5 circuits will be described.

Applying the Function 1 code to the decoder assembly activates coincidence gate "C", causing its output to momentarily drop to ground potential. This turns on PNP transistor Q1, which turns on Q6, energizing relay K1. When energized, the relay locks up through its normally-open contacts (K1-12 and -13). When tone is removed from the decoder, the output of coincidence gate "C" goes positive, turning off driver transistors Q1 and Q6. Relay K1 remains locked up until the Function 5 relay is energized.

Applying the Function 5 code to the decoder momentarily activates coincidence gate "G" which turns on driver transistors Q5 and Q10. This momentarily energizes relay K5 (which is not connected to lockup), and opens the normally closed contacts K5-11 and -12. Opening the contacts removes the ground to relay K1 (and all locked-up relays), releasing the relay(s).

INHIBIT CIRCUIT

The inhibit circuitry prevents the function relays with lower code numbers from being energized when a function relay with a higher code number is dialed. This is accomplished by applying a positive inhibit voltage from the envelope detector to the anodes of diodes CR3 through CR7 during the time a digit is being counted (see Figure 13).

Assume that the Function 1 code is 5-9-5, the Function 2 code is 5-9-6, and the Function 2 code has been dialed. On the last digit of the code, six pulses are applied to the bit counter (and one pulse to the digit counter). At the instant the fifth pulse in the last digit is counted, all conditions for the 5-9-5 have been met. This activates coincidence gate "C",and its output momentarily drops to ground which would normally energize the Function 1 relay. However, the positive inhibit voltage keep diodes CR3 through CR7 forward biased, which keeps driver transistors Q1 through Q5 from turning on.

After the sixth pulse is counted, coincidence gate "D" is activated and its output drops to ground. With the digit count completed, the inhibit pulse is removed, allowing the Function 2 relay to energize.

LOCKUP-RELEASE CIRCUIT

The lockup-release circuit consists of diodes CR13 through CR24, transistor Q11, and resistors R17 and R18. The circuit is used only when the relay board is strapped for individual relay operation where the operation of any relay releases any previously-operated relay. Strapping instructions for individual relay operation are contained in the Relay Strapping Procedure (see Table of Contents).

The strapping for this type of operation consists of removing the standard jumpers connecting contact 12 on all of the relays to ground (through K5-11 and -12), and connecting contact 12 to the collector circuit of Q11 (at H174 through H178). Q11 is normally on with its collector near ground potential. This provides the ground return for locking up the relays.

Assume that the Function 1 and Function 2 relays are connected as described, and that the Function 2 relay is locked up. Dialing the Function 1 code momentarily turns on relay drivers Q1 and Q6. The collector of Q6 drops to near ground potential, energizing relay K1. This ground is connected through CR18 to the base of Q11, turning the transistor off. When turned off, the collector of Q11 is not at ground, releasing the Function 2 relay (K2).

When tone is removed from the decoder, Q6 turns off. Q11 turns on very quickly (before K1 can drop out), keeping the relay locked up.

AC POWER SUPPLY

An optional 117-volt AC, 50/60 Hz power supply is available for supplying the decoder panel when the panel is used in other than MASTR Progress Line base stations.

Connecting P501 to a voltage source applied 117 volts to the primary of step-down transformer T501. The AC voltage developed across the secondary windings of T501 is rectified by full-wave bridge rectifiers CR1 through CR4. The rectified output is filtered by C501 and R501, and the 13-volt output is applied to the 6-volt regulator circuit on the pulse routing board.

## MAINTENANCE

DISASSEMBLY

To gain access to the decoder counter board, remove the four #6 screws in the decoder front cover plate and remove the cover plate.

To gain access to the tone receiver and pulse routing boards, remove the two #6 screws in the decoder rear cover plate and remove the plate for access to the tone receiver board. Next, remove the single screw in one end of the hinged tone receiver board and swing the board out.

TROUBLESHOOTING

Procedures for troubleshooting the decoder include DC readings and waveforms for the tone receiver, pulse routing and counter boards. Refer to the Troubleshooting Procedure as listed in the Table of Contents.

TONE RECEIVER ADJUSTMENT

Coil L1/L2 on the tone receiver board is the only adjustment on the decoder panel. This coil is set at the factory and will normally require no further adjustment unless it is necessary to replace L1/L2, C5/C6 or C7/C8/C9. If any of these components are replaced, adjust L1/L2 as follows:

1. Connect a VTVM across C5/C6 or C7/C8/C9.
2. Apply a continuous tone to the decoder at the proper operating frequency (590-Hz, 1500-Hz or 2805-Hz).
3. Tune L1/L2 for maximum meter reading.

The relays may be strapped for different methods of operation, depending on the control function desired. The procedure consists of adding jumpers to the numbered holes on relay board A701, depending on the method selected. Three of the strapping procedures are as follows:

NOTE

Before adding new jumpers, make sure that all previous jumper connections have been removed (see Tables I, II and III).

MULTIPLE LOCK-UP

The decoder panel is shipped from the factory strapped for this method of operation. The locking path for relays K1 through K4 is connected to ground through the normally-closed contacts of relay K5. Relays K1 through K4 may be locked up individually and in any sequence. Dialing the Function 5 code momentarily energizes K5 (approximately four seconds), releasing all locked up relays. The multiple lock-up jumper connections are shown in Table I.

Table I

| From | To |
|---|---|
| H5 | H21 |
| H21 | H38 |
| H38 | H54 |
| H54 | H70 |
| H71 | H189 |

EXCLUSIVE LOCK-UP

When strapped for this method of operation, the locking path for all of relays is controlled by the operation of transistor Q11. Relays K1 through K5 may be operated individually and in any sequence. The operation of any relay releases any previously operated relay so that only one relay may be locked up at a time. The exclusive lock-up connections are shown in Table II.

Table II

| From | To |
|---|---|
| H5 | H174 |
| H21 | H175 |
| H38 | H176 |
| H54 | H177 |
| H71 | H178 |
| H72 | H190 |

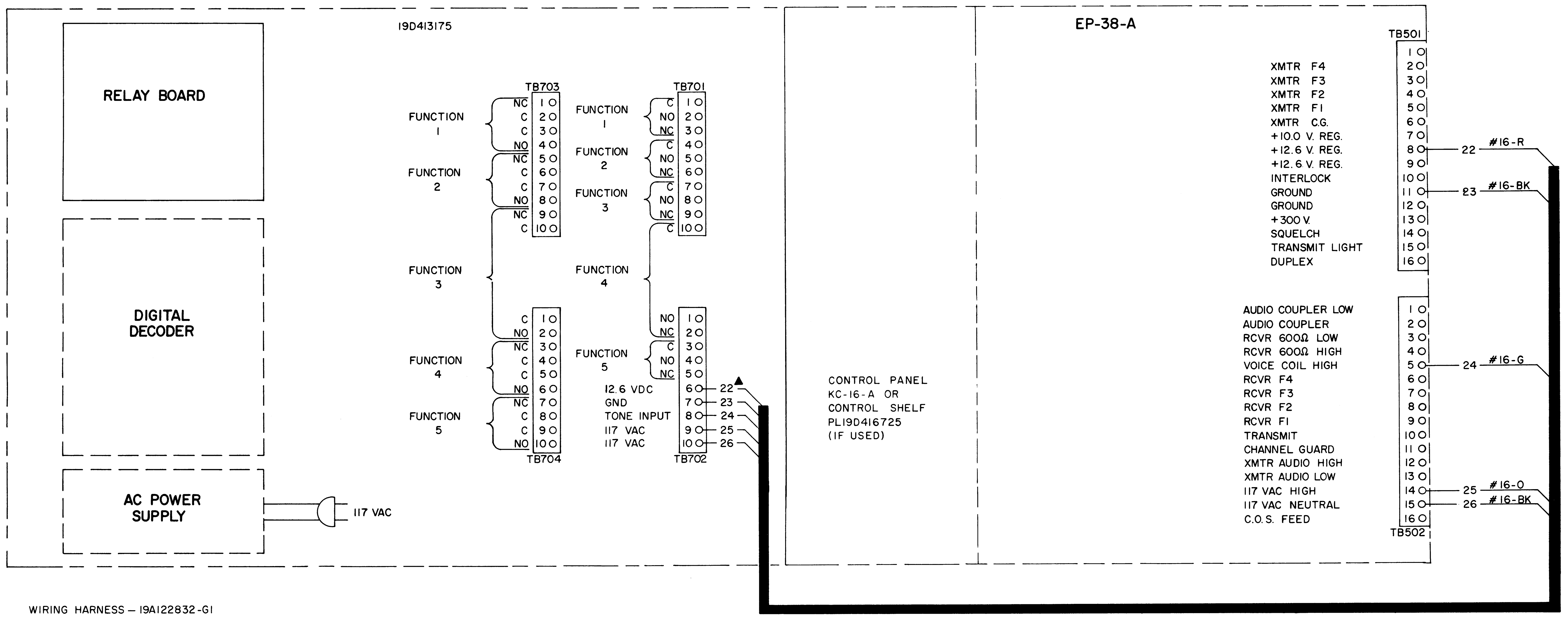
SEQUENTIAL DROP-OUT

When strapped for this method of operation, the locking path of the lower numbered relay is connected through the normally closed contacts of the higher numbered relays. Relays K1 through K4 may be operated individually in any sequence. However, operating a higher numbered relay releases any locked-up lower numbered relay so that only one relay may be locked up at a time.

Any relay that has been released by the operation of a higher numbered relay may be energized momentarily (approximately four seconds) by dialing the appropriate code.

Table III

| From | To |
|---|---|
| H5 | H20 |
| H21 | H37 |
| H38 | H53 |
| H54 | H70 |
| H71 | H189 |




WIRING HARNESS — 19A122832-G1

NOTE. 1. TERMINATE WIRES WITH TERMINAL 19B209260-P4.

2. HARNESS TO BE CONSTRUCTED IN SUCH A WAY AS TO ALLOW ENOUGH SLACK TO PERMIT MOUNTING PANELS TOTALING 15.75 BETWEEN EP-38-A & DECODER PANEL 19D413175.

▲ REMOVE WIRE NO.22 FROM TB702-6 WHEN AC POWER SUPPLY IS USED.

(19D413181, Rev. 3)

## INTERCONNECTION DIAGRAM

FIVE-FUNCTION DIGITAL DECODER PANEL
MODELS 4EJ18C10-12

# CODE SETTING

## 1-DIGIT DROP-OUT

When the counter board is modified for one digit drop-out, dialing a single number releases all locked-up relays. It is recommended that a higher number be used to minimize falsing (i.e., 7,8,9, or 0).

> **NOTE**
>
> The number used for the one digit drop-out code cannot be used in any other code.

