



**MAINTENANCE MANUAL
FOR
GE-NET TMX™
LOGIC BOARD 19D902151G1**

TABLE OF CONTENTS

DESCRIPTION	1
CIRCUIT ANALYSIS	1
OUTLINE DIAGRAM	6
SCHEMATIC DIAGRAM	7
PARTS LIST	9
IC DATA	10

DESCRIPTION

Logic Board 19D902151G1 controls the operation of the GE-NET TMX 900 MHz, trunked mobile radio. The Logic Board contains a microcontroller and associated memory circuits which include an EPROM for controller software, a programmable EEPROM to store customer Area/Group Sets, frequencies and options, and RAM for controller working memory. MTX and MRX modem data from the Audio Board are controlled by a Modem IC on the Logic Board.

The Logic Board also contains latch circuitry for tone generation, data I/O and volume control. An electrically erasable potentiometer (EEPOT) is used for the volume control. In addition, the board provides the audio paths between RF Board A3, Audio Board A2 and the Handset or Mic/Speaker Amplifier.

The logic board mounts on the bottom of the frame assembly underneath the Audio Board. A Block Diagram of the Logic Board is shown in Figure 1.

The logic board generates and receives the control signals described in Table 1.

CIRCUIT ANALYSIS

A description of the symbol numbers used in the following text is contained in the Block Diagram, Outline and

Schematic Diagrams, and Parts List as listed in the Table of Contents above. Also, refer to the IC/Module Data Sheets for pin out information (see Table of Contents).

MICROCONTROLLER, DECODER AND LATCH

Microcontroller U701 is an 8-bit, control-oriented microcomputer with internal input/output interface (I/O), and 256x8 random access memory (RAM). The microcontroller provides all of the radio timing and control signals. An 11.0592 MHz external crystal (Y701) is used for clocking.

Microcontroller U701 controls the following circuits:

- Synthesizer
- Transmit circuit
- Decoding of RX Signal Tones
- Generation of TX Signal Tones
- Microphone, Speaker and Data mute gates

Communications between the microcontroller and control unit is by 300 Baud serial data. Keypad and Display Serial lines for the handset test mode are Channel Select 0 and 1 respectively. Refer to Maintenance Manual LBI-38116 for more details on the Control Unit.

Keypad and Display Serial lines are RXD and TXD respectively are for PC Programmer operation. A 9600 Baud,

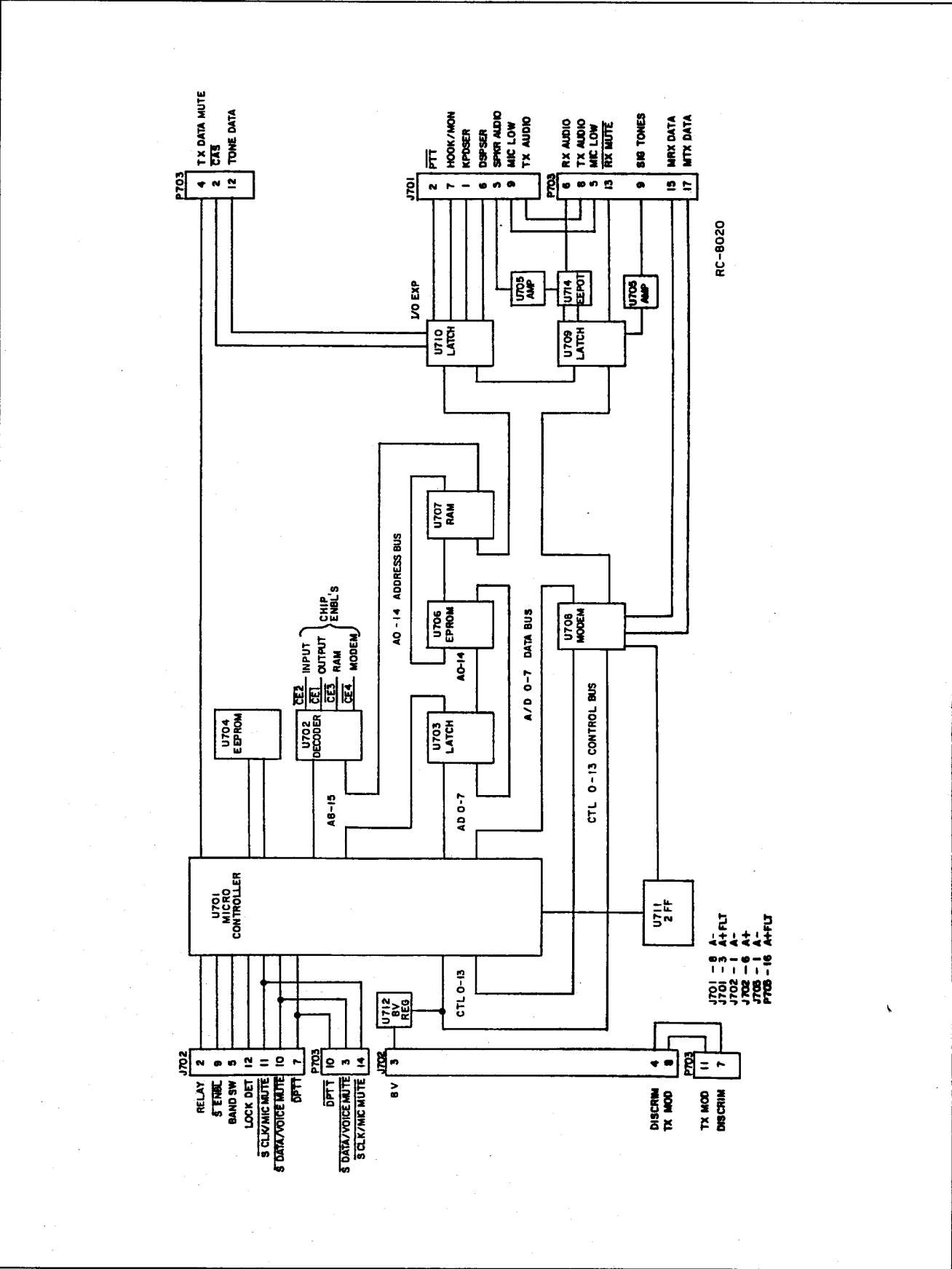


Figure 1 - Logic Board Block Diagram

Table 1 - Control Signals

RECEIVES FROM	GENERATES TO	RECEIVES FROM	GENERATES TO
AUDIO BOARD: RX TONE DATA MRX DATA CAS (SQUELCH) TX DATA MUTE RX MUTE MIC MUTE DATA/VOICE BAND SWITCH	AUDIO BOARD: SIGNAL TONES MTX DATA DPTT	RF BD SYNTH: LOCK DETECT	RF BD SYNTH: CLK/MIC MUTE ENABLE DATA/VOICE MUTE
HANDSET: KEYPAD SERIAL PTT HOOK/MONITOR	HANDSET: DISPLAY SERIAL	XMIT CIRCUIT: MUTE DPTT	

RS-232 ASCII link interfaces the radio to the PC Programmer. Refer to Programming Manual TQ3325 for more information.

