

DIGITAL CLOCK/ CALENDAR CIRCUIT

CAL-TEX MOS INTEGRATED CIRCUITS

CT7001
(SERIES)

FEATURES

- 28/30/31 DAY CALENDAR
- 12/24 HOUR CLOCK AND 24 HOUR ALARM
- SNOOZE ALARM
- 50/60 Hz OPERATION
- 6 DIGIT DISPLAY (HR., MIN., SEC.)
- DIRECT DRIVE TO LUMINESCENT ANODE TUBES
- EASY INTERFACE WITH SPERRY TUBES
- DIRECT DRIVE TO LED SEGMENTS
- CLOCK RADIO FEATURES
- ON CHIP 60 Hz BACK-UP
- EASILY SETTABLE COUNTERS
- DEPLETION MODE MOS/LSI
- SEGMENT AND DIGIT BLANKING
- SEGMENT AND DIGIT OUTPUTS CAN BE "WIRE OR'D"
- TO SHARE CALCULATOR DISPLAY
- SEVEN-SEGMENT OR BCD OUTPUTS AVAILABLE

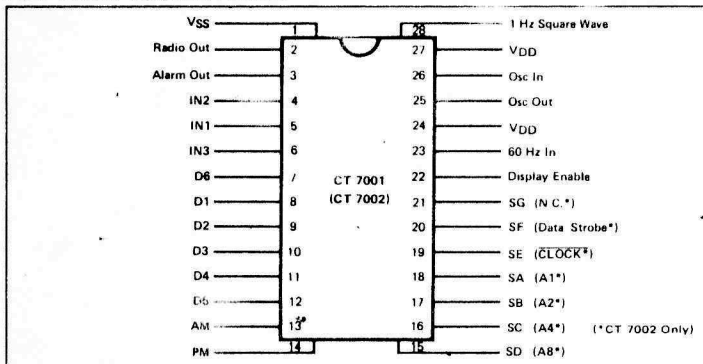
GENERAL DESCRIPTION

OCTOBER 1973

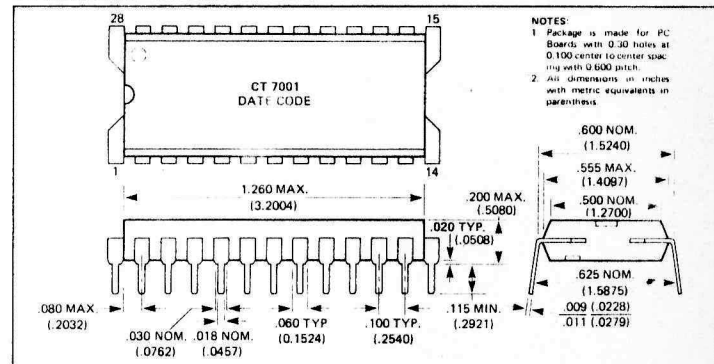
The CT7001 is an extremely versatile MOS/LSI digital clock/calendar circuit. The CT7001 has many features which may be selected by various wiring configurations of the three scanned input pins. This enables the user to easily tailor the CT7001 to his specific requirements. It is available with either seven segment outputs (CT7001) or BCD outputs (CT7002).

Setting any counter (time, alarm, calendar, and clock radio) is quite easy since a separate control of the hour and minutes digits has been provided. The setting of any counter does not affect the contents of any other counter.