PROCEDURE:

1. If the decoder is strapped for three-digit codes, move CR20 to the dotted position (see Figure 15). If the decoder is strapped for two-digit codes, move CR19 to the dotted position.
2. Write a "G" beside the number selected in the column below. The number used in the example is a 0 (must be counted as a 10).
3. Read the screw positions for the selected number, and move the four screws to their proper position in line G.

| CODE NUMBER | SCREW POSITIONS |
|---|---|
| 1 | 2 4 6 8 |
| 2 | 1 4 6 8 |
| 3 | 2 3 6 8 |
| 4 | 1 3 6 8 |
| 5 | 2 4 5 8 |
| 6 | 1 4 5 8 |
| 7 | 2 3 5 8 |
| 8 | 1 3 5 8 |
| 9 | 2 4 6 7 |

EXAMPLE: G----(10)----------(1 4 6 7)

## CODE SETTING PROCEDURE

FIVE-FUNCTION DIGITAL DECODER PANEL
MODELS 4EJ18C10-12

## 2-DIGIT CODES

Set the codes according to the following procedure:

1. Connect a jumper from H31 to H32 (see Figure 15).
2. Move diodes CR7, CR8, CR10, CR11, CR13, CR14, CR16, CR17, CR19 and CR20 to the dotted positions shown in Figure 15.
3. The codes used as examples are:

FUNCTION 1 - 55
FUNCTION 2 - 56
FUNCTION 3 - 57
FUNCTION 4 - 58
FUNCTION 5 - 59

1. Write the complete codes in boxes below. (The first digit of each code must be the same).

FUNCTION CODES

| | |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

EXAMPLE

FUNCTION CODES

| | |
|---|---|
| 1 | 55 |
| 2 | 56 |
| 3 | 57 |
| 4 | 58 |
| 5 | 59 |

2. Place the first digit beside the letter A in the column of letters below. Next add second digit to the first and put this sum beside C. Add the second digit of each of the other 4 codes to A and place these sums beside D through G respectively.

NOTE: Zero on the telephone dial actually provides 10 pulses. When a zero appears in a code number, it must be added as a 10.

EXAMPLE

FUNCTION 1 CODE
```
A      First Digit
 + ___ Second Digit
C ___  Total
```

FUNCTION 1
```
     55
A    5     First Digit
    +5     Second Digit
C   10     Total
```

FUNCTION 2 CODE
```
A      First Digit
 + ___ Second Digit
D ___  Total
```

FUNCTION 2
```
     56
A    5     First Digit
    +6     Second Digit
D   11     Total
```

FUNCTION 3 CODE
```
A      First Digit
 + ___ Second Digit
E ___  Total
```

FUNCTION 3
```
     57
A    5     First Digit
    +7     Second Digit
E   12     Total
```

FUNCTION 4 CODE
```
A      First Digit
 + ___ Second Digit
F ___  Total
```

FUNCTION 4
```
     58
A    5     First Digit
    +8     Second Digit
F   13     Total
```

FUNCTION 5 CODE
```
A      First Digit
 + ___ Second Digit
G ___  Total
```

FUNCTION 5
```
     59
A    5     First Digit
    +9     Second Digit
G   14     Total
```

3. Write each letter beside its corresponding subtotal in the columns at right.
4. Read the screw positions for each subtotal and move the four screws for each letter to their proper positions.

| LETTERS | SUBTOTALS | SCREW POSITIONS |
|---|---|---|
| | 1 | 2 4 6 8 |
| | 2 | 1 4 6 8 |
| | 3 | 2 3 6 8 |
| | 4 | 1 3 6 8 |
| A | (5) | (2 4 5 8) |
| | 6 | 1 4 5 8 |
| | 7 | 2 3 5 8 |
| | 8 | 1 3 5 8 |
| | 9 | 2 4 6 7 |
| C | (10) | (1 4 6 7) |
| D | (11) | (2 3 6 7) |
| E | (12) | (1 3 6 7) |
| F | (13) | (2 4 5 7) |
| G | (14) | (1 4 5 7) |
| | 15 | 2 3 5 7 |
| | 16 | 1 3 5 7 |
| | 17 | 2 4 6 8 |
| | 18 | 1 4 6 8 |
| | 19 | 2 3 6 8 |
| | 20 | 1 3 6 8 |

## 3-DIGIT CODES

Set the codes according to the following procedure. The codes used as examples in this procedure are:

FUNCTION 1 - 595
FUNCTION 2 - 596
FUNCTION 3 - 597
FUNCTION 4 - 598
FUNCTION 5 - 599

1. Write the complete codes in the boxes below. (The first 2 digits of each code must be the same).

FUNCTION CODES

| | |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

EXAMPLE

FUNCTION CODES

| | |
|---|---|
| 1 | 595 |
| 2 | 596 |
| 3 | 597 |
| 4 | 598 |
| 5 | 599 |

2. Place the first digit beside the letter A in the column of letters below. Next, add the second digit to the first and put this sum beside B. Add the third digit of the first code to figure placed at B, and place this sum at C. Add the 3rd digit of each of the other 4 codes to B and place these sums beside D through G respectively.

NOTE: Zero on the telephone dial actually provides 10 pulses. When a zero appears in a code number, it must be added as a 10.

EXAMPLE

FUNCTION 1
```
A       First Digit
 + ___  Second Digit
B       Subtotal
 + ___  Third Digit
C ___   Total
```

FUNCTION 1
```
     595
A    5     First Digit
    +9     Second Digit
B   14     Subtotal
    +5     Third Digit
C   19     Total
```

FUNCTION 2
```
A       First Digit
 + ___  Second Digit
B       Subtotal
 + ___  Third Digit
D ___   Total
```

FUNCTION 2
```
     596
A    5     First Digit
    +9     Second Digit
B   14     Subtotal
    +6     Third Digit
D   20     Total
```

FUNCTION 3
```
A       First Digit
 + ___  Second Digit
B       Subtotal
 + ___  Third Digit
E ___   Total
```

FUNCTION 3
```
     597
A    5     First Digit
    +9     Second Digit
B   14     Subtotal
    +7     Third Digit
E   21     Total
```

FUNCTION 4
```
A       First Digit
 + ___  Second Digit
B       Subtotal
 + ___  Third Digit
F ___   Total
```

FUNCTION 4
```
     598
A    5     First Digit
    +9     Second Digit
B   14     Subtotal
    +8     Third Digit
F   22     Total
```

FUNCTION 5
```
A       First Digit
 + ___  Second Digit
B       Subtotal
 + ___  Third Digit
G ___   Total
```

FUNCTION 5
```
     599
A    5     First Digit
    +9     Second Digit
B   14     Subtotal
    +9     Third Digit
G   23     Total
```

3. Write each letter beside its corresponding subtotal in the columns at right.
4. Read the screw positions for each subtotal and move the four screws for each letter to their proper positions.

| LETTERS | SUBTOTALS | SCREW POSITIONS |
|---|---|---|
| | 1 | 2 4 6 8 |
| | 2 | 1 4 6 8 |
| | 3 | 2 3 6 8 |
| | 4 | 1 3 6 8 |
| A | (5) | (2 4 5 8) |
| | 6 | 1 4 5 8 |
| | 7 | 2 3 5 8 |
| | 8 | 1 3 5 8 |
| | 9 | 2 4 6 7 |
| | 10 | 1 4 6 7 |
| | 11 | 2 3 6 7 |
| | 12 | 1 3 6 7 |
| | 13 | 2 4 5 7 |
| B | (14) | (1 4 5 7) |
| | 15 | 2 3 5 7 |
| | 16 | 1 3 5 7 |
| | 17 | 2 4 6 8 |
| | 18 | 1 4 6 8 |
| C | (19) | (2 3 6 8) |
| D | (20) | (1 3 6 8) |
| E | (21) | (2 4 5 8) |
| F | (22) | (1 4 5 8) |
| G | (23) | (2 3 5 8) |
| | 24 | 1 3 5 8 |
| | 25 | 2 4 6 7 |
| | 26 | 1 4 6 7 |
| | 27 | 2 3 6 7 |
| | 28 | 1 3 6 7 |
| | 29 | 2 4 5 7 |
| | 30 | 1 4 5 7 |

> **NOTE**
>
> The letters A through G used in the Code Setting Procedure correspond to a line of screw positions on The Counter Board. The numerals 1 through 8 represent the position of each screw in the selected screw line.

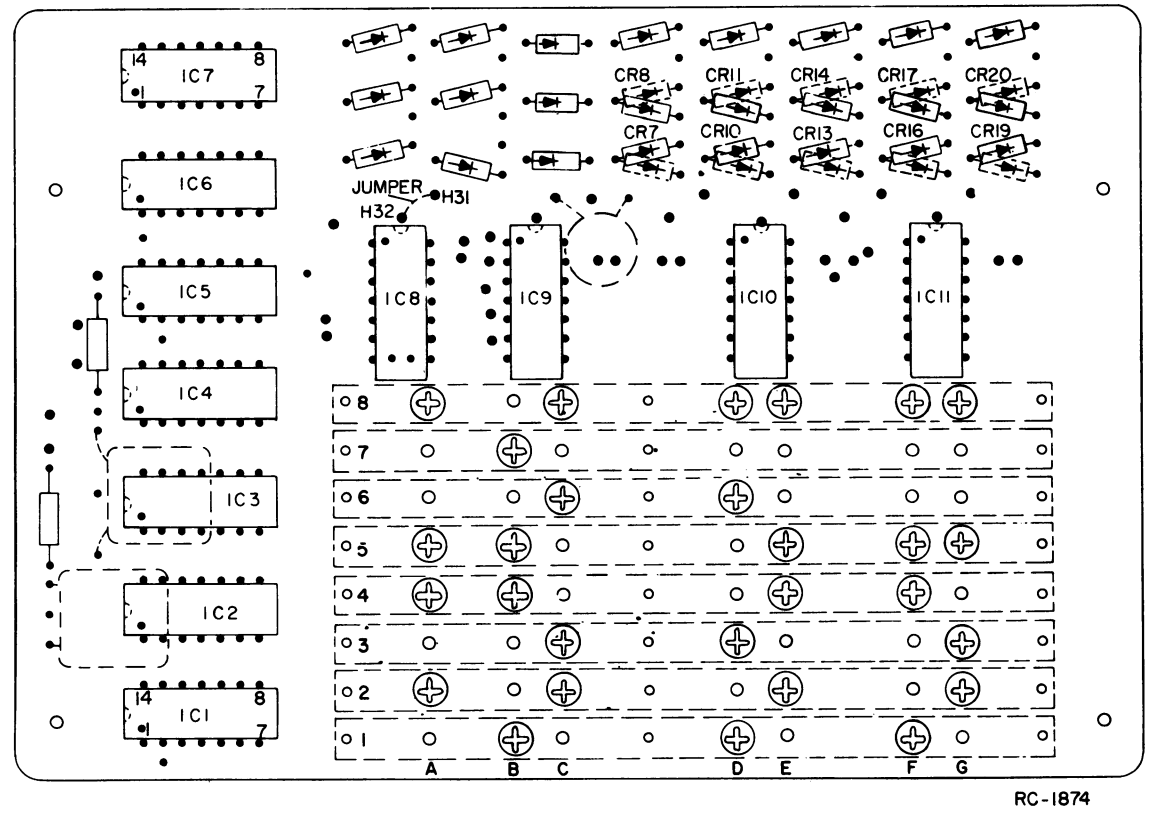
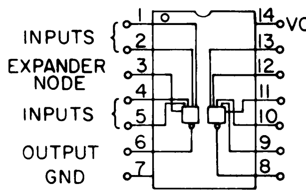
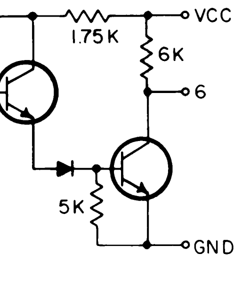