Two additional ICs directly support the controller. U703 is an Octal 3-state, non-inverting transparent Latch used with ALE (Add- Address Latch Enable). U703 is used to demultiplex the controller Address/Data Bus. U702 is a three bit address to one-of-eight active low decoder outputs. It uses address lines A13, A14 and A15 as inputs, and provides Chip Enables for INPRT (U710 I/O EXP), OUTPRT (U709 D Latch), RAM (U707) and Modem (U708). NOR gate (U713) combines Read and Write to the enable signal for INPRT and OUTPRT.

ERASABLE PROM (EPROM)

EPROM U706 is a 32K x 8 bit, ultraviolet Erasable and Electrically Programmable Read Only Memory. U706 stores all the software routines required by the controller for radio operation. The EPROM does not contain any customer specific information.

ELECTRICALLY ERASABLE PROM (EEPROM)

EEPROM U704 is a 512 x 8 bit memory device designated the "personality" PROM. This personality PROM stores all required Customer information, which includes:

- Area/Group Sets
- Frequencies
- Options

The EEPROM can be conveniently programmed through J701 on the Logic Board without opening the radio.

RAM

The (U707) IC is a 2K x 8 bit, High Speed Static CMOS RAM. This IC is used by the controller for additional temporary data storage during radio operation.

MODEM AND JK FLIP FLOP

Modem chip U708 provides for transmitting and receiving 4800 baud, high speed data. This is performed by serial/parallel and parallel/serial conversions for MTX and MRX data respectively. The controller passes and receives modem data on the parallel Data bus. Another Modem chip function is to provide for a "watchdog timer" in controller operation. Whenever the timer is not routinely set, as with a software failure, the modem IC re-initiates the system startup (powers up the radio).

A 11.0592 MHz clock signal is provided for microcontroller operation by crystal Y701. A JK Flip Flop (U711) performs a divide by two function to provide the 5.5296 MHz used by the modem.

BUS TRANSCEIVER

U710 is an Octal, 3-state, non-inverting Bus Transceiver. Grounding pin 1 of I/O expansion IC U710 permits data to pass in only one direction. CAS (Squelch) and RX Tone Data are applied to the Logic Board from the Audio Board. PTT, Hook/Mon, Keypad and Display Serial data are applied from the Control Unit. The output of U710 is applied to the Data Bus.

D-TYPE FLIPFLOP AND EEPOT

U709 is an octal D-type flipflop that is used to latch the RX MUTE, UP/DN, INC and Signal Tones from the microcontroller. Signal Tones generated by the microcontroller are latched and transformed into sine waves (digital to analog conversion) by resistor network R723. The network output is applied to Op Amp U705B for the required gain.

The UP/DN and INC signals are used to control the direction and value of EEPOT U714. The digitally controlled potentiometer has a minimum resistance of 40 ohms, and a maximum resistance of 10K ohms. The EEPOT is adjusted in 101-ohm increments. Incrementing UP increases the speaker audio volume.

Filtering and gain is provided by Op Amp U705A. The EEPOT is preset to 80% volume level to provide proper audio levels for the control unit speaker amplifier.

RELAY AND VOLTAGE REGULATOR

In addition to the control and latching circuits, the Logic Board contains a horn relay circuit, a +5 volt voltage regulator and battery voltage filter.

Horn Relay

The horn relay circuit consists of NPN buffer transistor Q702 and NPN relay driver transistor Q703. The circuit is activated by the controller for a received call, when enabled by the EEPROM. The circuit is capable of handling up to 150 milliamperes to drive an external relay coil.

Voltage Regulator

Voltage regulator U712 supplies a regulated +5 volts DC to all of the Logic Board ICs except for Op Amp U705. U705 is supplied by the filtered A+. A reset circuit is combined with the regulator to provide the controller (via the modem chip) with a power-up signal for start-up or restarts. The +8 volts DC is supplied to U712 from 8-volt regulator U102 located on the RF Board.

Battery Voltage Filter

Transistor circuit Q704 operates as a filter circuit for the A+ battery voltage. This circuit is used to reduce "alternator whine" interference. The filtered A+ (13 Volts DC) is used in the handset and on the Audio Board. Transistors Q708 and

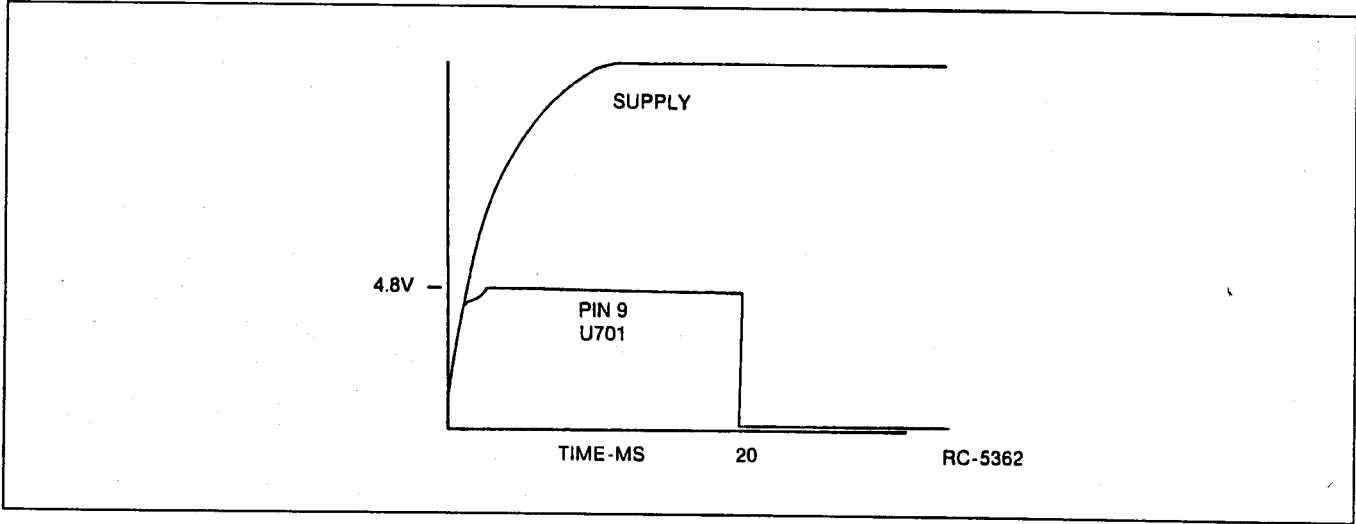


Figure 2 - Reset Waveform

Q707 provide surge protection for Q704 by automatically shutting down if an over current condition is sensed at J701. Reset occurs when power is re-applied to the unit.

LOGIC BOARD QUICKCHECKS

If a faulty Logic Board is suspected, it can be confirmed by substitution of a known good board.

DC CHECKS

Power for the Logic Board is supplied by the 8 volts on J702, Pin 3. This comes the +8-Volt Regulator (U102) located on the RF Board.

