TOKO, INC.

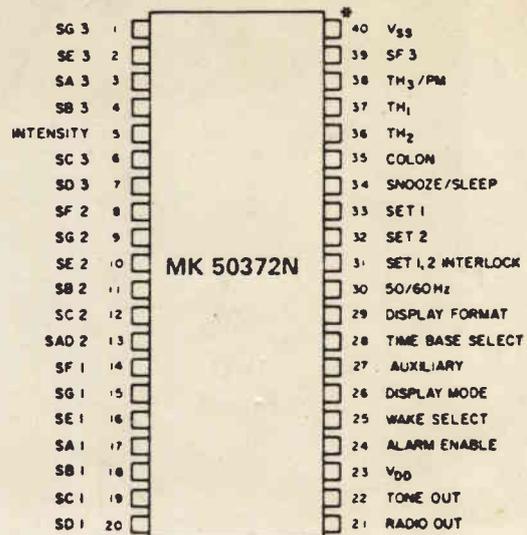## NON-MULTIPLEXED CLOCK RADIO TIMER

MK 50372N

FEATURES

- Single chip operation
- LED direct drive (10mA/segment)
- Fluorescent direct drive
- Simple forward or reverse time setting
- Intensity control
- 4-digit non-multiplexed display
- Slow up circuitry eliminates RFI
- AM/PM and 1Hz activity indicator
- 12 Hr. or 24 Hr. display format
- 50Hz or 60Hz
- 24-Hr. Alarm
- Three function wake select (radio, radio & tone, radio followed by tone in 8 minutes)
- Variable sleep (1 to 59 minutes)
- Count inhibit
- Seconds display
- Set 1,2 interlock pin
- Power-up clear
- Brown-out indication
- Leading zero suppression for tens of hours
- Four year calendar
- Month date or date month format
- One time zone register
- A second alarm time

DESCRIPTION

The MK50372N is a versatile MOS/LSI clock circuit by TOKO using its depletion-load, ion-implantation process and P-channel technology. The circuit can be used to construct a digital radio alarm clock

PIN CONNECTIONS   Top View

	Pin		Pin	
SG 3	1		40	Vss
SE 3	2		39	SF 3
SA 3	3		38	TH3/PM
SB 3	4		37	TH1
INTENSITY	5		36	TH2
SC 3	6		35	COLON
SD 3	7		34	SNOOZE/SLEEP
SF 2	8		33	SET 1
SG 2	9		32	SET 2
SE 2	10	MK 50372N	31	SET 1,2 INTERLOCK
SB 2	11		30	50/60Hz
SC 2	12		29	DISPLAY FORMAT
SAD 2	13		28	TIME BASE SELECT
SF 1	14		27	AUXILIARY
SG 1	15		26	DISPLAY MODE
SE 1	16		25	WAKE SELECT
SA 1	17		24	ALARM ENABLE
SB 1	18		23	VDD
SC 1	19		22	TONE OUT
SD 1	20		21	RADIO OUT

*NOTE: Indexing dot is on bottom of package. Indexing dot is adjacent to pin 40. See package description.

with the addition of only a simple power supply and display. The MK50372N will display time in either a 12 or 24 hour format and will accept either a 50Hz or 60Hz input. An AM/PM and activity indicator (flashing colon) is generated by the chip. The alarm has three modes of operation: tone & radio, radio only, and radio followed by a tone. The alarm operates in a 24-hour mode, which allows the alarm to be disabled and immediately re-enabled to activate 24 hours later. The snooze inhibits an activated alarm for 10 minutes. The sleep feature activates the radio for an adjustable period of time of 1 to 59 minutes.

Additional features on the MK 50372N include a four year calendar that can be displayed in either month-date or date-month format, a time zone register and a second alarm time.

ABSOLUTE MAXIMUM RATINGS (all voltages relative to $V_{SS} = 0$ volts)

Operating temperature range (ambient) . . . . .0°C to 50°C

Storage temperature range (ambient) . . . . −55°C to 125°C

Voltages on segment and colon outputs . . . . +0.3 to −26V

Voltage on all other pins . . . . +0.3V to −20V

Circuit power dissipation . . . . 1.25 Watts @ T_A = 25°C (Refer to derating curve)

*Operation at or above absolute maximum ratings may cause permanent damage to the device.