PIN CONFIGURATIONS



PACKAGE TYPE



BLOCK SCHEMATIC

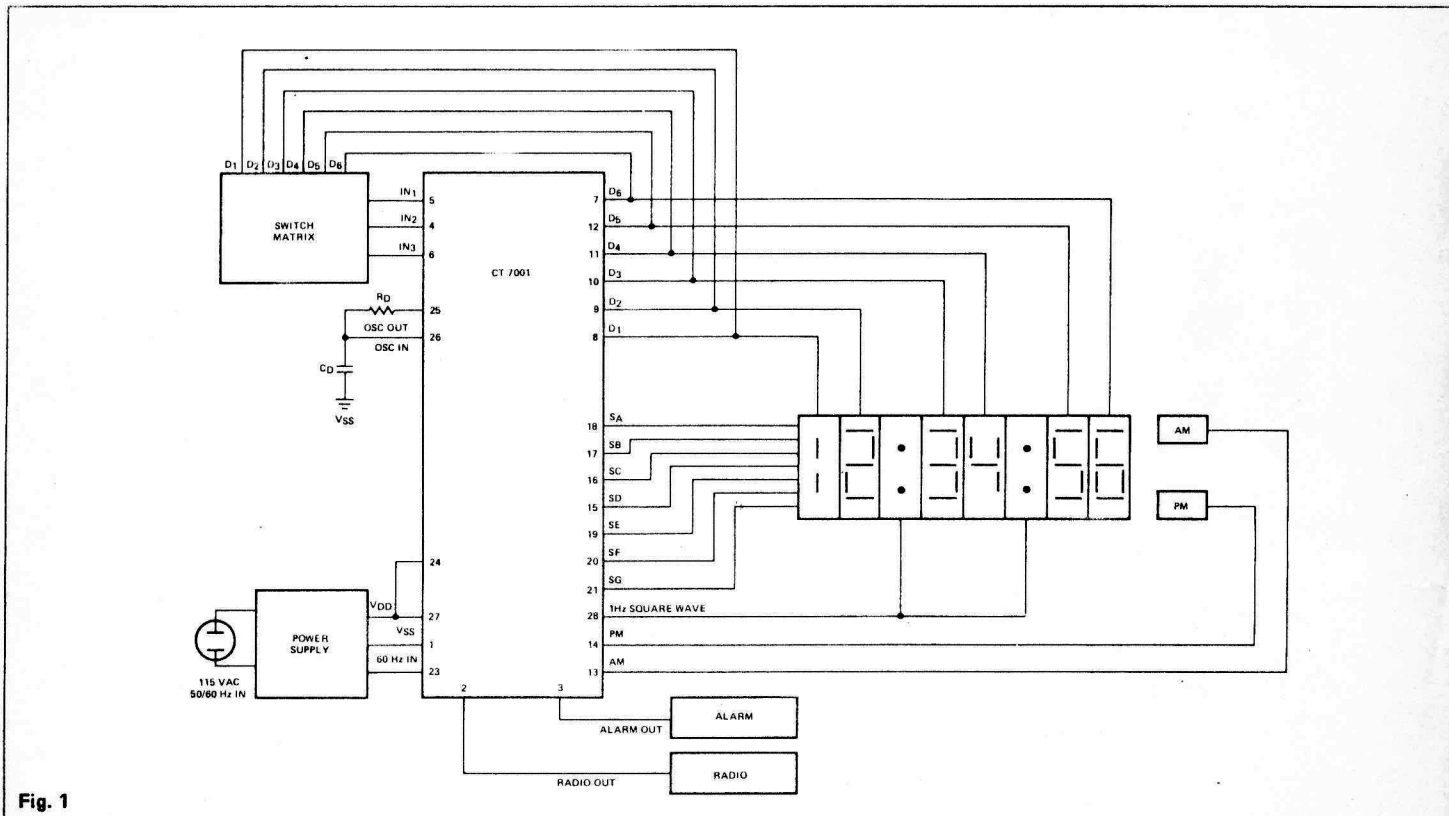


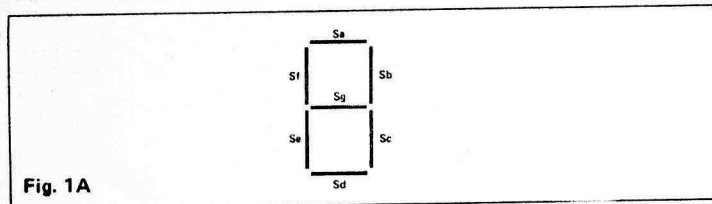
Fig. 1

CT7001 MOS/LSI DIGITAL CLOCK/CALENDAR CIRCUIT

The CT7001 will accommodate either four or six standard seven-segment displays. This circuit will direct drive luminescent common anode display tubes. The CT7001 will also direct drive the anodes of common cathode LED's. The CT7001 segment and digit outputs can be "wire OR'd" to other chips. This enables the clock to share the same display with another chip such as a calculator. See Figure 9.

The CT7001 can operate from either a 50/60 Hz line frequency or an external 100.8 KHz signal. If battery back-up is provided, the CT7001 will continue to operate during power outages by virtue of an on-chip 50/60 Hz backup counter.

DECODING OF SEGMENT DRIVER OUTPUTS



OPERATIONAL DESCRIPTION

Display Options

The display outputs consist of seven segment outputs (SA, SB, SC, SD, SE, SF, SG) multiplexed by six timing outputs (D1 ~ D6). The segment and digit outputs are active high. See Figure 1A. (See also paragraph on page 4 describing CT7002 BCD outputs.)

There are three normal display modes:

- 1) With no connections to the C₁ or C₂ inputs, time will be displayed for 8 seconds and calendar for 2 seconds.
- 2) Closing the C₂ input will cause the calendar to be displayed.
- 3) Closing the C₁ input will cause the time to be displayed.

See Scanned Input Options Table on page 3.

Both the AM and PM outputs are active only during the clock and alarm (12-hour sequence) display modes.

When the Display Enable Input (Pin 22) is connected to V_{DD}, the segment, digit, AM and PM outputs will float and the IN₁, IN₂ and IN₃ inputs will be disabled. This option can be used to "wire OR" the outputs to another chip. See Figure 9.

Clock Options

The two 24-hour modes are 12 hours with AM and PM or 24 hours (00 00 00 to 23 59 59). These options are selected by the 12/24 hour input.

The clock displays hours, minutes, and seconds. If the user desires to economize display costs, he need only use hours and minutes.

Calendar

The calendar displays month and day. The day counter will count the correct number of days for each month. The normal count for February is 28 days. February 29 must be manually set. The calendar will automatically count from February 29 to March 1.