1. Check for +5 * 0.25 volts on U712, Pin 5.

2. Check the Microcontroller Reset line (U701, Pin 10). If Reset is occurring, check the Regulator U705, Pin 2 and Q701. See Figure 2 for Reset Waveform.

3. Check for oscillator activity by examining the ALE clock on U701, Pin 33 (see Figure 3). If not present, examine the system clock on U701, Pin 20. The presence of a system clock but no ALE may indicate that U701 is defective. If the system clock is not present, check Y701 and related components.

4. All output lines from the Microcontroller are pulled to +5 Volts through 50K-Ohm resistors inside the Microcontroller. If a line is high, ground that pin and monitor the results. **Service Note:** If a line is low, the line may not be forced to +5 Volts.

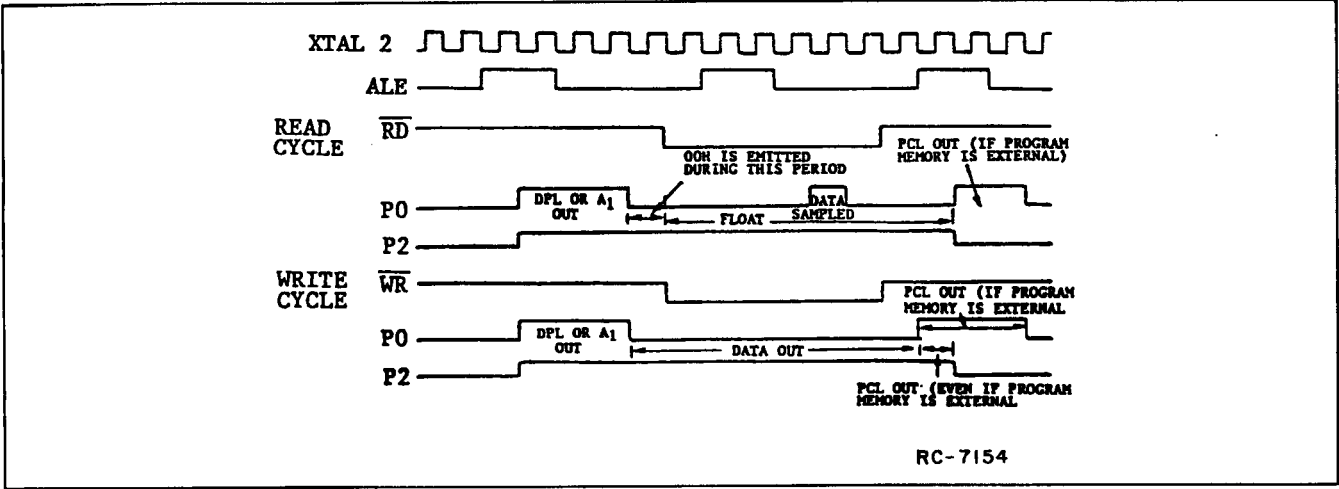


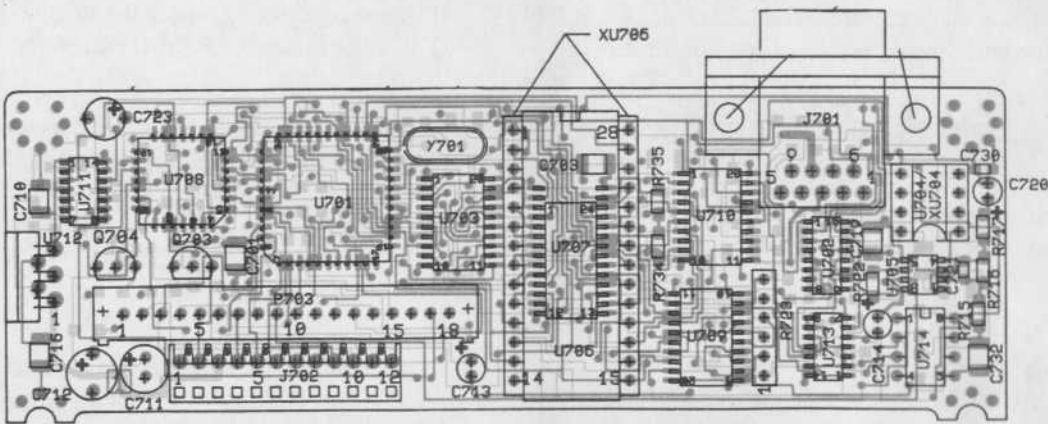
Figure 3 - Timing Waveforms



GE Mobile Communications

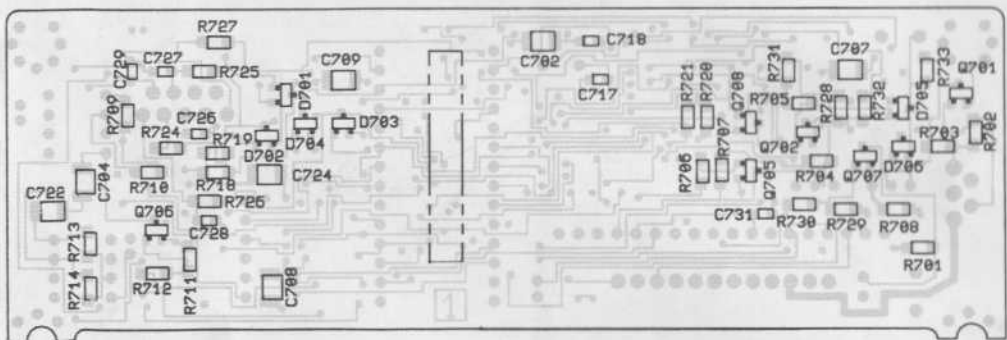
General Electric Company
Lynchburg, Virginia 24502

COMPONENT SIDE



(19D902151, Rev. 0)
(19D902152, Layer 1, Rev. 1)
(19D902152, Layer 4, Rev. 1)

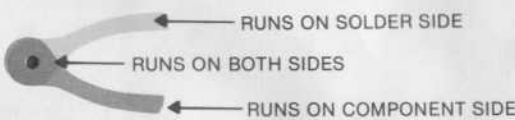
SOLDER SIDE



VIEW FROM SOLDER SIDE

(19D902151, Rev. 0)
(19D902152, Layer 4, Rev. 1)