Figure 15 - Counter Board

## DUAL 4-INPUT GATES
19A115913-P1

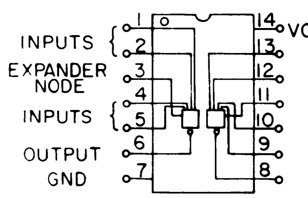



LOGIC DIAGRAM

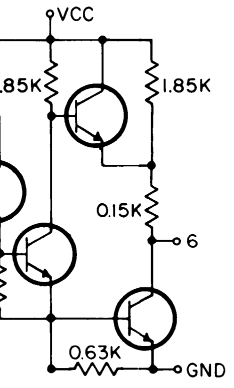



TYPICAL SCHEMATIC DIAGRAM
(ONE GATE ONLY)

## DUAL 4-INPUT BUFFERED GATES
19A115913-P3

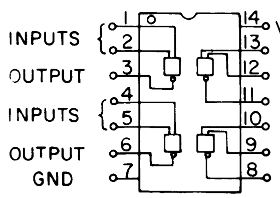



LOGIC DIAGRAM

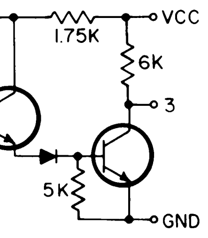



TYPICAL SCHEMATIC DIAGRAM
(ONE GATE ONLY)

## QUADRUPLE 2-INPUT GATES
19A115913-P7

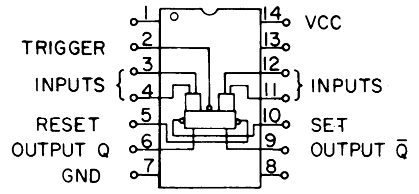



LOGIC DIAGRAM

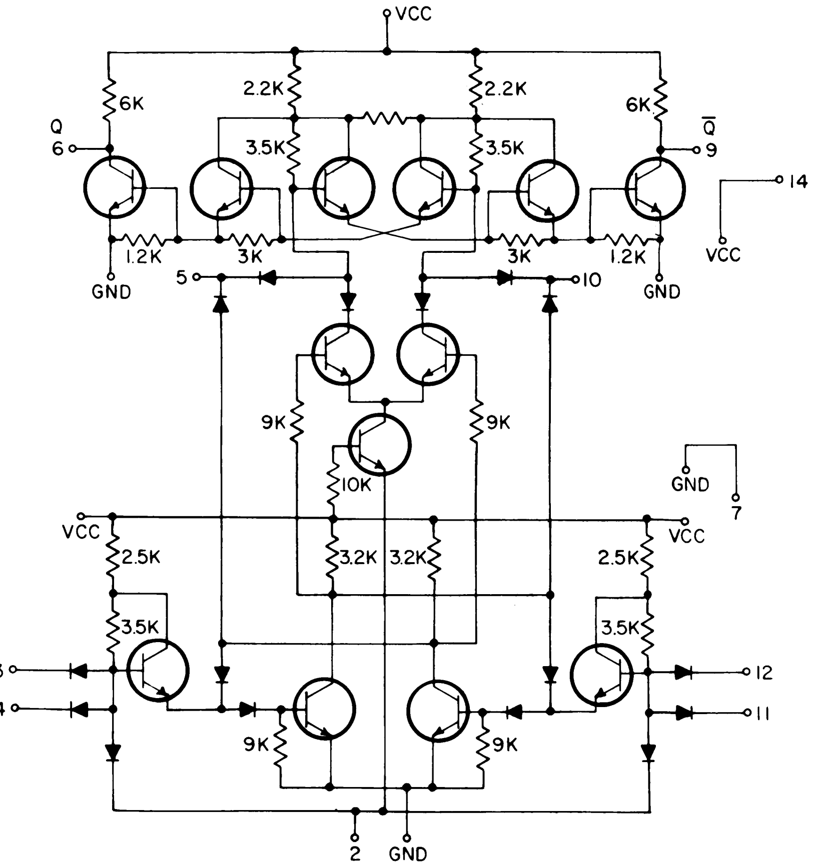



TYPICAL SCHEMATIC DIAGRAM
(ONE GATE ONLY)

## MASTER-SLAVE FLIP-FLOP
19A115913-P6




LOGIC DIAGRAM



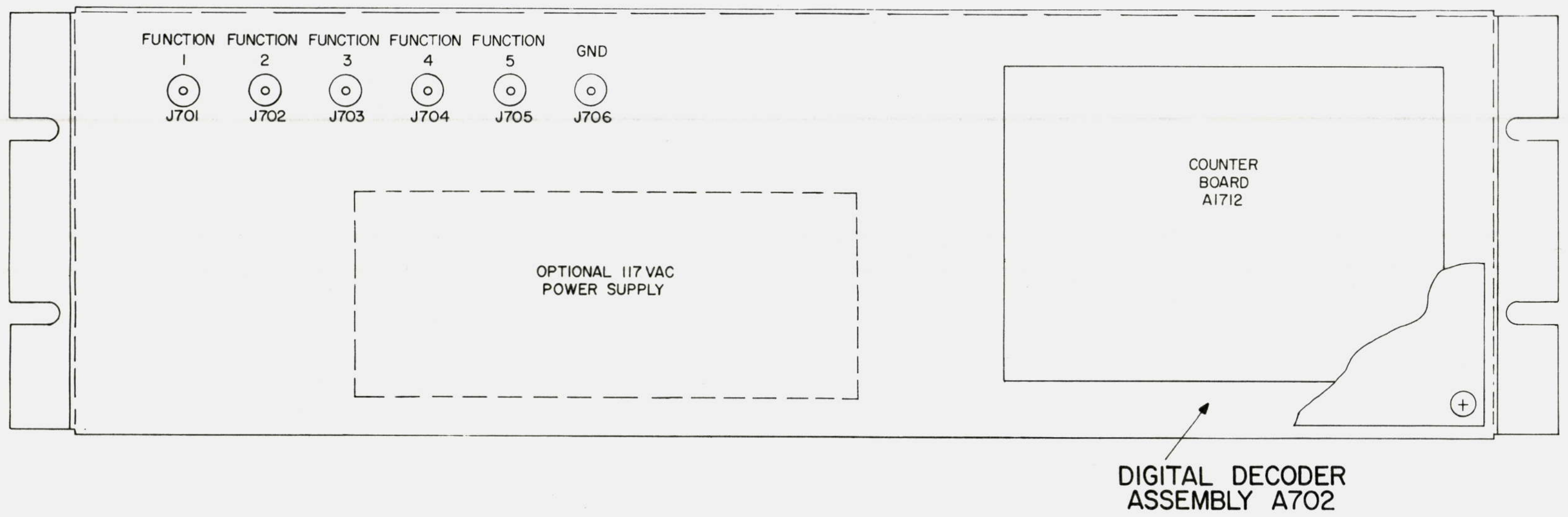

(RC-1837)