Alarm

The alarm is a true 24-hour alarm.

When the clock is coincident with the preset alarm setting and the alarm switch is closed, the alarm output (Pin 3) will go high. The alarm is terminated by opening the alarm switch.

Snooze Alarm

By closing the snooze switch, the alarm output will be disabled for a period of 10 minutes. The snooze switch may be closed as many times as desired until the alarm is disabled by the alarm switch.

Clock Radio Options

There is a 9 hour and 59 minutes counter, which is settable in 1-minute increments, that is associated with the alarm and clock radio logic. This counter can be used to turn on the clock radio for the preset period of time. If the CT7001 is not used in a clock radio application, this counter can be used as an auxilliary appliance timer or for any other timing operation.

The radio out output (Pin 2) will go high for the preset time period by closing the clock radio switch and terminated prematurely by opening the clock radio switch. Mode A and Mode B inputs must be off for this condition. (See table on page 3.)

Radio out will go high for the preset time period and also go high at the alarm time. This condition is initiated by closing the clock radio switch and having Mode A input on and Mode B input off.

The Radio Out will be high for the preset time at the alarm time if the clock radio switch is closed and Mode A and Mode B inputs are on.

Setting Counters

First, the counter desired to be set is selected by the set clock, set calendar, set alarm, or set clock radio inputs. This results in the chip displaying the contents of the selected register. The digits to be set are selected by the Set H/M input. Closing the Set H/M input allows for the setting of the hours or months digits. Opening the Set H/M input allows for the setting of the minutes or days digits. Closing the set input increments the selected digits of the selected counter at a 1 Hz rate. Setting the digits of any counter will not affect the other digits of the counter or the contents of any other counter.

60-Second Timer

Reset the seconds counter by closing both the Set and Set Clock inputs. Open the Set input, the seconds counter will remain in the reset condition. Opening the Set Clock input will enable the seconds counter to start counting and closing the Set Clock input will freeze the contents of the seconds counter.

CT7001 MOS/LSI DIGITAL CLOCK/CALENDAR CIRCUIT

50/60 Hz Input

This circuit can operate from a 50 Hz or 60 Hz base input frequency. If the 50/60 Hz input is closed, the circuit operates from a 50 Hz input frequency. If the input is open, the circuit operates from a 60 Hz input frequency.

On Chip Display Oscillator

The on chip display oscillator drives the display multiplexing signals (D₁ ~ D₆). R_D and C_D must be connected to Pins 25 and 26 as shown in Figure 1. Suggested values for R_D and C_D are 1.5 K ohm and 150 pf respectively.

On Chip 50/60 Hz Backup Circuitry

This circuitry provides for continuous operation during an AC power failure.

The circuitry operates in conjunction with the display oscillator. For an accurate operation, R_D should be adjusted so that D1 is

1.05 KHz for 60 Hz operation and 875 Hz for 50 Hz operation.

External Time Base Operation

The circuit can operate from an external time base where more accuracy is required, or where there is no 50/60 Hz line frequency. Connect the 60 Hz in input to V_{SS} and open the Oscillator Out output (Pin 25). Connect a 100.8 KHz signal to the Oscillator In input (Pin 26).

Battery Backup

For protection from temporary AC power failures, it is advisable to connect a large filter capacitor or a rechargeable battery in parallel with the V_{DD} supply. See Figure 10.

If the V_{DD} backup voltage becomes too low for reliable circuit operation, the display will display all "8's" as a warning that the contents of the chip may be incorrect. This condition is reset by closing the Set input.

SCANNED INPUT OPTIONS:

INPUT PIN	SCAN TIME	INPUT NAME	DEFINITION CONNECTION	DEFINITION, NO CONNECTION
IN1	D ₁	Set	Set Counter	Set Counter
IN1	D ₂	Set H/M	Set Hour or Month Digit	Set Minute or Day Digit
IN1	D ₃	Clock Radio Switch	Clock Radio Switch - On	Clock Radio Switch - Off
IN1	D ₄	Mode A	Mode A - Off	Mode A - On
IN1	D ₅	Mode B	Mode B - On	Mode B - Off
IN1	D ₆	50/60 Hz	50 Hz Input	60 Hz Input
IN2	D ₁	Set Calendar	Set Calendar Counter	
IN2	D ₂	Set Clock	Set Clock Counter	
IN2	D ₃	Set Alarm	Set Alarm Counter	
IN2	D ₅	Set Clock Radio	Set Clock Radio Counter	
IN2	D ₆	Snooze Switch	Snooze Switch - On	Snooze Switch - Off
IN3	D ₁	Alarm Switch	Alarm Switch - On	Alarm Switch - Off
IN3	D ₂	12/24 Hour	24-Hour Operation	12-Hour Operation
IN3	D ₃	C ₁	C ₁	C ₁
IN3	D ₄	C ₂	C ₂	C ₂