1 NOTES:

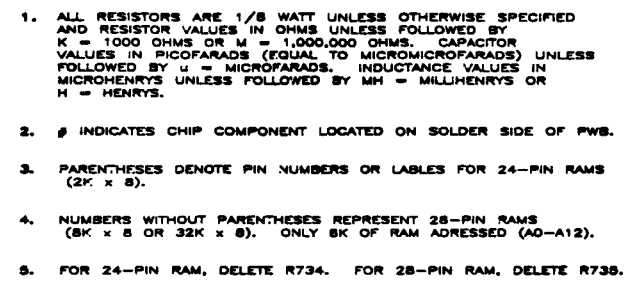


THE FOLLOWING DEVICES ARE ELECTROSTATIC SENSITIVE
DEVICES REQUIRING SPECIAL CARE:
U701-U704, U707-U711, & U713

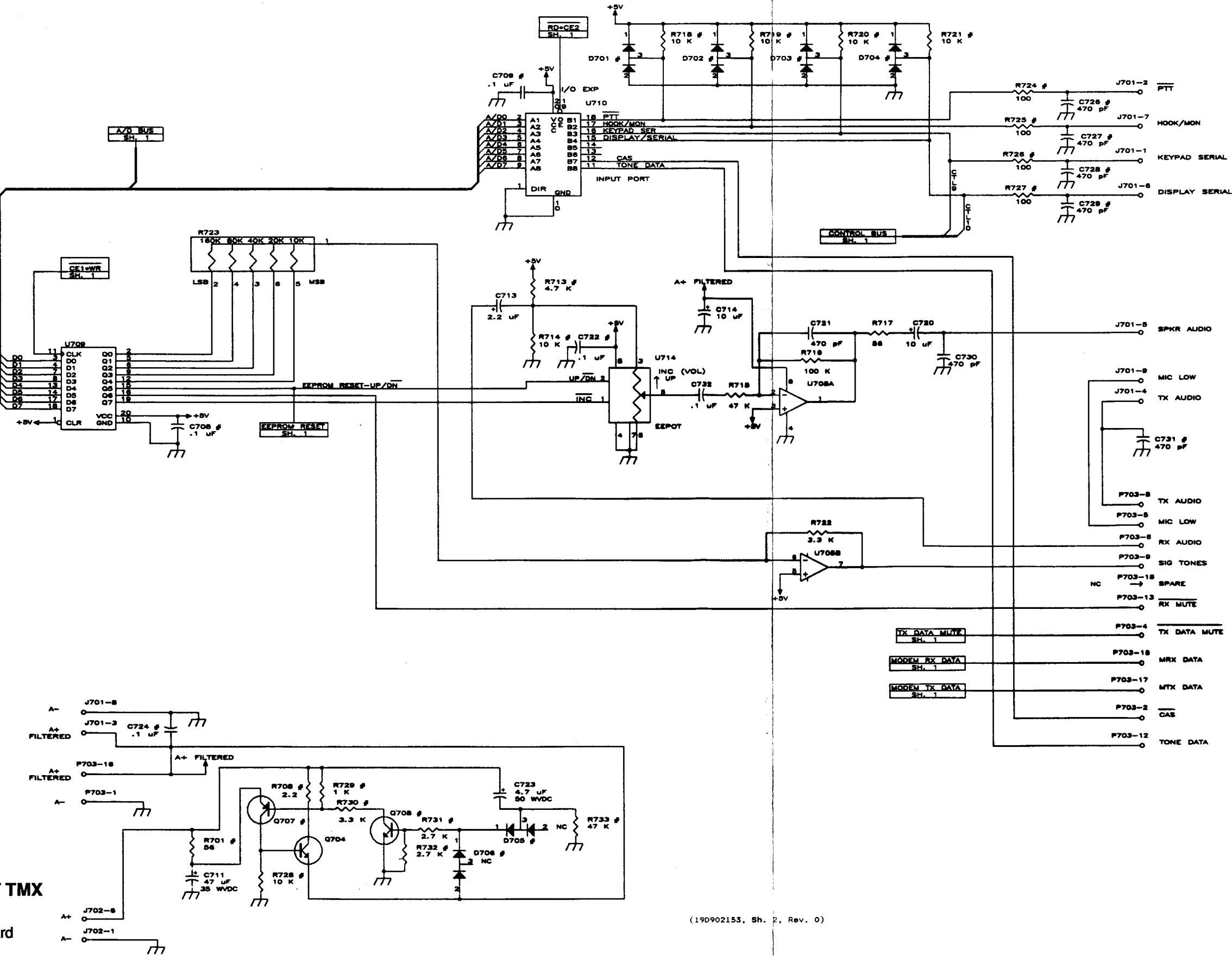
GE-NET TMX

Logic Board

PIN 1 OF R723 IDENTIFIED BY DOT, COLOR
STRIPE, VENDORS LOGO OR NOTCH.



Logic Board



GE NET TMX

Logic Board

(19D902153, Sh. 2, Rev. 0)

PARTS LIST

LOGIC BOARD
19D902151G1
ISSUE 1

SYMBOL	GE PART NO.	DESCRIPTION
----- CAPACITORS -----		
C701 thru C704	19A702052P26	Ceramic: 0.1 uF + or - 10%, 50 VDCW.
C707 thru C710	19A702052P26	Ceramic: 0.1 uF + or - 10%, 50 VDCW.
C711	19A704879P15	Electrolytic: 47 uF + or -20%, 35 VDCW.
C712	19A701534P9	Tantalum: 47 uF + or -20%, 6.3 VDCW.
C713	19A704879P8	Capacitor, Electrolytic: 2.2uF + or - 20%, 50 VDCW.
C714	19A704879P5	Electrolytic: 10 uF + or -20%, 16 VDCW.
C716	19A702052P26	Ceramic: 0.1 uF + or - 10%, 50 VDCW.
C717 and C718	19A702061P37	Ceramic: 33 pF + or -5%, 50 VDCW, temp coef 0 + or -30 PPM/C.
C719	19A702052P26	Ceramic: 0.1 uF + or - 10%, 50 VDCW.
C720	19A704879P5	Electrolytic: 10 uF + or -20%, 16 VDCW.
C721	19A702061P77	Ceramic: 470 pF + or - 5%, 50 VDCW, temp coef 0 + or - 30 PPM.
C722	19A702052P26	Ceramic: 0.1 uF + or - 10%, 50 VDCW.
C723	19A703314P9	Electrolytic: 4.7 uF -10+50% tol, 50 VDCW; sim to Panasonic LS Series.
C724	19A702052P26	Ceramic: 0.1 uF + or - 10%, 50 VDCW.
C726 thru C731	19A702061P77	Ceramic: 470 pF + or - 5%, 50 VDCW, temp coef 0 + or - 30 PPM.
C732	19A702052P26	Ceramic: 0.1 uF + or - 10%, 50 VDCW.
----- DIODES -----		
D701 thru D706	19A700053P2	Silicon, fast recovery (2 diodes in series).
----- JACKS -----		
J701	19B209727P29	Connector.
J702	19A704779P11	Connector; sim to Molex 22-17-2122.
----- PLUGS -----		
P703	19A704874P1	Connector: sim to: Elco 00-9021-18-12-00-339.
----- TRANSISTORS -----		
Q701 and Q702	19A700076P2	Silicon, NPN.
Q703 and Q704	19A702503P2	Silicon, NPN.
Q705	19A700076P2	Silicon, NPN.
Q706 and Q707	19A700059P2	Silicon, PNP.
Q708	19A700076P2	Silicon, NPN.
----- RESISTORS -----		
R701	19B800607P560	Metal film: 56 ohms + or - 5%, 200 VDCW, 1/8 w.
R702	19B800607P473	Metal film: 47K ohms + or - 5%, 200 VDCW, 1/8 w.
R703	19B800607P472	Metal film: 4.7K ohms + or - 5%, 200 VDCW, 1/8 w.
R704	19B800607P102	Metal film: 1K ohms + or - 5%, 200 VDCW, 1/8 w.