RECOMMENDED OPERATING CONDITIONS (0°C to 45°C)

| PARAMETER	MIN	MAX	UNITS	NOTES
Operating Voltage, V_{DD}	−12	−16	Volts	
Standby Voltage, V_{DD}	−6.0	−10.0	Volts	1,2
Input Logic Levels: Set 1, Set 2, Display Mode, Snooze/Sleep, 50/60Hz, Display Format, Alarm Enable, Wake Select, Time Select, Time Base Select, Auxiliary	V_{SS} V_{DD} +1.0	V_{SS}−1.0 V_{DD}	Volts Volts	Logic "1" Voltage Logic "0" Voltage
Intensity Control	3	30	K−OHMS	3
Segments, Colon		−26	Volts	4

Note 1. Brown out will occur when operating power is in this range.
Note 2. Data will be retained. However, the chip may not continue to count.
Note 3. When using fluorescent displays, connect pin 5 to V_{DD}.
Note 4. Leakage 40 μA − 26V relative to V_{SS}.

ELECTRICAL CHARACTERISTICS OVER RECOMMENDED OPERATING CONDITIONS T_A (+25°C)

PARAMETER	MIN	MAX	UNITS	NOTES
*Segments	10.0	16.0	mA	V_{DD} = −15V, R = 3K, V_{FWD} LED = 1.8V
*Segments	.5	2.0	mA	V_{DD} = −15V, R = 30K, V_{FWD} LED = 1.8V
Radio/Alarm Out Logic "1" Current	1.0		mA	V_{DD} = −12V
Logic "1" Voltage	V_{SS}	V_{SS}−2	Volts	V_{DD} = −12V OPEN DRAIN
Supply Current I_{DD}		10	mA	Outputs Open
*V_{DRAIN} Segments and Colon	−3.0		Volts	

*NOTE: Colon, SAD_2, TH_1, TH_2, are double this value. TH_3 is 3X when a 2 or 3 is in MSD or 1X when used to drive AM PM indicator.

INTENSITY
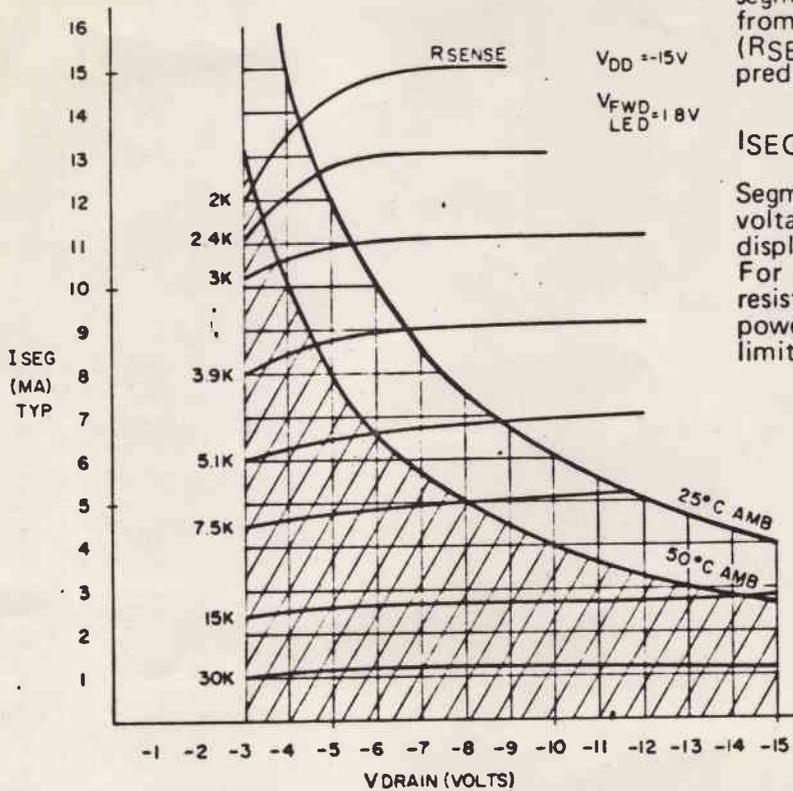
The intensity input regulates the current of the segment outputs and colon output. Over a range from 3K Ω to 30K Ω for the intensity resistor (RSENSE), the following equation may be used to predict segment current (ISEG):

$$I_{SEG} \cong 18 \frac{V_{FWD} \text{ LED (in volts)}}{R_{SENSE} \text{ (in Kohms)}} \text{ mA}$$

Segment current is relatively independent of the voltage on the segment pins, therefore the LED display voltage supply need not be well filtered. For minimum value of R_{SENSE} (intensity control resistor), care should be taken to insure total circuit power dissipation does not exceed safe operating limits described by the graph.