DIGIT MULTIPLEXING

DIGIT TIME	TIME	CALENDAR	DIGIT TIME	TIME	CALENDAR
D ₁ - PIN 8	10 HR	10 MONTHS	D ₄ - PIN 11	1 MIN	1 DAY
D ₂ - PIN 9	1 HR	1 MONTH	D ₅ - PIN 12	10 SEC	
D ₃ - PIN 10	10 MIN	10 DAYS	D ₆ - PIN 7	1 SEC	

DIGIT TIMING

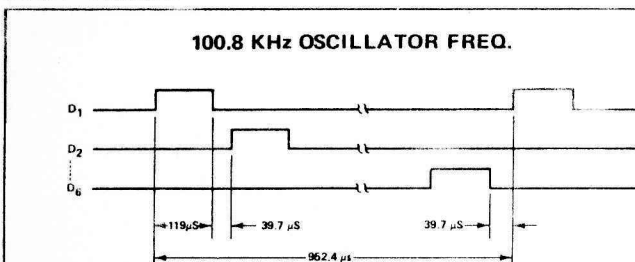


Fig. 2

SEGMENT TIMING

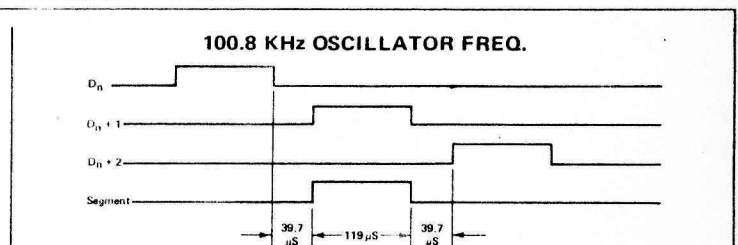


Fig. 3

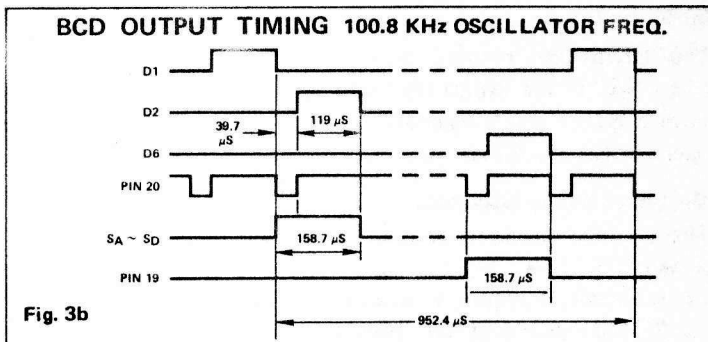
CT7001 MOS/LSI DIGITAL CLOCK/CALENDAR CIRCUIT

BCD OUTPUT OPTION

The CT7002 is electrically the same as the CT7001 but provides BCD outputs in place of the standard seven-segment format. Outputs from pins 15, 16, 17, and 18 are in BCD format as shown below.

DATA	A1(18)	A2(17)	A4(16)	A8(15)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

Pin 19 is valid at digit 6 time as shown in Figure 3b. This output is only present when data other than clock (calendar, alarm or clock radio) is being displayed. Pin 20 is an "active low" Data Strobe which is present every digit time as shown in Figure 3b. Pin 21 is not connected. Low voltage detection is the same as the CT7001 except the indication is A₁ and A₈ outputs are high.



ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS} (Except Sa to Sg, 1 Hz Sq. Wave, D₁ to D₆, AM, PM) +0.3 to -20V
 Voltage on Sa to Sg, 1 Hz Sq. Wave, D₁ to D₆, AM, PM relative to V_{SS} +0.3 to -35V
 Operating Temperature (Ambient) 0°C to 70°C
 Storage Temperature (Ambient) -55°C to 150°C

RECOMMENDED OPERATING CONDITIONS

PARAMETER		LIMITS		
		MIN	MAX	UNITS
V _{DD}	Supply Voltage	-17.0	-10.0	V
I _{DD}	Supply Current @ -10.0V		10	mA