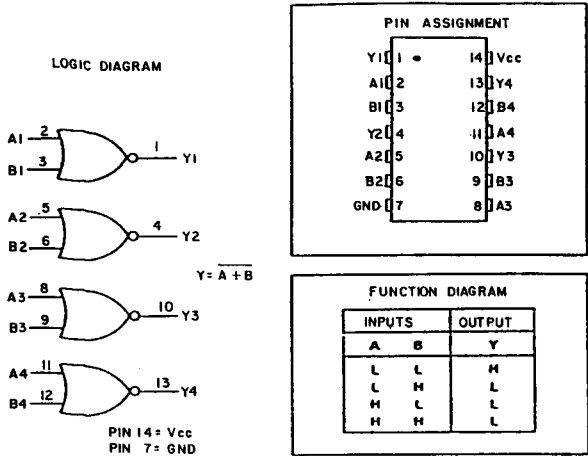
SYMBOL	GE PART NO.	DESCRIPTION
R705 and R706	19B800607P473	Metal film: 47K ohms + or - 5%, 200 VDCW, 1/8 w.
R707	19B800607P472	Metal film: 4.7K ohms + or - 5%, 200 VDCW, 1/8 w.
R708	19B800607P2R2	Metal film: 2.2 ohms + or -5%, 200 VDCW, 1/8 w.
R709 and R710	19B800607P103	Metal film: 10K ohms + or - 5%, 200 VDCW, 1/8 w.
R711 thru R713	19B800607P472	Metal film: 4.7K ohms + or - 5%, 200 VDCW, 1/8 w.
R714	19B800607P103	Metal film: 10K ohms + or - 5%, 200 VDCW, 1/8 w.
R715	19B800607P473	Metal film: 47K ohms + or - 5%, 200 VDCW, 1/8 w.
R716	19B800607P104	Metal film: 100K ohms + or - 5%, 200 VDCW, 1/8 w.
R717	19B800607P560	Metal film: 56 ohms + or - 5%, 200 VDCW, 1/8 w.
R718 thru R721	19B800607P103	Metal film: 10K ohms + or - 5%, 200 VDCW, 1/8 w.
R722	19B800607P332	Metal film: 3.3K ohms + or - 5%, 200 VDCW, 1/8 w.
R723	19A704885P5	Resistive Network: + or -2%, 1/8 w.
R724 thru R727	19B800607P101	Metal film: 100 ohms + or - 5%, 200 VDCW, 1/8 w.
R728	19B800607P103	Metal film: 10K ohms + or - 5%, 200 VDCW, 1/8 w.
R729	19B800607P102	Metal film: 1K ohms + or - 5%, 200 VDCW, 1/8 w.
R730	19B800607P332	Metal film: 3.3K ohms + or - 5%, 200 VDCW, 1/8 w.
R731 and R732	19B800607P272	Metal film: 2.7K ohms + or - 5%, 200 VDCW, 1/8 w.
R733	19B800607P473	Metal film: 47K ohms + or - 5%, 200 VDCW, 1/8 w.
R735	19B800607P1	Metal film: 0 ohms (50 Milli-ohms Max), 1/8 w.
----- INTEGRATED CIRCUITS -----		
U701	19A705557P2	Integrated circuit, microcomputer.
U702	19A704445P101	Integrated circuit.
U703	19A703471P102	Integrated circuit.
U704	19A704724P1	Digital: EE PROM; sim to XICOR X2404P.
U705	19A116297P7	Linear, OP AMP.
U706	19A705635Q2	Integrated circuit. Includes: Programmable Read Only Memory: 256K Ultraviolet Erasable.
U707	19A702934P3	Read/Write Memory, CMOS.
U708	19A704727P1	Integrated Circuit, Mode 28 Hook.
U709	19A704380P111	High speed, CMOS: OCTAL D Flip-Flop.
U710	19A703471P108	Integrated circuit.
U711	19A704380P201	High speed, CMOS: Dual J-K Flip-Flop with reset.
U712	19A704970P1	Voltage Regulator, 5 volts; sim to: 806 L387.
U713	19A703483P101	High speed, CMOS.
U714	19A705180P2	Potentiometer, digitally controlled; sim to CAT X9103P.
----- SOCKETS -----		
XU704	19A700156P15	Integrated circuit: 8 positions; sim to Burndy DILB 8P-108.
XU706	19B801236P3	Socket, strip.
----- CRYSTALS -----		
Y701	19A702511G15	Quartz: 11.059200 MHz.
----- MISCELLANEOUS -----		
	19B800608P156	Rivet Tube.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

DEMULTIPLEXER
19A704445PI01
(U702)

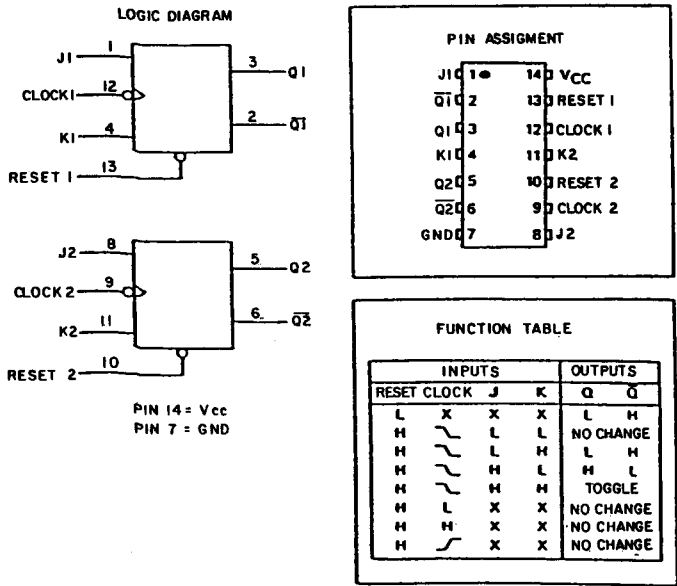
OCTAL D FLIP-FLOP WITH COMMON CLOCK AND RESET
19A704380PIII
(U709)

QUAD 2-INPUT NOR GATE
19A703483PI01
(U713)