TOTAL CHIP POWER DISSIPATION
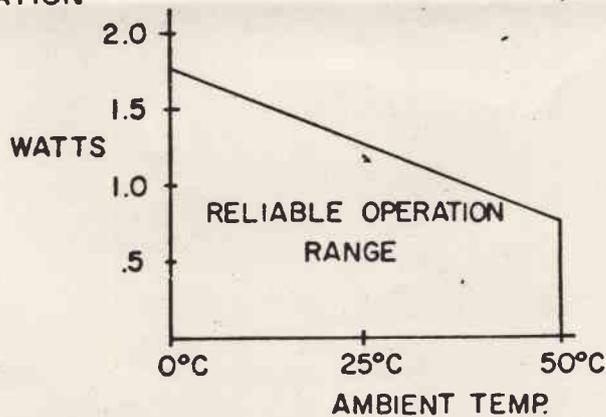
RECOMMENDED POWER SUPPLY FOR LED OPERATION

3
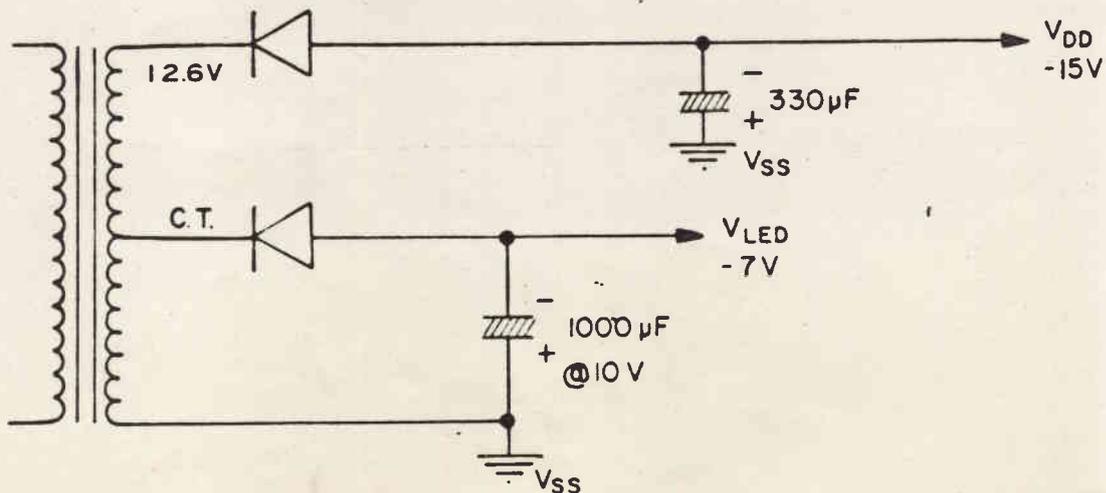
OPERATION

POWER UP

When power is initially applied both real time and alarm time will be at 12:00 midnight in the 12 hour mode or 0:00 in the 24 hour mode with the display blinking. If the alarm is enabled it will activate upon power up conditions in the mode selected. To begin timekeeping when power up conditions occur, enable set 1,2 interlock and activate either set 1 or set 2 to adjust time. To insure power up display blinking, the V_{DD} supply must have a RISE TIME minimum of 50 micro seconds. Also, set 2 must have less than 100 pF wiring capacitance attached.

BROWN-OUT

If a "brown-out" occurs, all digits will flash at a 1Hz rate to signify a possible incorrect display time. The low power indication continues until proper power is restored and the set 2, forward switch is closed. This condition may occur at power up. Brown out is triggered when the power supply is in the range of $-6V$ to $-10V$.