TYPICAL SCHEMATIC DIAGRAM

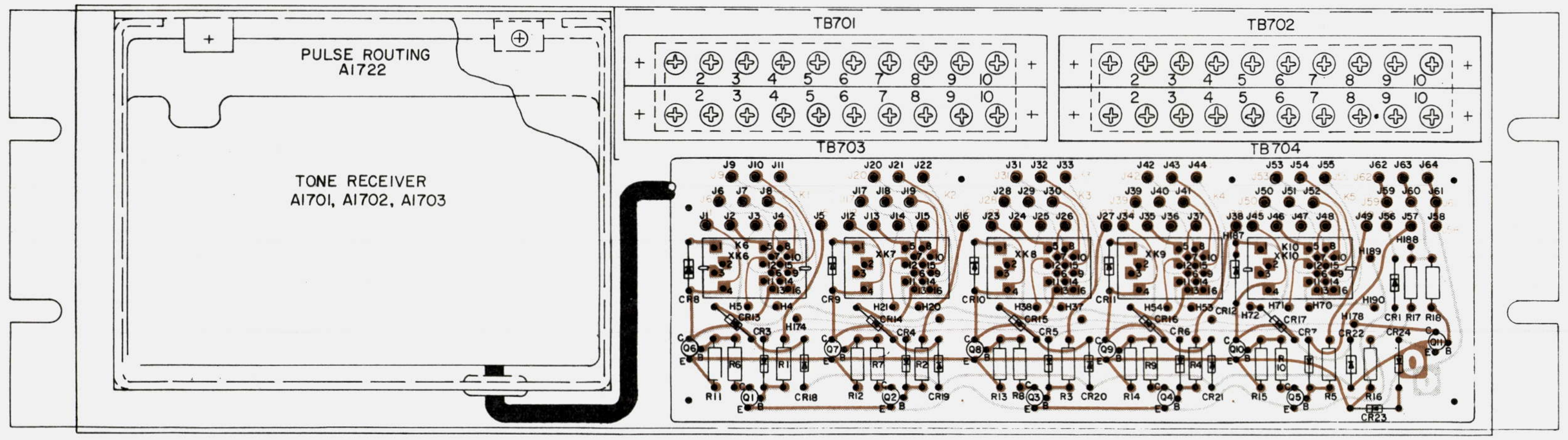
# TYPICAL LOGIC & SCHEMATIC DIAGRAMS

FOR INTERGRATED CIRCUIT MODULES
FIVE-FUNCTION DIGITAL DECODER MODELS 4EJ18C10-12

FRONT VIEW



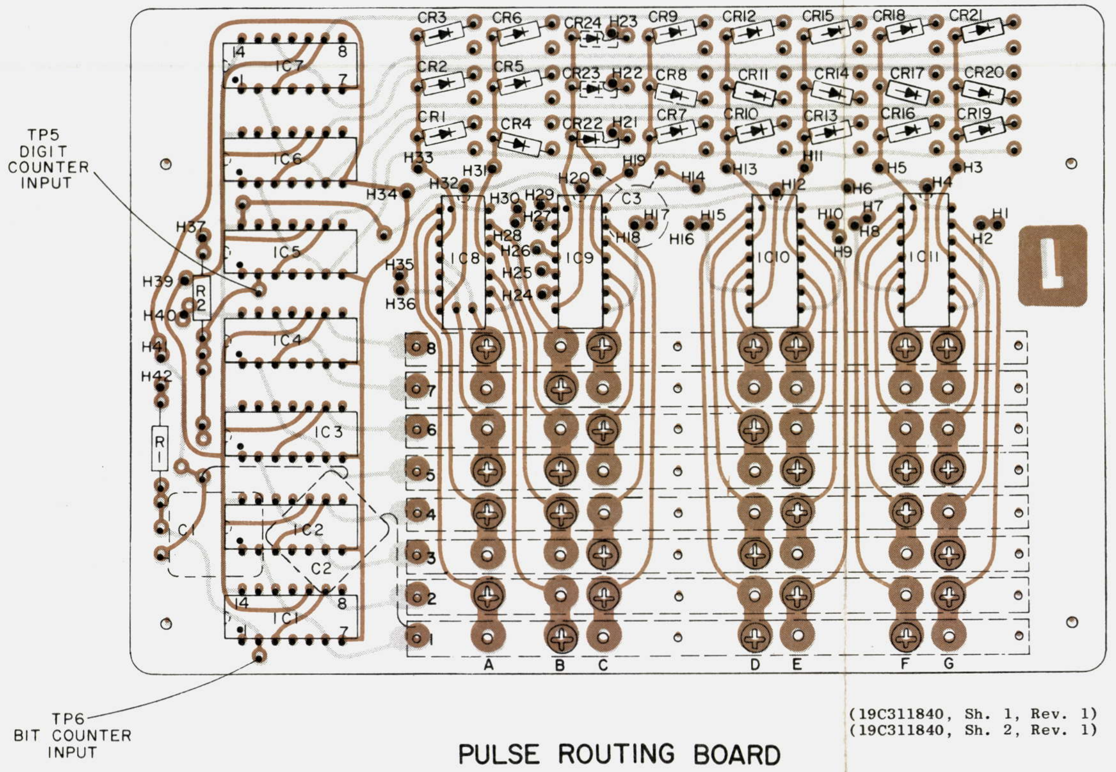

REAR VIEW




RELAY BOARD
A701

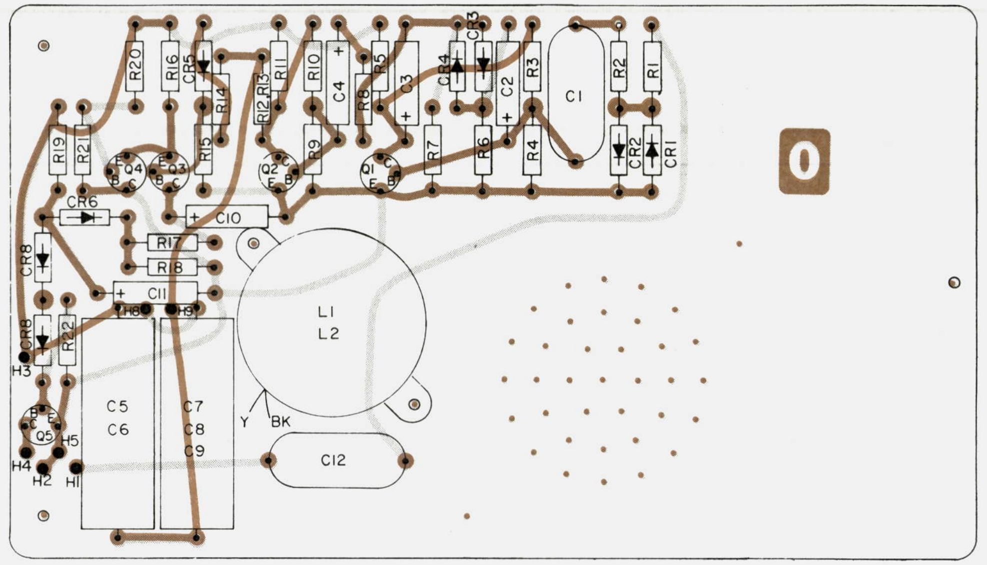
(19D416025, Sh. 1, Rev. 0)
(19D416025, Sh. 2, Rev. 0)

COUNTER BOARD
A1712



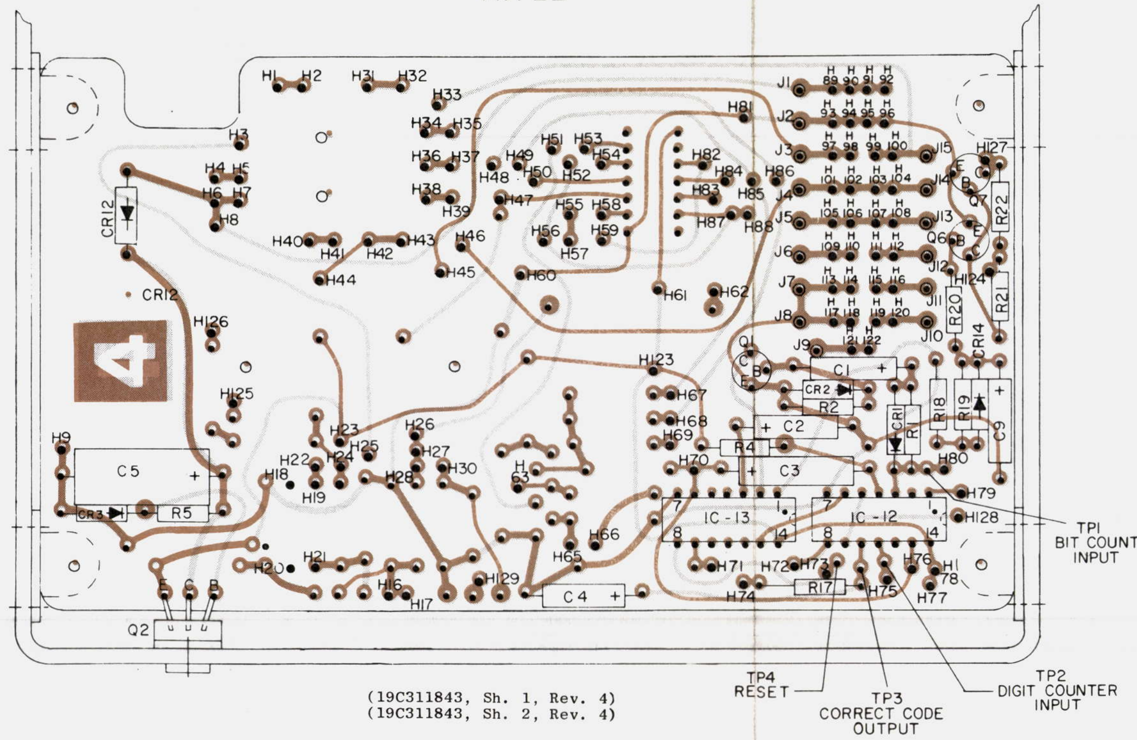

(19C311840, Sh. 1, Rev. 1)
(19C311840, Sh. 2, Rev. 1)

TONE RECEIVER BOARD
A1701, A1702 & A1703



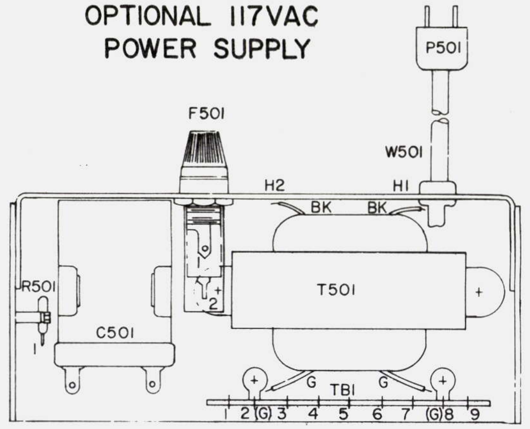

(19C311847, Sh. 1, Rev. 0)
(19C311847, Sh. 2, Rev. 0)

PULSE ROUTING BOARD
A1722

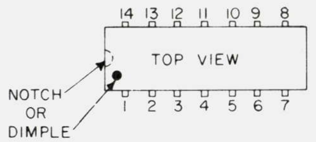



(19C311843, Sh. 1, Rev. 4)
(19C311843, Sh. 2, Rev. 4)

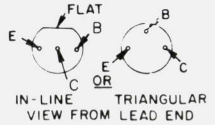
OPTIONAL 117VAC
POWER SUPPLY




INTEGRATED CIRCUIT
LEAD IDENTIFICATION

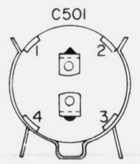



TRANSISTOR
LEAD IDENTIFICATION

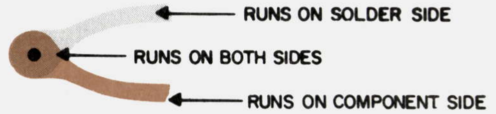



NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

TERMINAL VIEW



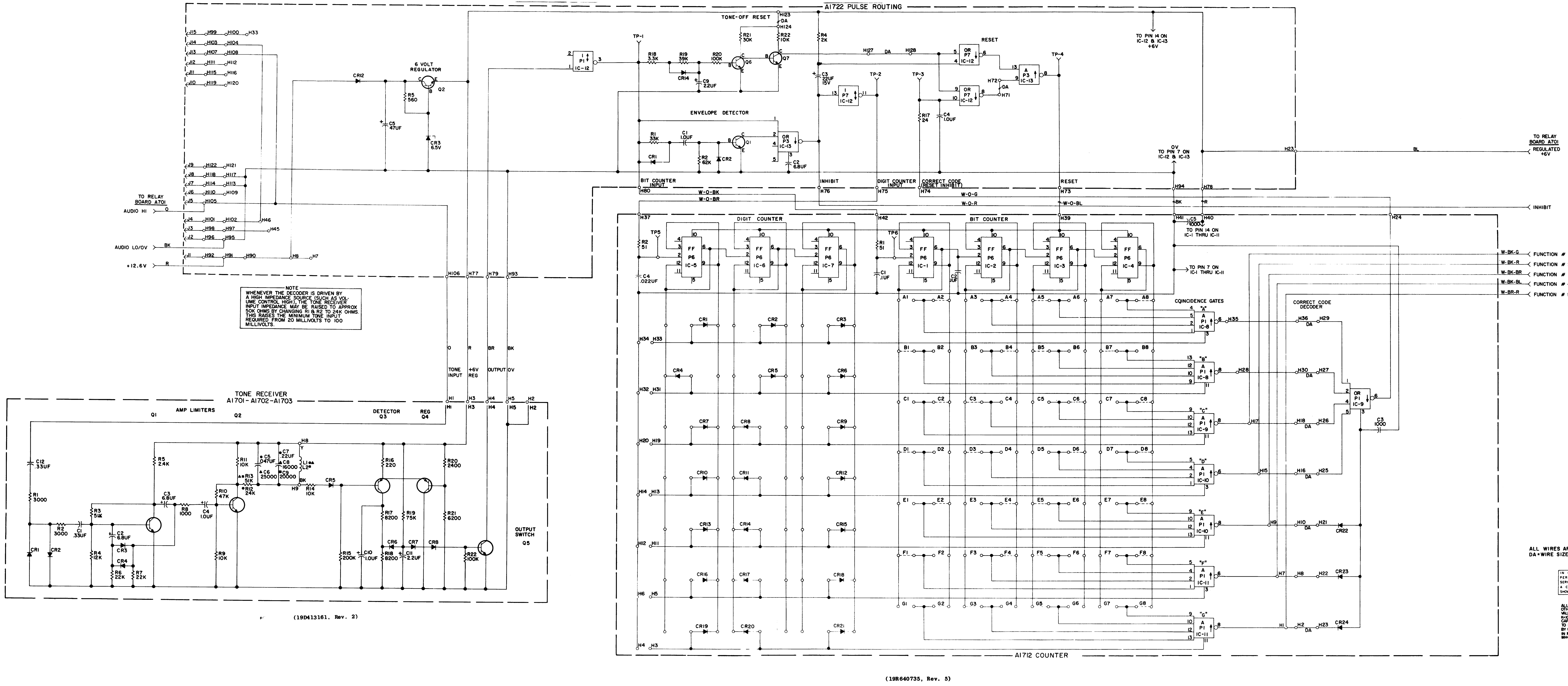

(19R621754, Rev. 0)




# OUTLINE DIAGRAM

FIVE-FUNCTION DIGITAL DECODER PANEL
MODELS 4EJ18C10-12

(DF-5036)




## TRUTH TABLES

THE TRUTH TABLES SHOW THE STATE OF THE FLIP-FLOPS AT TERMINAL 6 OF THE DIGIT AND BIT COUNTERS. IN THE TRUTH TABLES, A "1" INDICATES A VOLTAGE OF FROM +3 TO +6 VOLTS, AND A "0" INDICATES A VOLTAGE OF 0.5 VOLT OR LESS.