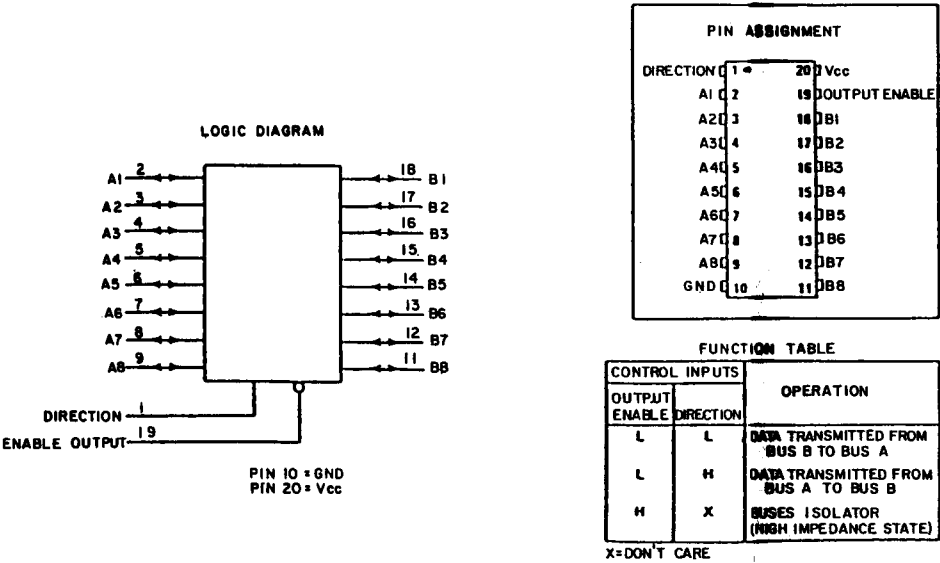
RC-8037

DUAL J-K FLIP-FLOP WITH RESET
19A704380P20I
(U711)



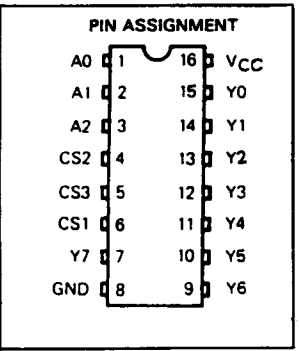
RC-8036

OCTAL 3-STATE NONINVERTING BUS TRANSCEIVER
19A703471PI08
(U710)



RC-8038

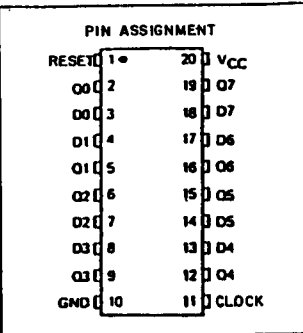
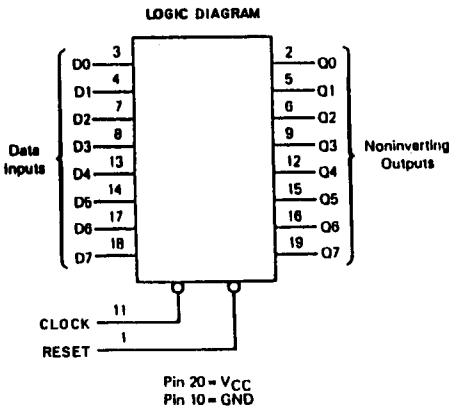
1-OF-8 DECODER



Inputs						Outputs							
CS1	CS2	CS3	A2	A1	A0	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	X	H	X	X	X	H	H	H	H	H	H	H	H
X	H	X	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	L	H	L	H	H	H	H	H	H	H
H	L	L	L	H	L	L	H	H	L	H	H	H	H
H	L	L	L	H	L	L	H	H	H	L	H	H	H
H	L	L	L	H	H	L	L	L	L	L	L	L	L
H	L	L	L	H	H	H	L	L	L	L	L	L	L
H	L	L	L	H	H	H	H	L	L	L	L	L	L
H	L	L	L	H	H	H	H	H	L	L	L	L	L
H	L	L	L	H	H	H	H	H	H	L	L	L	L
H	L	L	L	H	H	H	H	H	H	H	L	L	L
H	L	L	L	H	H	H	H	H	H	H	H	L	L

H = High Level (steady state)
L = Low Level (steady state)
X = Don't Care

RC-8028

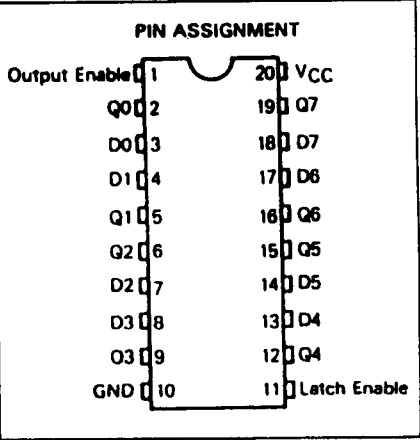
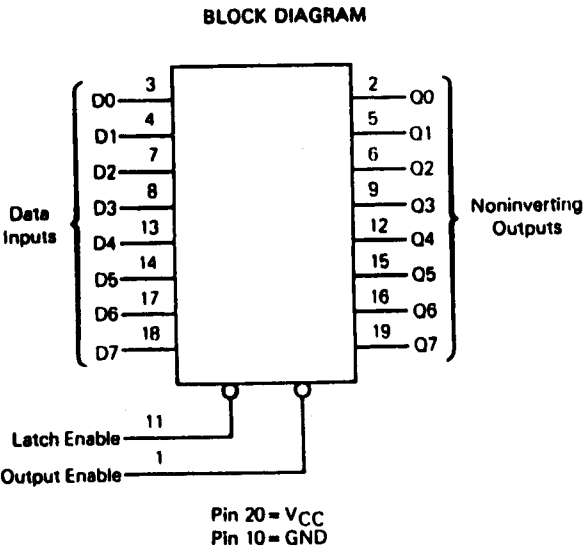


FUNCTION TABLE

INPUT		OUTPUT	
RESET	CLOCK	D	Q
L	X	X	L
H	X	H	H
H	X	L	L
H	X	X	NO CHANGE
H	X	X	NO CHANGE

RC-8035

74HC373 LATCH
19A703471PI02
(U703)



FUNCTION TABLE

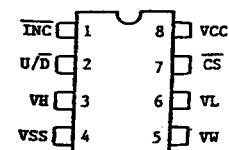
Output Enable	Latch Enable	D	Output
L	H	H	H
L	H	L	L
L	L	X	no change
H	X	X	Z

X = don't care
Z = high impedance

RC-8027

EEPOT 19A705180P2 (U714)

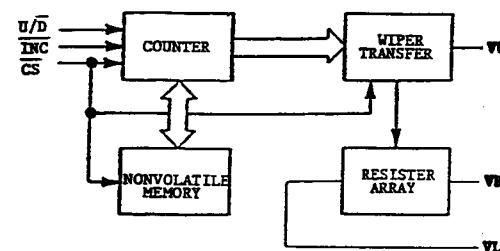
PIN CONFIGURATION



PIN NAME

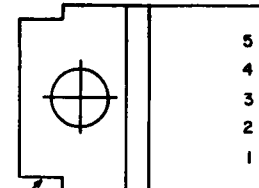
VH HIGH TERMINAL OF POT
VW WIPER TERMINAL OF POT
VL LOW TERMINAL OF POT
VSS GROUND
VCC SYSTEM POWER
U/D UP / DOWN CONTROL
INC WIPER MOVEMENT CONTROL
CS CHIP SELECT