DISPLAY MODE

A Three State Input is one of the features which TOKO has employed on the circuit to reduce system expense and simplify operation. By switching Display Mode to one of three possible states the mode of operation is as follows:

Display Mode Input	Mode
VSS	Alarm 1
Open	Current Time
VDD	Seconds

When in the alarm mode, the alarm time is displayed and may be altered using the time set procedure (see setting). In the current time mode the current time is displayed and may also be altered using the same procedure. Connection of the display input to V_{DD} will display the seconds in the minutes digit and the hours digit will be blanked. All set inputs will be ignored, while seconds are displayed. Current time setting requires Set 1, 2 interlock to be at V_{SS}.

SETTING

The setting mode allows either a forward setting or reverse setting of the display. The setting inputs are:

Set 1 or Set 2 Input	Mode
VSS	Forward Set
Open	—
VDD	Reverse Set

Current time setting requires Set 1, 2 interlock to be at V_{SS}. When either the set 1 input or set 2 input is connected to V_{SS} the display will increment. Connecting the input to V_{DD} will decrement the display. When the display is not being set, the inputs should be left open. The set 1 input changes the hours digits at two counts per second. The set 2 input changes the minute digits at two counts per second. Carrys or borrows are not allowed during time setting, except that minutes will carry to tens of minutes. Both set 1 and set 2 activation changes the tens minute display.

TIME BASE SELECT

A three state input allows selection of 50Hz, 60Hz or Count Inhibit. The input states are:

Time Base Select	Mode
VSS	60Hz
Open	Count Inhibit
VDD	50Hz

If the time base select input is connected to V_{SS}, the clock will require a 60Hz input. Connection of the input to V_{DD} will require a 50Hz input. Opening the input will reset the seconds to zero and inhibits the counting.

DISPLAY FORMAT

The display format is used to select a 12 hour display, 24 hour display or to blank the display. The connections are:

Display Format Input	Mode
VSS	12 Hour
Open	Blank Display
VDD	24 Hour

In the 12 hour mode, the hours digits will display time in 12 hour format with a PM output. When the input is connected to V_{DD}, the format will be 24 hour time. In the blank mode the segment outputs will float, allowing wire-or conditions. The colon or activity indicator will be on and blinking.

SET 1,2 INTERLOCK

Set 1,2 interlock is provided to prevent current time changes by accident. Any other settable function may be altered without regard to the interlock state.

ALARM ENABLE/WAKE SELECT

The alarm can operate in three modes according to the level of the wake select pin. The states are defined as:

Wake Input	Mode
VSS	Tone and Radio
Open	Radio
VDD	Radio followed by Tone (8 minutes later)

The Alarm enable pin disables alarm 1 when connected to V_{SS}. If it is left open it will enable alarm 1. When the alarm occurs it may be disabled and immediately re-enabled and will activate 24 hours later at the alarm time. The alarm will self-disable after one hour of operation. Three modes of alarm output are selectable. Radio and tone, radio only and radio followed by tone.

The tone output is in the range of 200 to 1000Hz and conducts to V_{SS} 8.3% of the time at a 1Hz rate. The tone output is open drain.

The radio output, when activated by the alarm or sleep function, will conduct to Vss. This output is open drain.

When an alarm cycle begins, if radio and tone were selected, both the radio output and tone output become active. If radio only was selected the radio output becomes active. If radio followed by tone mode is selected when an alarm cycle begins, the radio output becomes active immediately and eight minutes later the tone output activates.

Any alarm mode remains active until the alarm is disabled or one hour time out when the alarm is automatically reset to activate 24 hours later.

Alarm modes can be demonstrated by setting alarm time and mode, enabling the alarm, and then "chase" alarm time with current time. Radio followed by tone and the automatic alarm time out can be demonstrated by advancing current time using set 1 and set 2.

SNOOZE/SLEEP INPUT

The snooze and sleep inputs use a single pin to select snooze or sleep. The connections are:

Snooze/Sleep	Mode
Vss	Snooze
Open	No Change
Vdd	Sleep

The Snooze feature will temporarily turn off an activated radio and tone outputs to allow an additional 10 minutes sleep. Momentarily connecting snooze to Vss will activate the snooze. If left open an internal pull-down resistor will maintain the snooze feature inoperative.

If an alarm cycle is not in progress, connection of the snooze/sleep pin to Vdd will display the sleep time in minutes in the minutes digits. The time will start at 59 minutes, and the set 1, 2 inputs are used to set the sleep time. Radio out will conduct to Vss for the amount of time set.