BIT COUNTER

| | | | | |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | |
| 1 | 0 | 0 | 0 | |
| 0 | 1 | 0 | 0 | |
| 1 | 1 | 0 | 0 | |
| 0 | 0 | 1 | 0 | |
| 1 | 0 | 1 | 0 | |
| 0 | 1 | 1 | 0 | |
| 1 | 1 | 1 | 0 | |
| 0 | 0 | 0 | 1 | |
| 1 | 0 | 0 | 1 | |
| 0 | 1 | 0 | 1 | |
| 1 | 1 | 0 | 1 | |
| 0 | 0 | 1 | 1 | |
| 1 | 0 | 1 | 1 | |
| 0 | 1 | 1 | 1 | |
| 1 | 1 | 1 | 1 | ← RESET |

DIGIT COUNTER

| | | | | |
|---|---|---|---|---|
| | 0 | 0 | 0 | |
| | 1 | 0 | 0 | |
| | 0 | 1 | 0 | |
| | 1 | 1 | 0 | |
| | 0 | 0 | 1 | |
| | 1 | 0 | 1 | |
| | 0 | 1 | 1 | |
| RESET → | 1 | 1 | 1 | |

RC-1930

ALL WIRES ARE SF-24 UNLESS OTHERWISE SPECIFIED.
DA = WIRE SIZE # 22 AWG.

IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG = 1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF = MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH = MILLIHENRYS OR H = HENRYS.

SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER.