CT 7001 SYSTEM BLOCK DIAGRAM

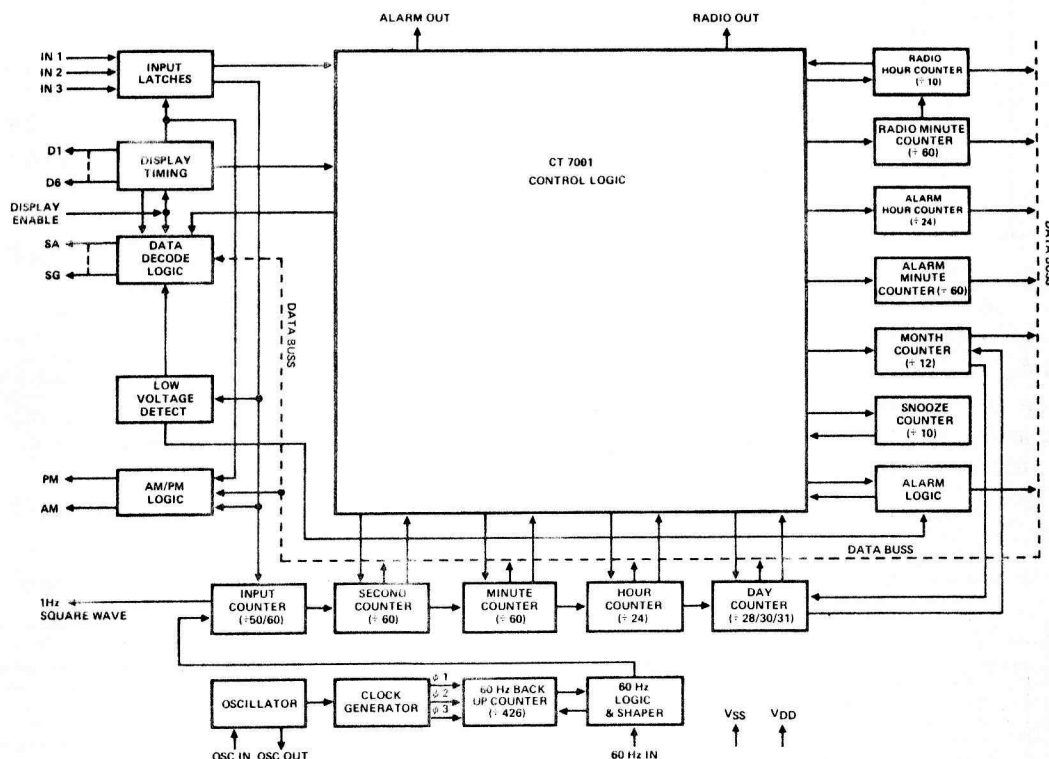


Fig. 4

ELECTRICAL CHARACTERISTICS ALL SPECIFICATIONS ARE AT $T_A = 25^\circ\text{C}$

PARAMETER	MIN	MAX	UNITS	NOTES
INPUTS:				
IN ₁ , IN ₂ , IN ₃				
V _{IN} "1" level	-5.0	+0.3	V	3
V _{IN} "0" level	—	V _{DD} + 0.5	V	
60 Hz IN, OSC IN, Display Enable				
V _{IN} "1" level	-1.0	+0.3	V	4
V _{IN} "0" level	—	V _{DD} + 0.5	V	
All Inputs @ V _{IN} = -17V	—	25	μA	
OUTPUTS:				
Radio Out, Alarm Out				
I _{OUT} "1" level @ V _{OUT} = -1.0V	0.5	—	mA	1
I _{OUT} "0" level @ V _{OUT} = V _{DD}	—	25	μA	
D ₁ to D ₆ , S _a to S _g , 1 Hz Sq. Wave, AM, PM				
I _{OUT} "1" level @ V _{OUT} = -4.0V	5.0	—	mA	1
I _{OUT} "1" level @ V _{OUT} = -1.0V	1.0	—	mA	
I _{OUT} "0" level @ V _{OUT} = -35.0V	—	25	μA	
OSC Out				
I _{OUT} "1" level @ V _{OUT} = -1.0V	0.4	—	mA	
I _{OUT} "0" level @ V _{OUT} = V _{DD} + 1.0V	40.0	—	μA	

NOTES:

- Open Drain Output — external pull-up resistors to V_{DD} required.
- All voltages are in reference to V_{SS} = 0 Volts.
- On inputs IN₁, IN₂, IN₃, an internal 125 K Ω (typ) resistor to V_{DD} is provided.
- V_{DD} = -17V and V_{SS} = 0V.

LED INTERFACE (Common Cathode)