The snooze input will reset an active sleep time. Sleep can be timed out for demonstrations using set 2 to advance current time.

COLON

In normal operation, the colon flashes at 1 one Hertz rate for an activity indicator. The colon output conducts to Vss with a 50% duty cycle in the 60Hz mode and 60% duty cycle in the 50Hz mode. It is continuously active regardless of display mode selected.

AM/PM OUTPUT

When in the 12 hour operating mode, the TH3/PM output conducts to Vss when active. The indicator will change states when the hours change from 11 to 12. When in the 24 hour mode this output drives segments A, D, & G on the most significant digit.

Consideration must be given to wiring the display to accommodate both 12 hour and 24 hour operation using the same display.

INTENSITY

The intensity input regulates the brightness of the displayed digits. A photo device ranging from $3K\Omega$ to $30K\Omega$ is recommended to control this input.

FUNCTION SELECTION

The displayed function is set using the set inputs while the appropriate function is displayed using the display mode input and auxiliary input. The set 1 input changes the hours or month digits at two counts per second. The set 2 input changes the minute or date digits at two counts per second. Carrys or borrows are not allowed during setting except for an illegal month date combination, and minutes to tens of minutes digits.

The additional features are selected by using the Display Mode Input and the Auxiliary Input. The selection is:

Function	Display Mode Input	Auxiliary Input
Alarm 1 Set	Vss	Open
Current Time	Open	Open
Seconds	Vdd	Open
Month Date	Open	Vss
Date Month	Open	Vdd
Alarm 2 Set	Vss	Vss
Time Zone	Vdd	Vdd

MONTH–DATE CALENDAR

The calendar is a four year calendar. Connecting the Auxiliary input to Vss will display a Month-Date format. A Date-Month format can be selected by connecting the Auxiliary input to Vdd. The display mode input must remain open.

TIME ZONE

In addition to current time, an additional time zone can be displayed. The time zone is displayed by connecting both the Display Mode and Auxiliary inputs to Vdd.

SECOND ALARM TIME

The second alarm time can be displayed by connecting the Display Mode input and the auxiliary input to Vss. To enable the alarm, the Alarm Enable pin should be connected to Vdd. Alarm 2 has the one hour automatic shutoff. Sleep will not be active during an alarm cycle. While in an alarm cycle, activating sleep will have no effect on the display, radio output or alarm.

INPUT SELECTION TABLE

Function	V_{SS}	Open	V_{DD}	Aux Input
Display Mode	Alarm 1	Current Time	Seconds	Open
Display Mode	Alarm 2	Month Date		VSS
Display Mode		Date Month	Time Zone	VDD
Set 1	Forward		Reverse	N.A.
Set 2	Forward		Reverse	N.A.
Time Base Select	60Hz	Count Inhibit	50Hz	N.A.
Display Format	12 Hour	Blank	24 Hour	N.A.
Wake Select	Tone & Radio	Radio Only	Radio followed by Tone	N.A.
Alarm Enable	OFF	Enable 1	Enable 2	N.A.
Snooze/Sleep	Snooze		Sleep	N.A.
Set 1,2 Interlock	Set Current Time	Inhibit Set Current Time	Reset	N.A.