| THIS ELEM DIAG APPLIES TO | |
|---|---|
| MODEL NO | REV LETTER |
| PL19D413162G2 | B |

# SCHEMATIC DIAGRAM

FIVE-FUNCTION DIGITAL DECODER PANEL
MODELS 4EJ18C10-12

## PARTS LIST

LBI-4037D

5 FUNCTION DECODER PANEL
MODELS 4EJ18C10-12

| SYMBOL | GE PART NO. | DESCRIPTION |
|---|---|---|
| | | DECODER ASSEMBLY 19D413175G1 |
| A701* | | 5 FUNCTION RELAY BOARD 19D413154G2 (Added to 19D413175G1 by REV A) |
| | | - - - - - - - DIODES AND RECTIFIERS - - - - - - |
| CR1 | 4036887P1 | Silicon, Zener. |
| CR3 thru CR24 | 19A115250P1 | Silicon. |
| | | - - - - - - - JACKS AND RECEPTACLES - - - - - - |
| J1 thru J64 | 4033513P4 | Contact, electrical: sim to Bead Chain L93-3. |
| | | - - - - - - - - - - RELAYS - - - - - - - - - - |
| K6 thru K10 | 5491595P14 | Armature: 1.5 w operating, 520 ohms ±15% coil res, 4 form C contacts; sim to Allied Control T154-X-131. |
| | | - - - - - - - - - TRANSISTORS - - - - - - - - |
| Q1 thru Q5 | 19A115768P1 | Silicon, PNP; sim to Type 2N3702. |
| Q6 thru Q11 | 19A115123P1 | Silicon, NPN; sim to Type 2N2712. |
| | | - - - - - - - - - - RESISTORS - - - - - - - - - |
| R1 thru R5 | 3R77P513J | Composition: 51,000 ohms ±5%, 1/2 w. |
| R6 thru R10 | 3R77P202J | Composition: 2000 ohms ±5%, 1/2 w. |
| R11 thru R15 | 3R77P104K | Composition: 100,000 ohms ±10%, 1/2 w. |
| R16 | 3R77P202J | Composition: 2000 ohms ±5%, 1/2 w. |
| R17 | 3R77P302J | Composition: 3000 ohms ±5%, 1/2 w. |
| R18 | 3R77P752J | Composition: 7500 ohms ±5%, 1/2 w. |
| | | - - - - - - - - - - SOCKETS - - - - - - - - - - |
| XK6 thru XK10 | 5491595P7 | Relay: 10 contacts; sim to Allied Control 30054-4. |
| A701* | | 5 FUNCTION RELAY BOARD 19D413154G1 (Deleted in 19D413175G1 by REV A) |
| | | - - - - - - - DIODES AND RECTIFIERS - - - - - - |
| CR1 | 4036887P1 | Silicon, Zener. |
| CR3 thru CR24 | 19A115250P1 | Silicon. |
| | | - - - - - - - JACKS AND RECEPTACLES - - - - - - |
| J1 thru J64 | 4033513P4 | Contact, electrical: sim to Bead Chain L93-3. |
| | | - - - - - - - - - - RELAYS - - - - - - - - - - |
| K1 thru K5 | 5491595P14 | Armature: 1.5 w operating, 520 ohms ±15% coil res, 4 form C contacts; sim to Allied Control T154-X-131. |
| | | - - - - - - - - - TRANSISTORS - - - - - - - - |
| Q1 thru Q5 | 19A115768P1 | Silicon, PNP; sim to Type 2N3702. |
| Q6 thru Q11 | 19A115123P1 | Silicon, NPN; sim to Type 2N2712. |
| | | - - - - - - - - - - RESISTORS - - - - - - - - - |
| R1 thru R5 | 3R77P513J | Composition: 51,000 ohms ±5%, 1/2 w. |
| R6 thru R10 | 3R77P202J | Composition: 2000 ohms ±5%, 1/2 w. |
| R11 thru R15 | 3R77P104K | Composition: 100,000 ohms ±10%, 1/2 w. |
| R16 | 3R77P202J | Composition: 2000 ohms ±5%, 1/2 w. |
| R17 | 3R77P302J | Composition: 3000 ohms ±5%, 1/2 w. |
| R18 | 3R77P752J | Composition: 7500 ohms ±5%, 1/2 w. |
| | | - - - - - - - - - - SOCKETS - - - - - - - - - - |
| XK1 thru XK5 | 5491595P5 | Relay: 16 contacts; sim to Allied Control 30054-2. |
| A702 | | DECODER 19D413162G2 |
| A1712 | | COUNTER BOARD 19D413160G2 |
| | | - - - - - - - - - CAPACITORS - - - - - - - - - |
| C1 | 19A116080P7 | Polyester: 0.1 µf ±20%, 50 VDCW. |
| C2* | 19A116080P7 | Polyester: 0.1 µf ±20%, 50 VDCW. |
| | | Earlier than REV A: |
| | 19B209243P7 | Polyester: 0.1 µf ±20%, 50 VDCW. |
| C3 | 5494481P11 | Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap. |
| C4* | 19A116080P103 | Polyester: 0.022 µf ±10%, 50 VDCW. Added by REV B. |
| C5* | 5494481P11 | Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap. Added by REV B. |
| | | - - - - - - - DIODES AND RECTIFIERS - - - - - - |
| CR1 thru CR24 | 19A115250P1 | Silicon. |
| | | - - - - - - - - INTEGRATED CIRCUITS - - - - - - - |
| IC1 thru IC7 | 19A115913P6 | Digital, Clocked J-K/R-S Flip-Flop; sim to DTL 945. |
| IC8 thru IC11 | 19A115913P1 | Digital, Expandable Dual 4- Input Gate; sim to DTL 930. |
| | | - - - - - - - - - - RESISTORS - - - - - - - - - |
| R1 and R2 | 3R152P510J | Composition: 51 ohms ±5%, 1/4 w. |
| | | - - - - - - - - - - TEST POINTS - - - - - - - - - |
| TP5 and TP6 | N503P304C13 | Cotter Pin. |
| A1722 | | PULSE ROUTING BOARD 19D413158G2 |
| | | - - - - - - - - - CAPACITORS - - - - - - - - - |
| C1 | 5496267P17 | Tantalum: 1.0 µf ±20%, 35 VDCW; sim to Sprague Type 150D. |
| C2 | 5496267P1 | Tantalum: 6.8 µf ±20%, 6 VDCW; sim to Sprague Type 150D. |
| C3 | 5496267P10 | Tantalum: 22 µf ±20%, 15 VDCW; sim to Sprague Type 150D. |
| C4 | 5496267P17 | Tantalum: 1.0 µf ±20%, 35 VDCW; sim to Sprague Type 150D. |
| C5 | 5496267P15 | Tantalum: 47 µf ±20%, 20 VDCW; sim to Sprague Type 150D. |
| C9 | 5496267P13 | Tantalum: 2.2 µf ±20%, 20 VDCW; sim to Sprague Type 150D. |
| | | - - - - - - - DIODES AND RECTIFIERS - - - - - - |
| CR1 and CR2 | 19A115250P1 | Silicon. |
| CR3 | 4036887P6 | Silicon, Zener. |
| CR12 | 4037822P1 | Silicon. |
| CR14 | 19A115250P1 | Silicon. |
| | | - - - - - - - - INTEGRATED CIRCUITS - - - - - - - |
| IC12 | 19A115913P7 | Monolithic, Quad 2- Input Gate; sim to DTL 946. |
| IC13 | 19A115913P3 | Monolithic, Dual Buffer; sim to DTL 932. |
| | | - - - - - - - JACKS AND RECEPTACLES - - - - - - |
| J1 thru J15 | 4033513P15 | Contact, electrical: sim to Bead Chain R40-1A. |
| | | - - - - - - - - - TRANSISTORS - - - - - - - - |
| Q1 | 19A115362P1 | Silicon, NPN; sim to Type 2N2925. |
| Q2 | 19A116118P1 | Silicon, NPN. |
| Q6 | 19A115889P1 | Silicon, NPN; sim to Type 2N2712. |
| Q7 | 19A115123P1 | Silicon, NPN; sim to Type 2N2712. |
| | | - - - - - - - - - - RESISTORS - - - - - - - - - |
| R1 | 3R152P333J | Composition: 33,000 ohms ±5%, 1/4 w. |
| R2 | 3R152P623J | Composition: 62,000 ohms ±5%, 1/4 w. |
| R4 | 3R152P202J | Composition: 2000 ohms ±5%, 1/4 w. |
| R5 | 3R152P561J | Composition: 560 ohms ±5%, 1/4 w. |
| R17 | 3R152P240J | Composition: 24 ohms ±5%, 1/4 w. |
| R18 | 3R152P332J | Composition: 3300 ohms ±5%, 1/4 w. |
| R19 | 3R152P393J | Composition: 39,000 ohms ±5%, 1/4 w. |
| R20 | 3R152P104J | Composition: 100,000 ohms ±5%, 1/4 w. |
| R21 | 3R152P303J | Composition: 30,000 ohms ±5%, 1/4 w. |
| R22 | 3R152P103J | Composition: 10,000 ohms ±5%, 1/4 w. |
| | | - - - - - - - - - - TEST POINTS - - - - - - - - - |
| TP1 thru TP4 | N503P304C13 | Cotter Pin. |
| | | - - - - - - - JACKS AND RECEPTACLES - - - - - - |
| J701 thru J705 | 7150763P2 | Jack, tip, stake-in: red nylon body; sim to Alden Products 110BC1-red. |
| J706 | 7150763P1 | Jack, tip, stake-in: black nylon body; sim to Alden Products 110BC1-black. |
| | | - - - - - - - - - TERMINAL BOARDS - - - - - - - - |
| TB701 thru TB704 | 7117710P10 | Phen: 10 terminals; sim to Cinch 1799. |
| A1701 thru A1703 | | TONE RECEIVER<br>A1701 19C311852G1 590 Hz<br>A1702 19C311852G2 1500 Hz<br>A1703 19C311852G3 2805 Hz |
| | | - - - - - - - - - CAPACITORS - - - - - - - - - |
| C1 | 19B209243P14 | Polyester: 0.33 µf ±20%, 250 VDCW. |
| C2 and C3 | 5496267P1 | Tantalum: 6.8 µf ±20%, 6 VDCW; sim to Sprague Type 150D. |
| C4 | 5496267P17 | Tantalum: 1.0 µf ±20%, 35 VDCW; sim to Sprague Type 150D. |
| C5 | 19C300075P 47001G | Polyester: 0.047 µf ±2%, 100 VDCW; sim to GE Type 61F. |
| C6 | 5496249P25000G | Polystyrene: 25,000 pf ±2-1/2%, 125 VDCW. |
| C7 | 19C300075P22002G | Polyester: 0.22 µf ±2%, 100 VDCW; sim to GE Type 61F. |
| C8 | 5496249P16000G | Polystyrene: 16,000 pf ±2-1/2%, 125 VDCW. |
| C9 | 5496249P20000G | Polystyrene: 20,000 pf ±2-1/2%, 125 VDCW. |
| C10 | 5496267P17 | Tantalum: 1.0 µf ±20%, 35 VDCW; sim to Sprague Type 150D. |
| C11 | 5496267P13 | Tantalum: 2.2 µf ±20%, 20 VDCW; sim to Sprague Type 150D. |
| C12 | 19B209243P14 | Polyester: 0.33 µf ±20%, 250 VDCW. |
| | | - - - - - - - DIODES AND RECTIFIERS - - - - - - |
| CR1 thru CR8 | 19A115250P1 | Silicon. |
| | | - - - - - - - - - - INDUCTORS - - - - - - - - - |
| L1 | 19B205354G2 | Coil. |
| L2 | 19B205354G3 | Coil. |
| | | - - - - - - - - - TRANSISTORS - - - - - - - - |
| Q1 | 19A115362P1 | Silicon, NPN; sim to Type 2N2925. |
| Q2 | 19A115123P1 | Silicon, NPN; sim to Type 2N2712. |
| Q3 and Q4 | 19A115768P1 | Silicon, PNP; sim to Type 2N3702. |
| Q5 | 19A115123P1 | Silicon, NPN; sim to Type 2N2712. |
| | | - - - - - - - - - - RESISTORS - - - - - - - - - |
| R1 and R2 | 3R152P302J | Composition: 3000 ohms ±5%, 1/4 w. |
| R3 | 3R152P513J | Composition: 51,000 ohms ±5%, 1/4 w. |
| R4 | 3R152P123J | Composition: 12,000 ohms ±5%, 1/4 w. |
| R5 | 3R152P242J | Composition: 2400 ohms ±5%, 1/4 w. |
| R6 and R7 | 3R152P223J | Composition: 22,000 ohms ±5%, 1/4 w. |
| R8 | 3R152P102J | Composition: 1000 ohms ±5%, 1/4 w. |
| R9 | 3R152P103J | Composition: 10,000 ohms ±5%, 1/4 w. |
| R10 | 3R152P473J | Composition: 47,000 ohms ±5%, 1/4 w. |
| R11 | 3R152P103J | Composition: 10,000 ohms ±5%, 1/4 w. |
| R12 | 3R152P243J | Composition: 24,000 ohms ±5%, 1/4 w. |
| R13 | 3R152P513J | Composition: 51,000 ohms ±5%, 1/4 w. |
| R14 | 3R152P103J | Composition: 10,000 ohms ±5%, 1/4 w. |
| R15 | 3R152P204J | Composition: 200,000 ohms ±5%, 1/4 w. |
| R16 | 3R152P221J | Composition: 220 ohms ±5%, 1/4 w. |
| R17 and R18 | 3R152P822J | Composition: 8200 ohms ±5%, 1/4 w. |
| R19 | 3R152P753J | Composition: 75,000 ohms ±5%, 1/4 w. |
| R20 | 3R152P242J | Composition: 2400 ohms ±5%, 1/4 w. |
| R21 | 3R152P622J | Composition: 6200 ohms ±5%, 1/4 w. |
| R22 | 3R152P104J | Composition: 100,000 ohms ±5%, 1/4 w. |
| | | ASSOCIATED ASSEMBLIES |
| | | AC POWER SUPPY 19A127347G1 |
| | | - - - - - - - - - CAPACITORS - - - - - - - - - |
| C501 | 7770994P28 | Electrolytic : 500-500 µf +200%-10%, 25-25 VDCW; sim to Mallory Type WP. |
| | | - - - - - - - DIODES AND RECTIFIERS - - - - - - |
| CR501 thru CR504 | 4037822P1 | Silicon. |
| | | - - - - - - - - - - FUSES - - - - - - - - - - |
| F501 | 7487942P1 | Slow blowing:1/4 amp at 250 v; sim to Bussmann MDL-1/4. |
| | | - - - - - - - - - - PLUGS - - - - - - - - - - |
| P502 and P503 | 4036634P1 | Contact, electrical; sim to AMP 42428-2. |
| | | - - - - - - - - - - RESISTORS - - - - - - - - - |
| R501 | 5496941P23 | Wirewound: 16 ohms ±5%, 15 w; sim to Tru-Ohm Type MOR-15. |
| | | - - - - - - - - - TRANSFORMERS - - - - - - - - - |
| T501 | 5493743P1 | Power: step down,<br>Pri: 117 v, 50/60 Hz,<br>Sec 1: 12.6 v ±3%, 2 amps. |
| | | - - - - - - - - TERMINAL BOARDS - - - - - - - - |
| TB1 | 7775500P25 | Phen: 9 terminals. |
| | | - - - - - - - - - - CABLES - - - - - - - - - - |
| W501* | 19A116740P2 | Power: approx. 8 ft. long. |
| | | Earlier than REV A: |
| | 4036441P8 | Power: approx. 8 ft. long, with 3- contact plug (P501). |
| | | - - - - - - - - - - SOCKETS - - - - - - - - - - |
| XF501 | 19B209005P1 | Fuseholder, post type, phen: 15 amps at 250 v; sim to Littelfuse 342012. |
| | | - - - - - - - - MISCELLANEOUS - - - - - - - - |
| | 19B216334P1 | Cover. |
| | | RELAY KIT 19A127344G1 |
| | | - - - - - - - - - - RELAYS - - - - - - - - - - |
| K2 thru K4 | 5491595P14 | Armature: 1.5 w operating, 520 ohms ±15% coil res, 4 form C contacts; sim to Allied Control T154-X-131. |
| | | - - - - - - - - MISCELLANEOUS - - - - - - - - |
| | 5491595P9 | Retainer: spring; sim to Allied Control 30040-2. (Used with K1-K5). |

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

## PRODUCTION CHANGES

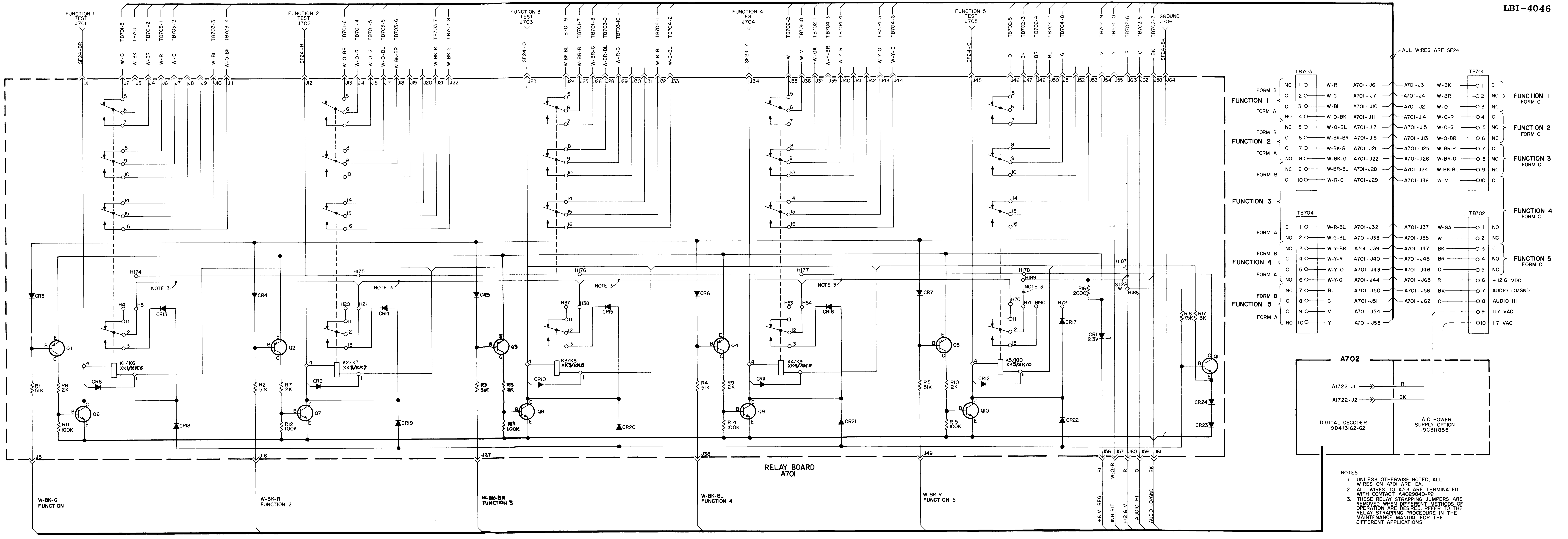
Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

REV. A - Relay Board (19D413175G1)
To incorporate printed wire board. Changed Relay Board A701 from eyelet board to printed wire board.