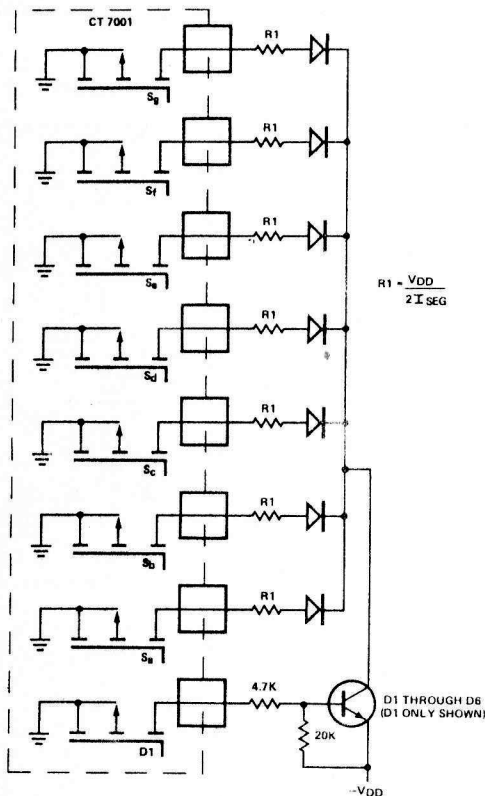


Fig. 5

PLASMA DISPLAY

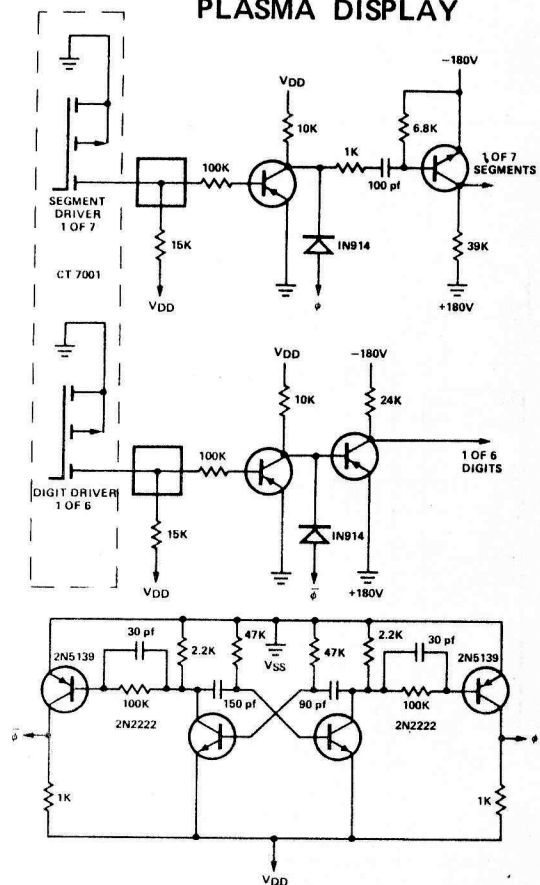


Fig. 6

CT7001 MOS/LSI DIGITAL CLOCK/CALENDAR CIRCUIT

FLUORESCENT TUBE INTERFACE

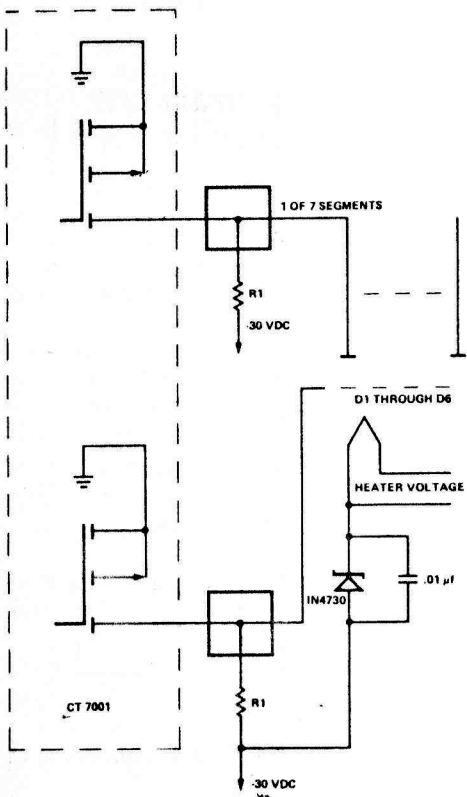


Fig. 7

GAS DISCHARGE TUBE INTERFACE

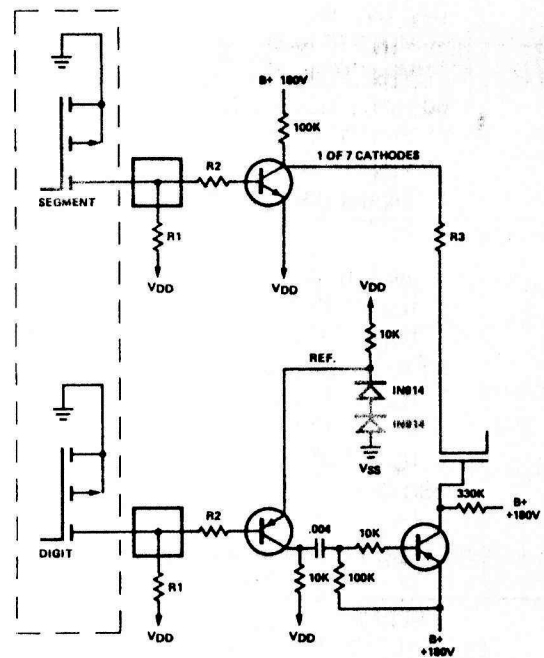


Fig. 8

CALCULATOR/CLOCK COMMON DISPLAY INTERFACE

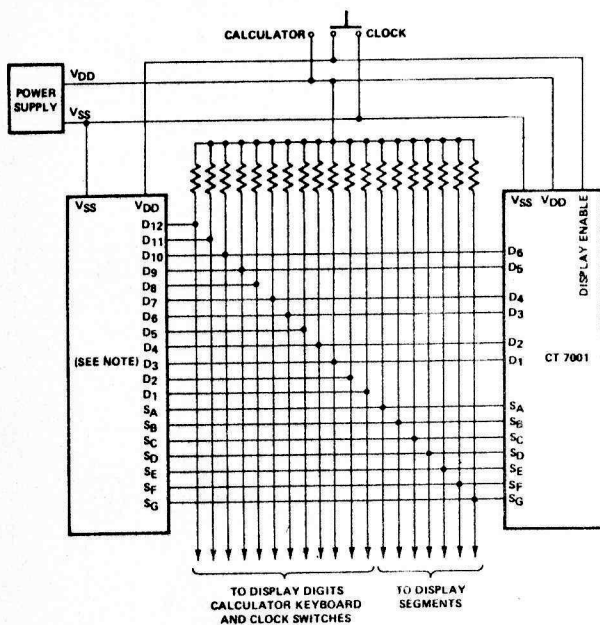


Fig. 9

NOTE: Calculator Chip must have "active high" outputs (similar to CT5002, CT5007 or CT5030 series).