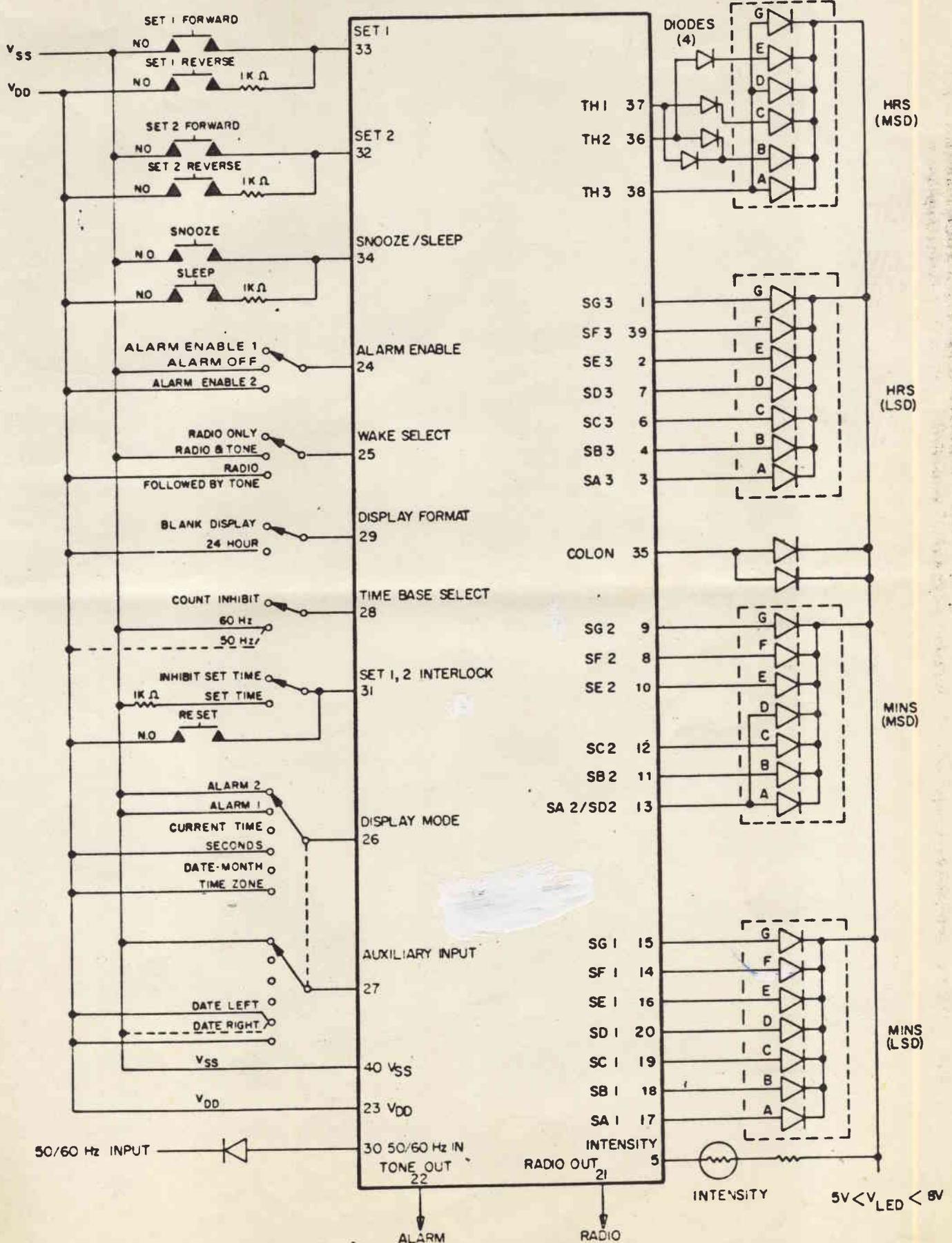## PACKAGE DESCRIPTION — 40-Pin Dual In-Line Plastic
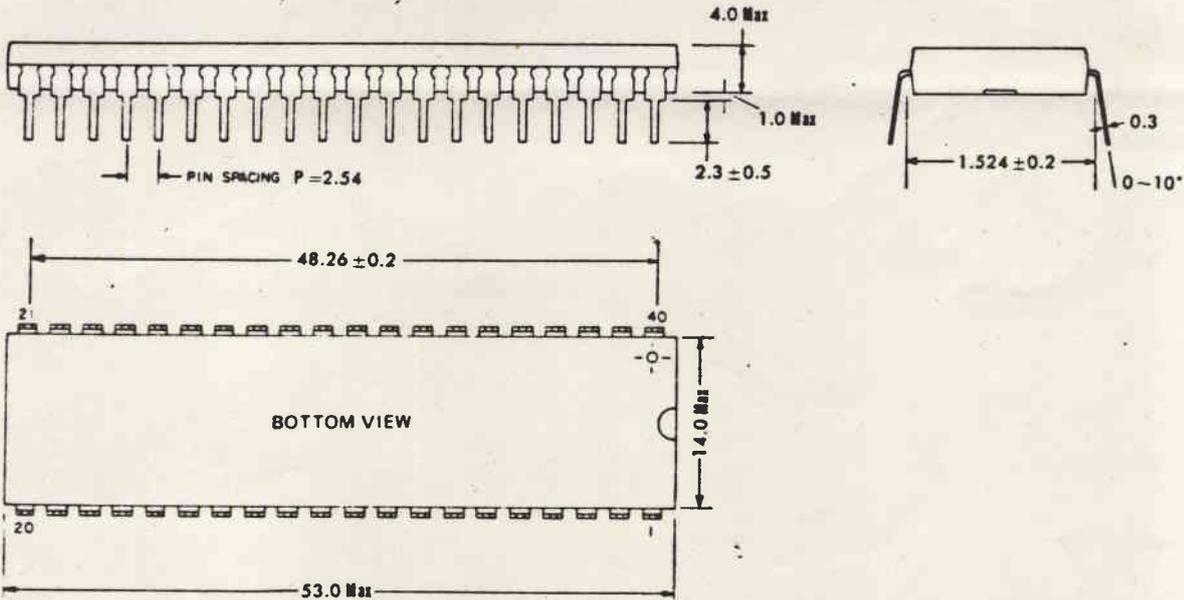