REV. A - Decoder (19D413162G2)
To improve the threshold of the input stages of the bit and digit counters. Deleted C2 and added C3.

REV. B - To prevent recognition of ignition noise and other stray pulses. Added C4 and C5.

REV. A - AC Power Supply (19C311855G1)
To add 3-wire power cable. Changed W501.




NOTES

1. UNLESS OTHERWISE NOTED, ALL WIRES ON A701 ARE DA.
2. ALL WIRES TO A701 ARE TERMINATED WITH CONTACT A4029840-P2.
3. THESE RELAY STRAPPING JUMPERS ARE REMOVED WHEN DIFFERENT METHODS OF OPERATION ARE DESIRED. REFER TO THE RELAY STRAPPING PROCEDURE IN THE MAINTENANCE MANUAL FOR THE DIFFERENT APPLICATIONS.

(DF-5036)

SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER.

| THIS ELEM DIAG APPLIES TO | |
|---|---|
| PL NO. | REV LETTER |
| PL19D413175G1 | A |

(19R621246, Rev. 8)

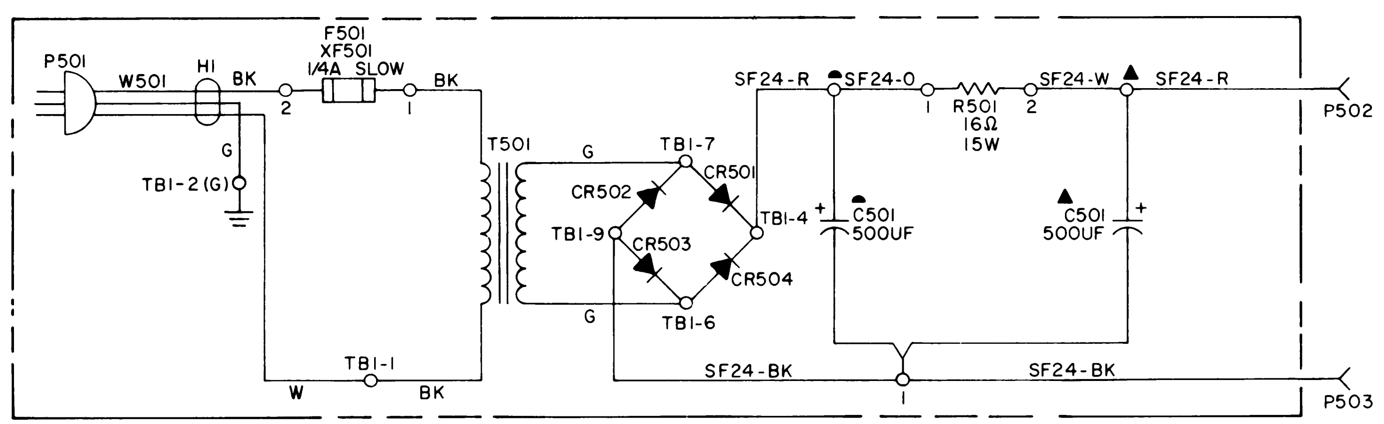
ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR H=HENRYS.

IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

## SCHEMATIC DIAGRAM

FIVE-FUNCTION DIGITAL DECODER PANEL
RELAY BOARD A701

Issue 4




ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF=MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH=MILLIHENRYS OR H=HENRYS.

IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER.

| THIS ELEM DIAG APPLIES TO | |
|---|---|
| MODEL NO | REV LETTER |
| 19C311855G1 | A |

(19B216280, Rev. 3)

**SCHEMATIC DIAGRAM**

FIVE-FUNCTION DIGITAL DECODER PANEL
AC POWER SUPPLY OPTION

# TROUBLESHOOTING PROCEDURE

EQUIPMENT REQUIRED

- DC-triggered oscilloscope
- AC and DC VTVM
- A tone generator of the proper frequency and a telephone-type dial, or a TGS-735 or TGS-740 encoder on the proper frequency
- A 12-volt, DC power supply

PRELIMINARY INSTRUCTIONS

1. All waveforms shown are with the proper tone applied and the digit 5 dialed. Note: the digit 6 was dialed for the incorrect code reset waveform shown in Figure 16.
2. The oscilloscope setting for all waveforms is 5 volts/division vertical and 100 milliseconds/division horizontal except where noted.
3. Before starting the procedure, check for +6 volts DC at the emitter of regulator transistor Q2 (see Fig. 16). Then check for +6 volts on the Counter and Tone Receiver Boards (see Figs. 17 and 18).

| SYMPTOM | PROCEDURE |
|---|---|
| | PULSE ROUTING AND COUNTER BOARDS |
| Decoder responds to a wrong code | 1. Check the screw placement on the counter board (refer to the Code Setting Procedure as listed in the Table of Contents).<br>2. Check to see that no screws are missing (one screw in each pad). |
| Decoder doesn't respond to correct code | 1. Check the screw placement on the counter board (refer to the Code Setting Procedure as listed in the Table of Contents). At no time should two screws be located in any one screw pad (see Figure 17).<br>2. Dial a "5" and check the waveforms at TP1 and TP2 (see Fig. 16). If the proper waveforms are not present, refer to Tone Receiver Board checks. If proper waveform is present, continue with Step 3.<br>3. Dial a correct first digit and keep the tone on after dialing. All of the screw heads in row A should measure approximately +6 volts DC, which indicates that the first digit was counted correctly.<br>Dial a correct second digit and keep the tone on after dialing. All of the screw heads in row B should be at +6 volts, indicating the second digit was counted correctly.<br>Dial a correct third digit and keep the tone on after dialing. All of the screw heads in row C should measure +6 volts, indicating that the third digit was counted correctly.<br>If all of the digits are counted correctly, refer to the Relay Board checks. If the screw heads do not go to +6 volts during the digit checks, continue with Step 4.<br>4. Connect the reset disable jumper to battery negative to prevent re-setting while dialing (see Fig. 16). Dial the correct first digit again, keeping the tone on after dialing. Check the screw heads in row A again for +6 volts. If all of the screw heads are at +6 volts, check for a positive voltage at the cathode of CR1, CR2 and CR3. If the screw heads or cathodes are not positive, check the flip-flops as instructed in Step 5.<br>If the screw heads and cathodes are positive (indicating a correct count), dial the second and third correct digits to check the screw heads in rows B and C, and the cathode of diodes CR4, CR5, CR6 and CR7, CR8, CR9. If all codes are counted correctly and the cathode of the diodes are positive, this indicates a fault in the reset circuit. Check the correct code, incorrect code reset and reset inhibit waveforms shown in Figure 16, and refer to the circuit analysis section for detailed operation and Truth Table for the reset circuitry. |
| Decoder doesn't respond to correct code (cont'd) | 5. With the reset disable jumper connected, dial a "5" and check the input waveforms at TP5 and TP6 (see Fig. 17). If the waveforms are not correct, check the Tone Receiver Board or the envelope detector circuitry.<br>If the waveforms are correct, check to see if the flip-flops are switching (one output terminal at +6 volts ("1") and the other at zero ("0"). Refer to the circuit analysis of the Counter Board and the Truth Table on the Schematic Diagram (see Table of Contents).<br>6. If the flip-flops are not switching properly (both output terminals at zero volts or both at +6 volts), remove all of the screws in the bit counter flip-flop or unsolder all of the diodes in the output of the digit counter and re-check the flip-flop output. If the flip-flop does not switch correctly, replace the IC module.<br>NOTE<br>To remove an IC module, clip off all of the leads as close as possible to the body of the module. Then unsolder and remove one lead at a time, being careful not to pull the printed wiring away from the board. |
| | TONE RECEIVER BOARD |
| No tone output | 1. While applying 100 millivolts of on-frequency tone, dial a "5" and check the waveform at C3 (see Fig. 18). If the proper waveform is not present, check the Tone Receiver input circuitry.<br>2. With tone applied, dial a "5" and check the waveform at C10 (see Fig. 18). If the proper waveform is present, check CR6, CR7, CR8 and Q5. If the waveform is not correct, check for a sine wave across L1/L2.<br>3. If the sine wave is present across L1/L2, connect a jumper across L1/L2 and check for a near zero reading at the positive end of C10. If the reading is not near zero, check CR5, Q3 and Q4. |
| No tone output at high input levels, but operates normally at low input levels | Check C2, C3, CR3, CR4, R6 and R7 in the limiter circuitry. |
| | RELAY BOARD |
| Relays won't energize | 1. With a meter connected to the appropriate Function Test jack, dial a correct code and check to see that the meter reading drops to near ground potential (less than one volt). If the reading does not drop to ground, continue with Step 2.<br>2. Check for a meter reading of near ground potential at J5, J16, J27, J38 or J49 of appropriate relay circuit. The reading at these jacks should drop from approximately 6 volts DC to less than 0.5 volt when the proper function code is dialed.<br>3. If the meter reading drops to ground potential, check the collector voltage of appropriate driver transistor (Q1 thru Q5). The collector voltage should rise from near ground to approximately +3.5 volts DC when the proper code is dialed.<br>4. If the collector voltage of Q1 thru Q5 does not rise to +3.5 volts, replace the appropriate transistor. If the proper voltage reading is obtained, check the collector voltage of the appropriate transistor Q6 thru Q10. The collector voltage should drop to near ground potential when the proper code is dialed. If the voltage does not drop to near ground, replace the appropriate transistor. |
| Relay won't lock up | 1. Check the latching path of the relay (refer to the Relay Strapping Procedure as listed in the Table of Contents).<br>2. If the relays are strapped for Exclusive Lock-Up (relay locking path controlled by the operation of Q11), check for a meter reading of less than 2 volts DC at the collector of Q11 with no function dialed. If the reading is not less than 2 volts, check R18, CR23, CR24 and Q11. |
| Relay won't de-energize | Check the relay latching path (refer to the Relay Strapping Procedure as listed in the Table of Contents). |
| Relays lock up prematurely | Check appropriate diodes CR3 thru CR7, and check the inhibit circuit on the decoder. |