POWER SUPPLY WITH BATTERY BACK-UP CIRCUIT

60 Hz INPUT CIRCUIT

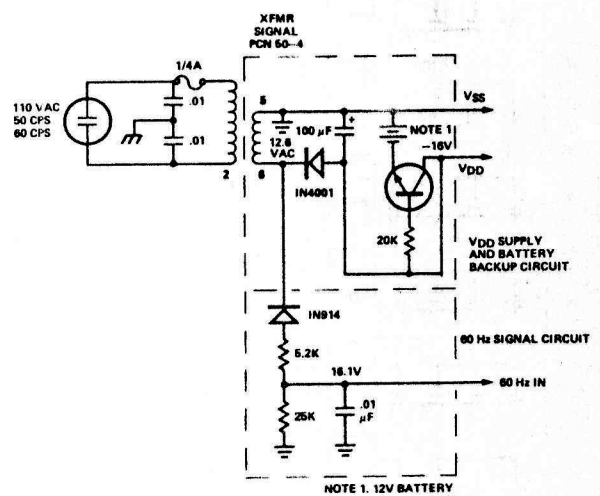


Fig. 10

DIGITAL CLOCK/CALENDAR

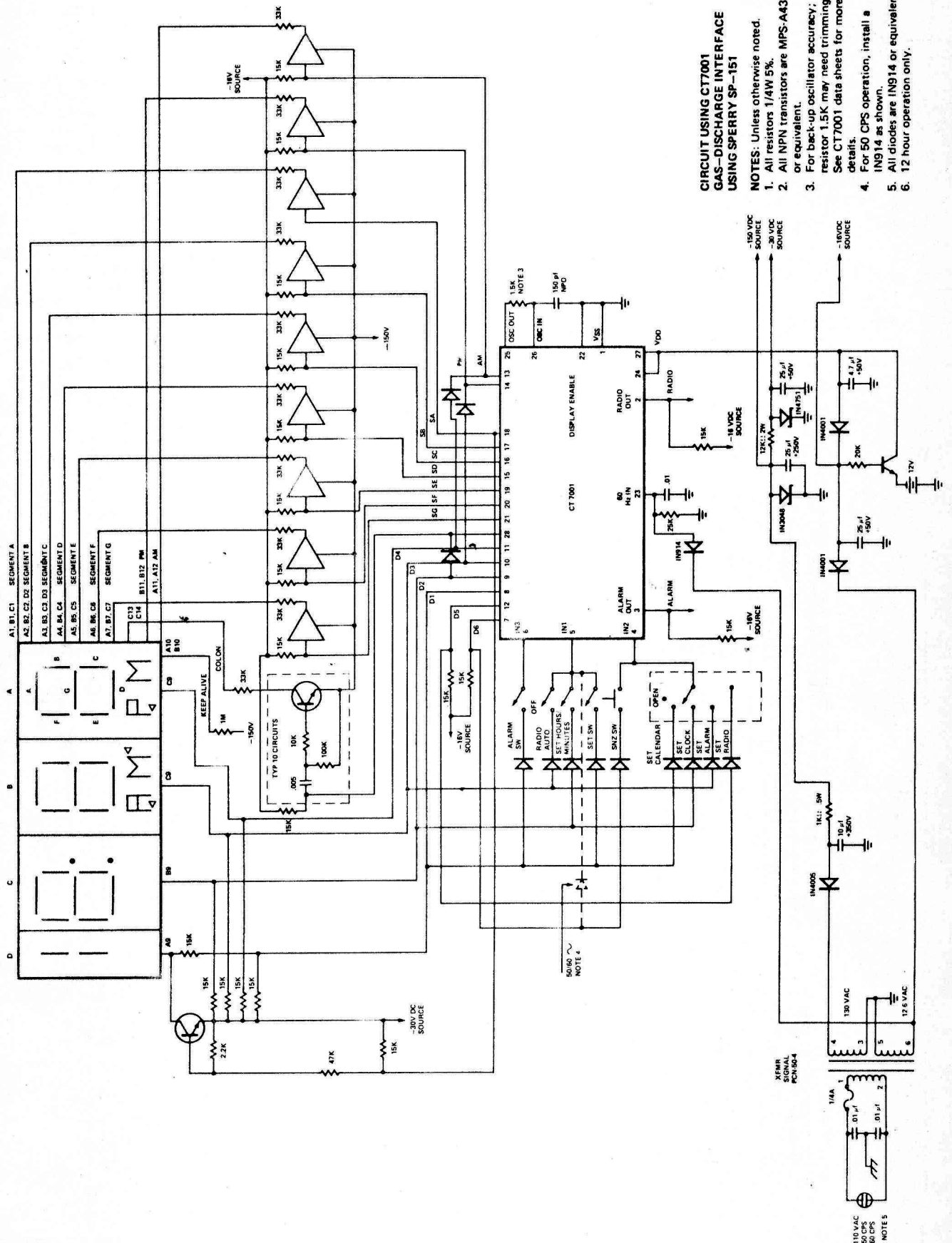
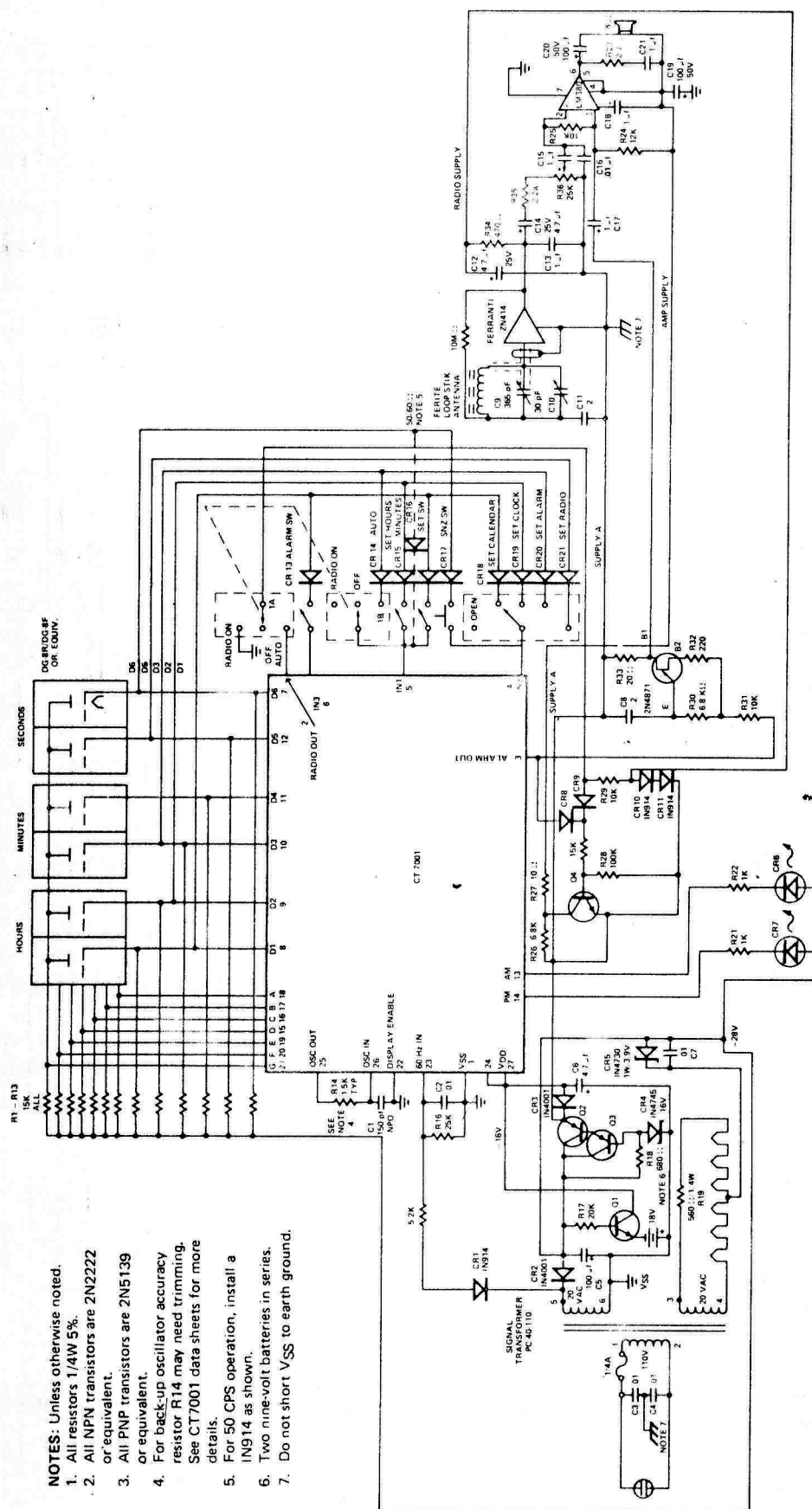


Fig. 11

CAL-TEX CANNOT ASSUME RESPONSIBILITY FOR THE CIRCUIT SHOWN OR REPRESENT THAT IT IS FREE FROM PATENT INFRINGEMENT.



DIGITAL CLOCK/CALENDAR/AM RADIO CIRCUIT WITH ALARM USING CT7001

Fig. 12