GENERALIZED CIRCUIT (12 HR. DISPLAY FORMAT)
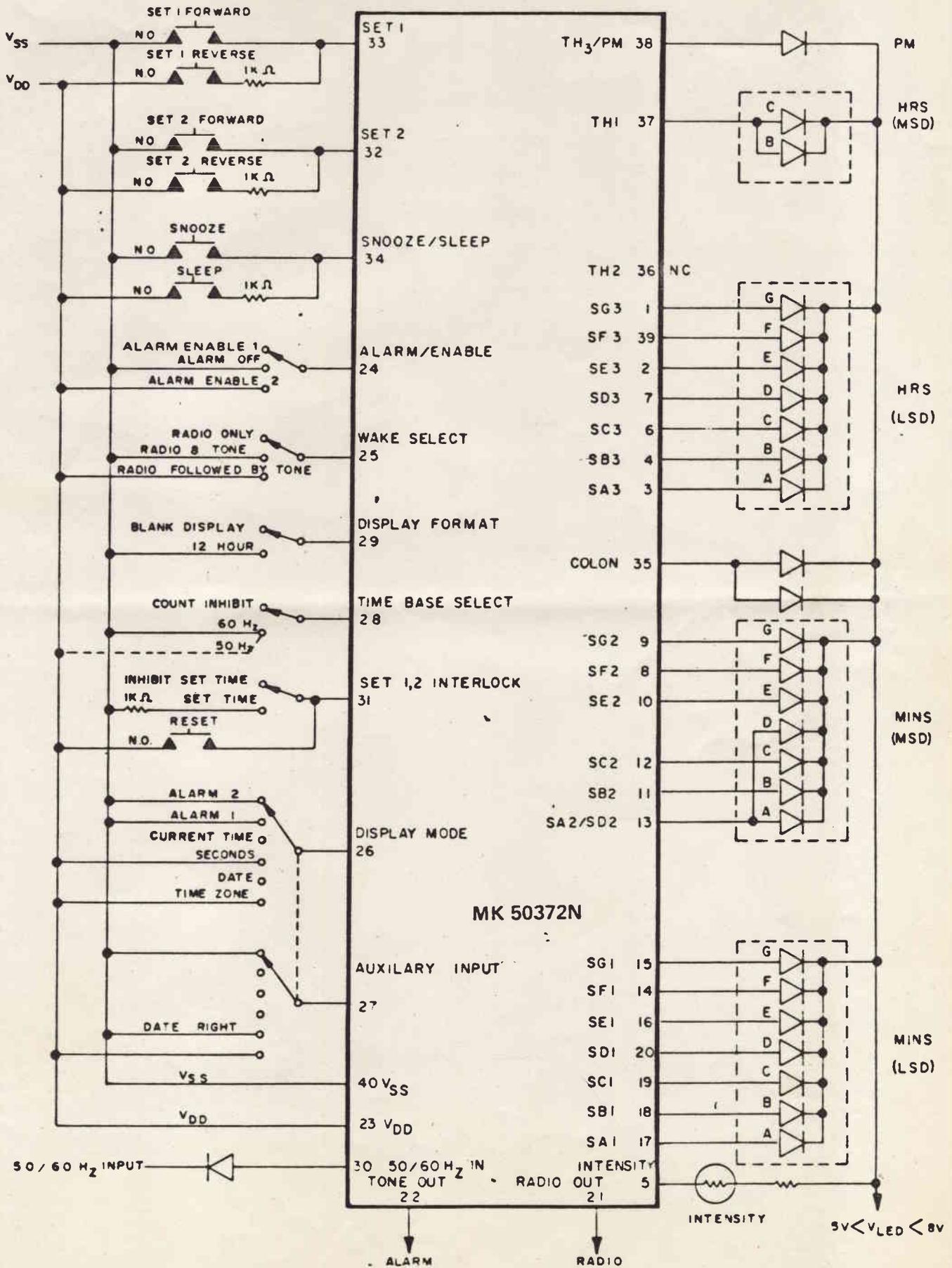
MK 50372N