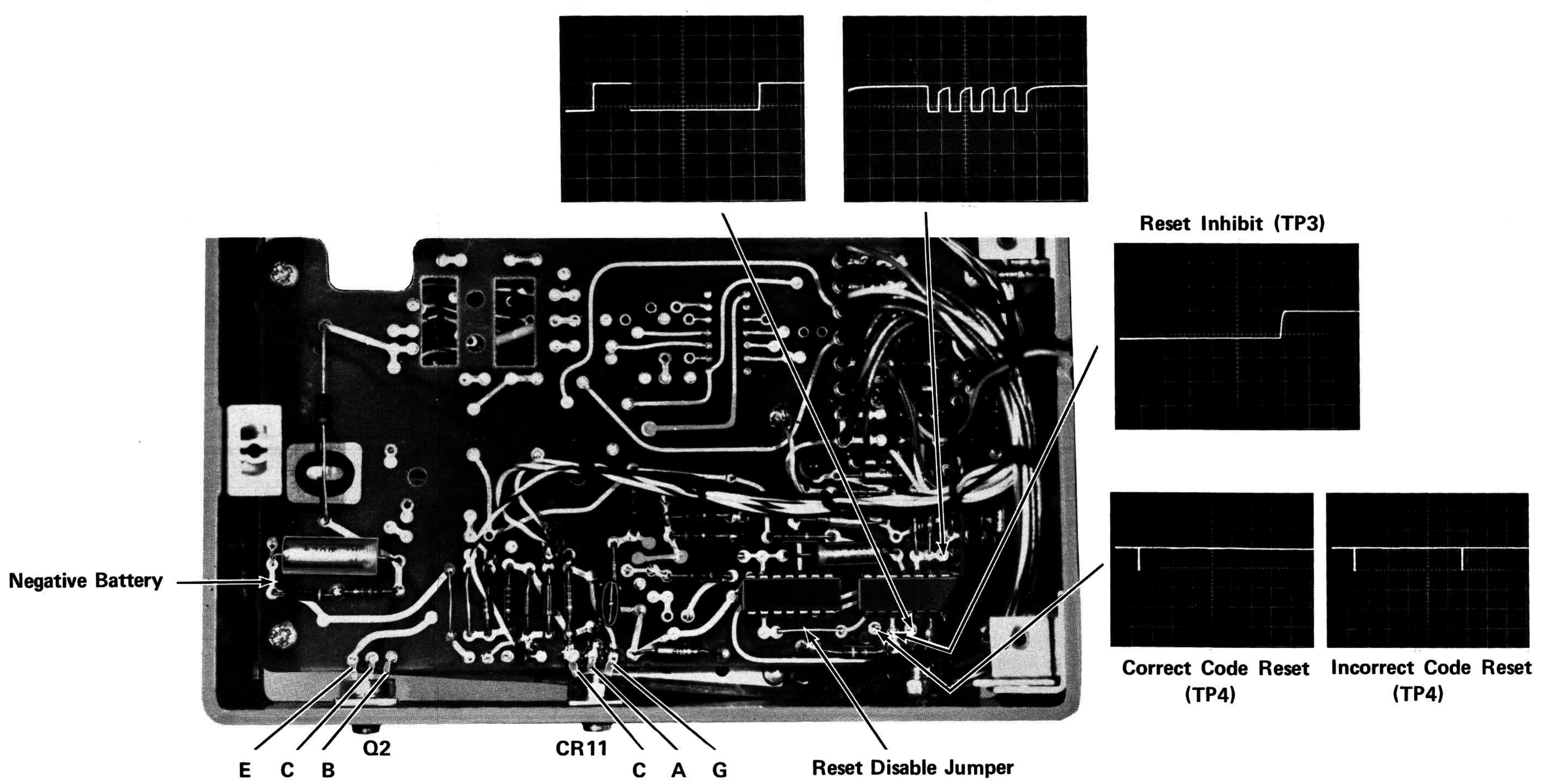



Figure 16 - Pulse Routing Board

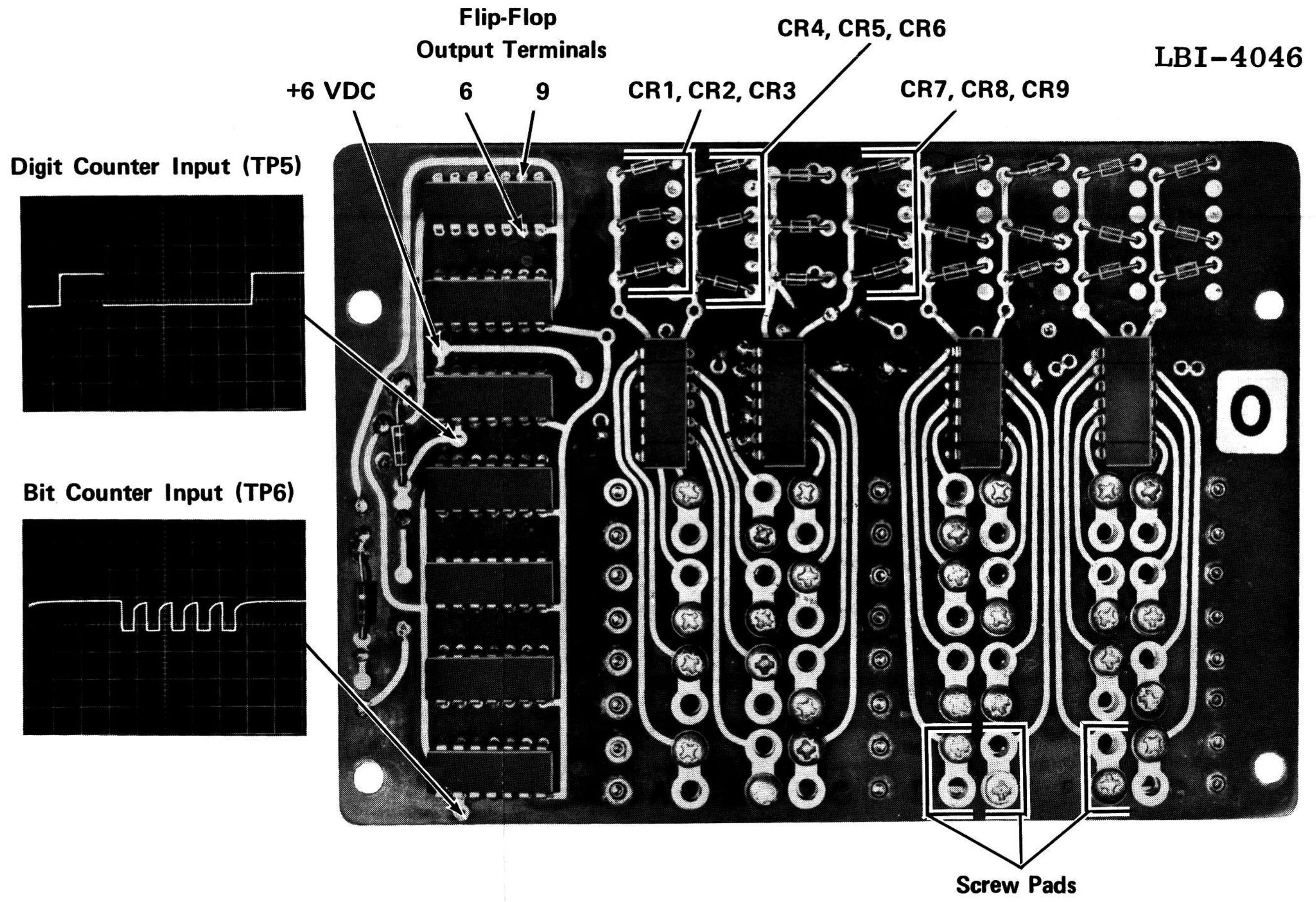



Figure 17 - Counter Board

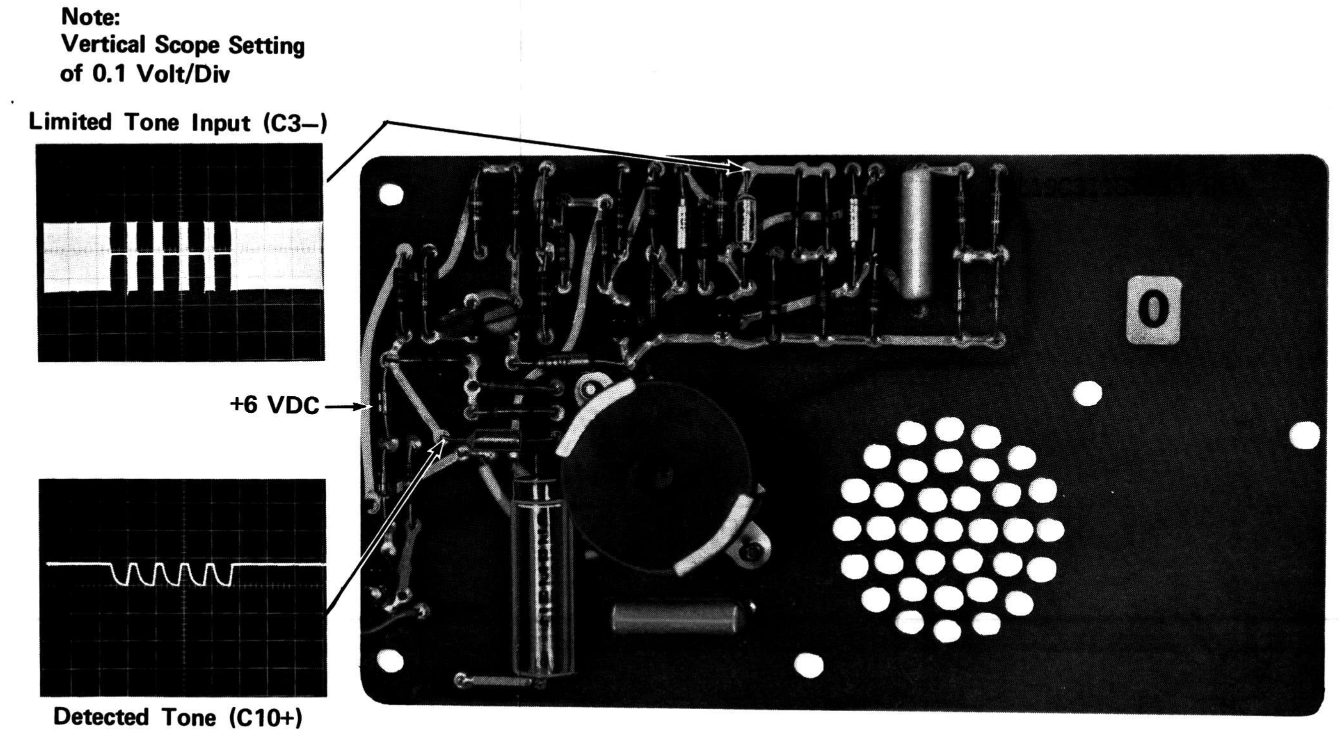



Figure 18 - Tone Receiver Board

# ORDERING SERVICE PARTS

Each component appearing on the schematic diagram is identified by a symbol number, to simplify locating it in the parts list. Each component is listed by symbol number, followed by its description and GE Part Number.

Service Parts may be obtained from Authorized GE Communication Equipment Service Stations or through any GE Radio Communication Equipment Sales Office. When ordering a part, be sure to give:

1. GE Part Number for component
2. Description of part
3. Model number of equipment
4. Revision letter stamped on unit

**MAINTENANCE MANUAL**

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DF-5036

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