FUNCTIONAL DIAGRAM

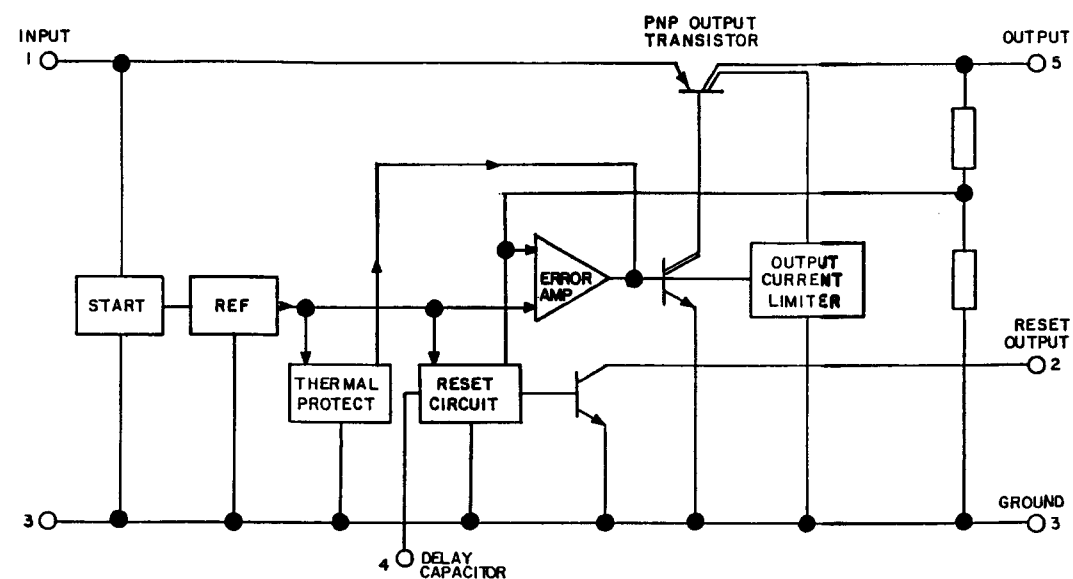


RC-8025

VOLTAGE REGULATOR (WITH RESET) 19A704970P1 PIN CONFIGURATION



(TAB CONNECTED TO PIN 3)

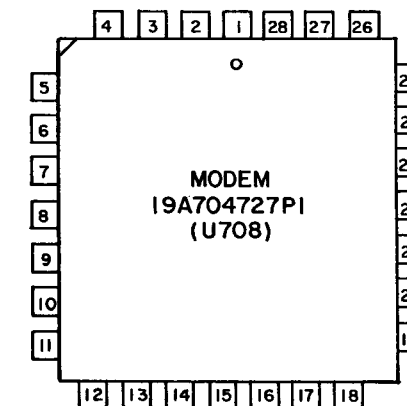


RC-5286A

IC DATA

LBI-38112

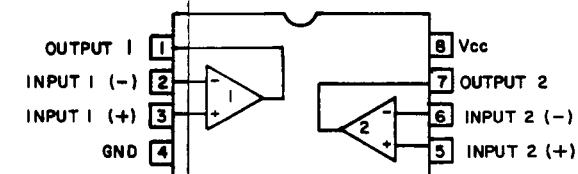
PIN	NAME	DESCRIPTION
1	RE	READ ENABLE (ACTIVE LOW).
2	EN	CHIP ENABLE (ACTIVE LOW).
3	RESOUT	RESET OUTPUT (ACTIVE HIGH).
4-11	ADD-AD7	BI-DIRECTIONAL ADDR/DATA BUS.
12	ALE	ADDRESS LATCH ENABLE (ACTIVE HIGH).
13	VSS	GROUND
14	CLK1	BUFFERED CLOCK OUTPUT.
15	VDD	+5V
16	XTAL1	OSCILLATOR INPUT.
17	XTAL2	OSCILLATOR OUTPUT.
18	CLK 2	640 kHz OUTPUT.
19	DATIN	RECEIVED DATA INPUT.
20	SAT	RECEIVED SAT INPUT.
21	TXDAT	TRANSMIT DATA OUTPUT.
22	RCVCLK	RECOVERED CLOCK OUTPUT.
23	RCVDAT	RECOVERED DATA OUTPUT.
24	INT	INTERRUPT REQUEST (ACTIVE LOW).
25	RESIN	RESET INPUT (ACTIVE HIGH).
26	CS	CHIP SELECT (ACTIVE LOW).
27	CLK 3	TRANSMIT CLOCK OUTPUT.
28	WR	WRITE ENABLE (ACTIVE LOW).



RC-8023

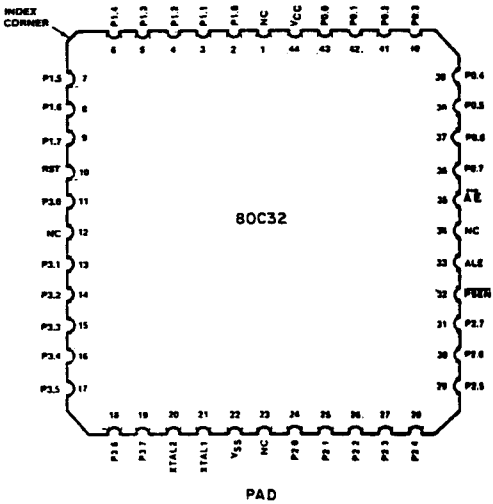
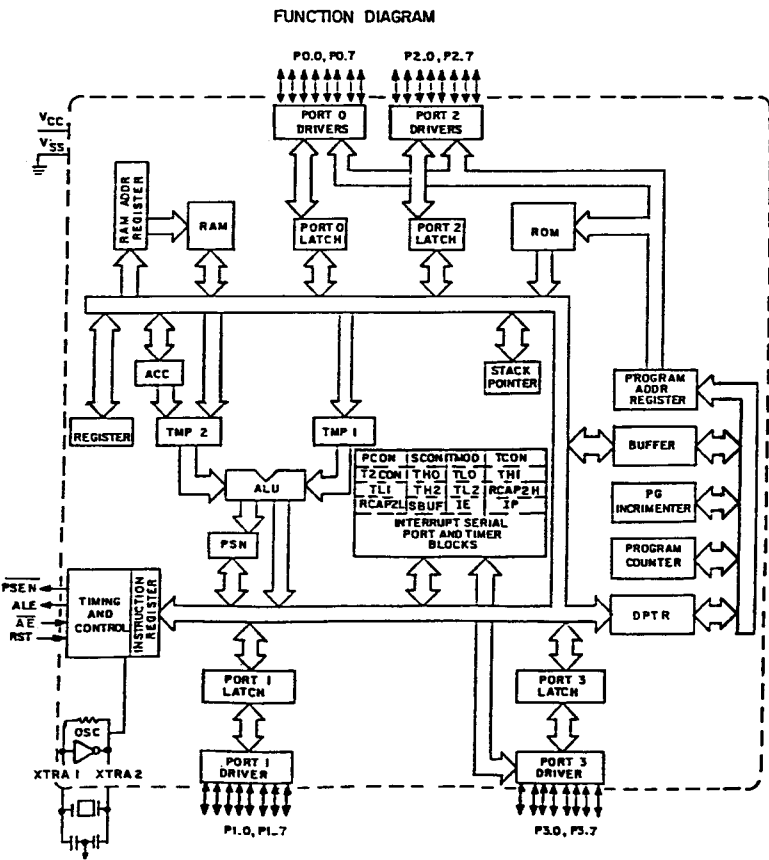
OP-AMP 19A116297P7 (U705)