NOTE: Any input may be tied to V_{DD} or V_{SS} or allowed to "FLOAT". Floating is intended to be an open position on the switch. The input may not be biased with external voltage to simulate floating conditions.
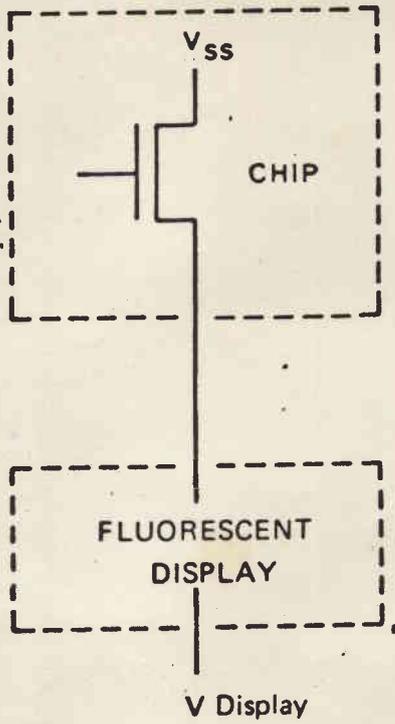
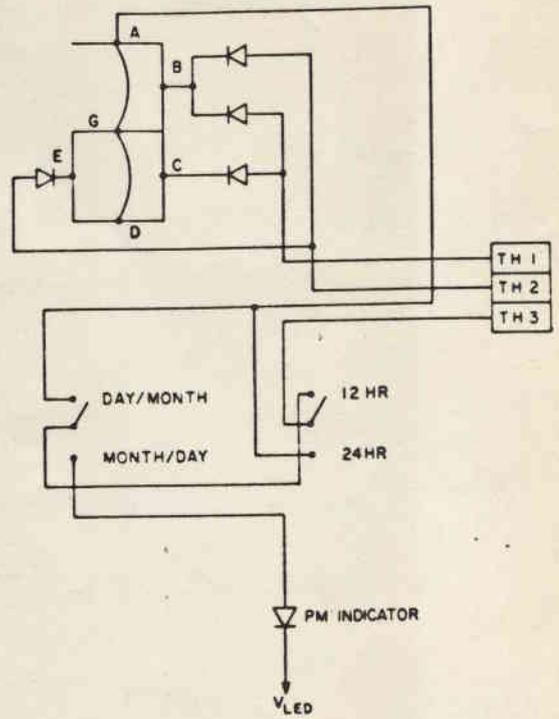# GENERALIZED CIRCUIT (24 HR. OR DATE LEFT DISPLAY FORMAT)

NOTE: Any input may be tied to V_{DD} or V_{SS} or allowed to "FLOAT." Floating is intended to be an open position on the switch. The input may not be biased with external voltage to simulate floating conditions.
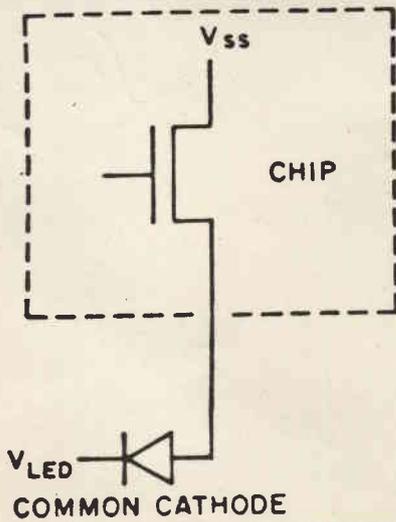
DISPLAY CONNECTIONS

FLUORESCENT CONNECTION

SELECTABLE 12 HR. OR 24 HR. DISPLAY

LED CONNECTION

ALARM SWITCHING