PIN CONNECTIONS



RC-8026

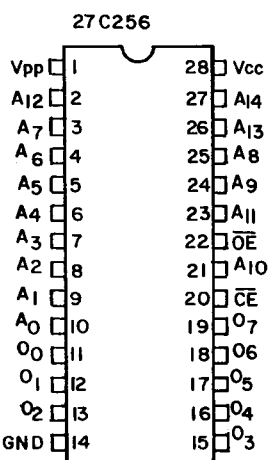
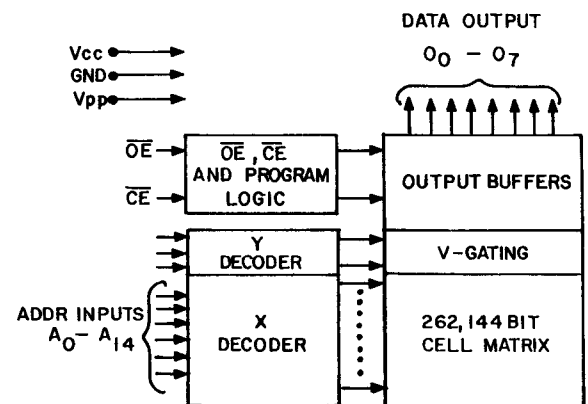
MICROCONTROLLER
19A705557P2
(U701)



VSS
VCC
PORT 0
PORT 1
PORT 2
PORT 3
RST
ALE
PSEN
EA
XTAL1
XTAL2

CIRCUIT GROUND POTENTIAL
+5V POWER SUPPLY
8-BIT OC BI-DIRECTIONAL I/O PORT.
8-BIT QUASI-BIDIRECTIONAL I/O PORT.
8-BIT QUASI-BIDIRECTIONAL I/O PORT.
8-BIT QUASI-BIDIRECTIONAL I/O PORT.
RXD — SERIAL PORT RECEIVER DATA.
TXD — SERIAL PORT TRANSMITTER DATA.
INT0 — INTERRUPT 0 INPUT.
INT1 — INTERRUPT 1 INPUT.
T1 — COUNTER 1 INPUT.
WR — WRITE CONTROL.
RD — READ CONTROL.
RESET.
ADDRESS LATCH ENABLE.
PROGRAM STORE ENABLE OUTPUT.
INTERNAL/EXTERNAL INSTRUCTION FETCH.
INPUT TO OSCILLATOR AMPLIFIER.
OUTPUT FROM OSCILLATOR AMPLIFIER.

EPROM
19A704305P3
(U706)



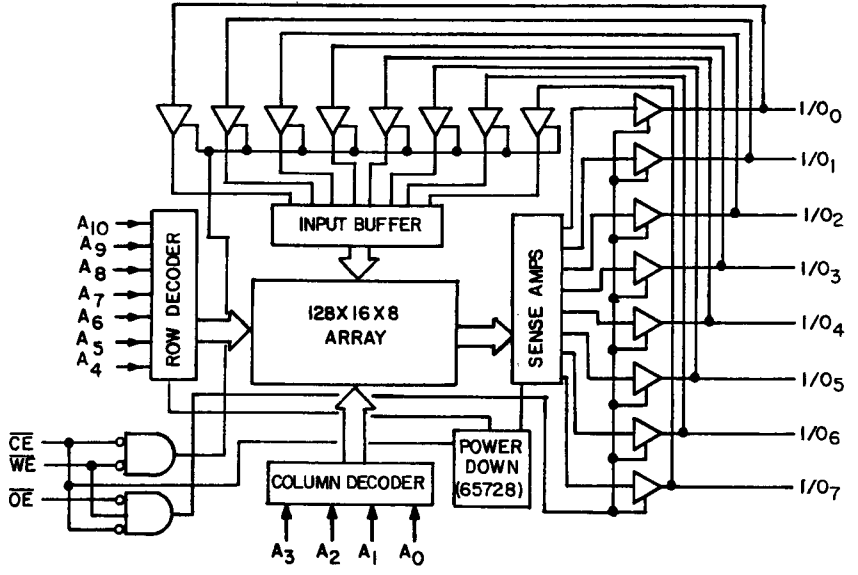
PIN NAME	
A0-A14	ADDRESSES
CE	CHIP ENABLE
OE	OUTPUT ENABLE
O0-O7	OUTPUTS

RC-8031

RC-8032

RAM
19A702934P3
(U707)

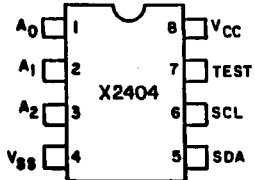
FUNCTIONAL DIAGRAM



RC-8034

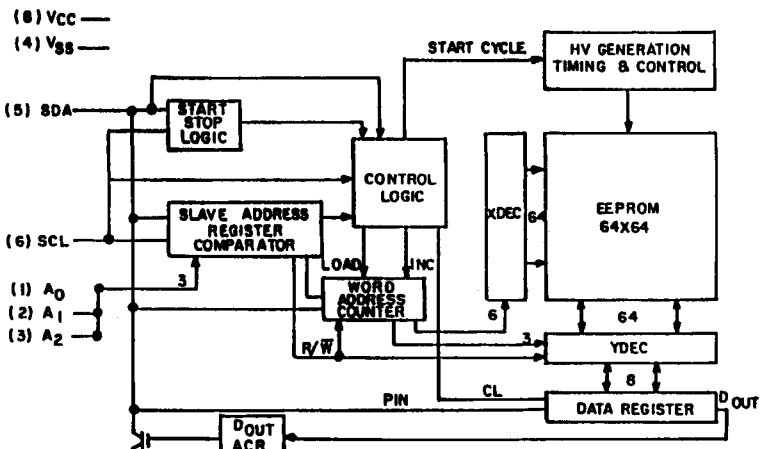
DIGITAL 512X8 EEPROM
19A704724P1
(U704)

PIN CONFIGURATION



1 A0 TO Vss
2 AND 3 A AND A ADDRESS INPUTS
4 Vss
5 SDA SERIAL DATA I²C BUS
6 SCL SERIAL CLOCK BUS
7 TEST INPUT TO Vss
8 Vcc

FUNCTION DIAGRAM



RC-5281A