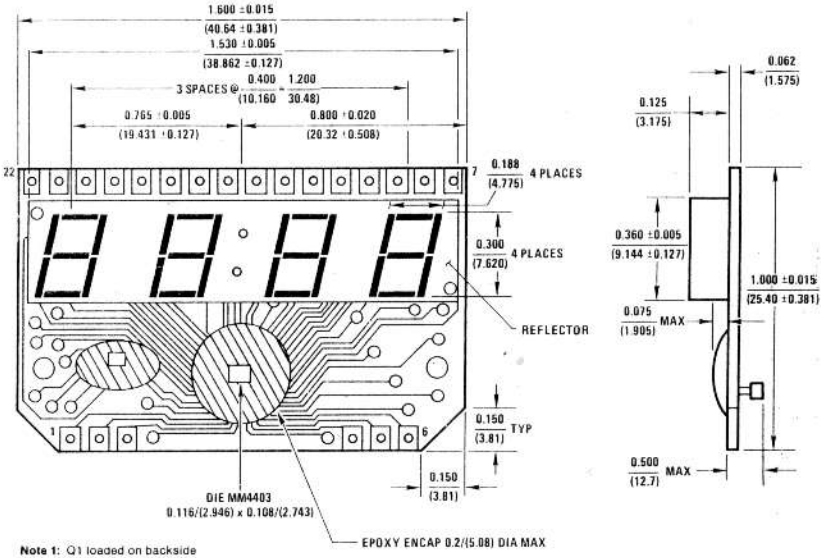

Note 1: Q1 loaded on backside

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MA5036 Low Cost Digital LED Clock/Timer Module

General Description

The MA5036 is an electronic digital clock/timer module featuring four-digit LED displays. This is designed to offer a low cost digital clock/timer module for the user with electronic assembly capability. In addition to a transformer and setting switches, a minimum number of discrete components are required to produce a full-featured movement for use in alarm clock, clock radio, instrument panel clock and appliance timer applications. Advanced packaging techniques allow minimum overall size and high reliability in finished products.

Key features include multiple 9-minute snooze; "one finger" sleep setting; easy to use fast and slow setting controls; five display modes (time, seconds, alarm, sleep and lamp test); PM, alarm ON and LED colon indicators; power failure indication; time-set lockout; and battery powered back-up oscillator for timekeeping during power loss. All models are designed to generate a selectable frequency alarm tone output gated at a 2 Hz rate (provided the user adds an external resistor and capacitor). Maximum flexibility is provided by optional 12 or 24-hour display format, 50 or 60 Hz input frequency selection and fixed or blinking colon indicator. The display brightness level can be varied with a single external potentiometer for continuous control.

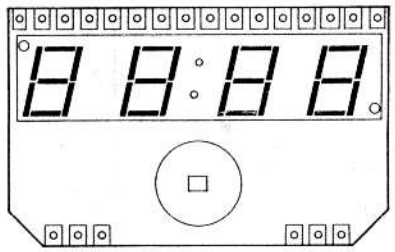
Functional Features

- Available in 0.3" display size with adhesive mylar cover/diffuser and clear surface color
- "One finger" 59-minute sleep counter setting
- Multiple 9-minute snooze control
- 24-hour alarm with ON/OFF control
- PM, colon and alarm ON LED indicators
- Entire display flashes to indicate power loss
- Simple fast/slow setting controls
- Time set "lockout" feature eliminates accidental time-setting without inhibiting alarm or sleep settings
- Five display modes (time, seconds, alarm, sleep and lamp test)
- User selectable 12/24-hour, 50/60 Hz and fixed or flashing colon operation
- Leading zero blanking
- Low power consumption
- Direct drive LED display/no RFI
- Display brightness control
- Back-up oscillator allows continuous timekeeping during power-line failure with a single 9V battery and external 5 MΩ potentiometer
- Selectable frequency alarm tone output, gated at a 2 Hz rate, provides an easy interface to an 8Ω speaker for alarm clock application
- DC level sleep output provides an easy interface for clock radio and timer applications
- 24-hour output for an optional calendar circuit
- Separate inputs for all settings and display modes

Applications

- Clock radio timers
- Alarm clocks
- Desk clocks
- TV, stereo timers
- Appliance timers
- Instrument panel clocks

Display Outline



TL/W/5476-1

Ordering Information

MA5036XXX

Surface Color
W = Clear

Surface Type
Z = Adhesive Mylar

Display Color/Function
A = With standby oscillator
B = Without standby oscillator
G = Green
Y = Yellow

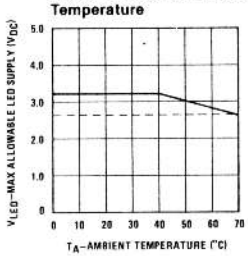
Note: Versions A and B come in red display color. Green or yellow modules come with standby oscillator.

 TL/W/5476

IM-B30M73/Printed in U.S.A.

ypical DC Performance Characteristics (Continued) Unless otherwise specified $T_A = 25°C$, $V_{DD} = 9V$, $V_{SS} = 0V$, and $V_{LED} = 2.5V$

Maximum Allowable LED Supply Voltage vs Ambient Temperature

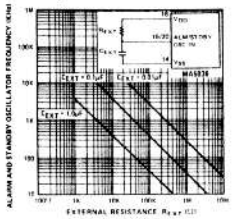


TL/W/5476-7

CONDITIONS:

1) $7V \leq V_{DD} \leq 11V$
2) $R_b = 0\Omega$, i.e. pin 21 = V_{DD} (Max. Brightness)
3) Lamp Test (Note 4)

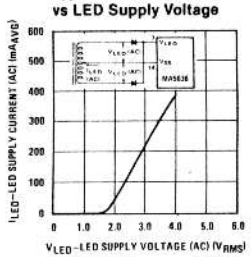
Typical Alarm and Standby Oscillator Frequency vs External Resistance and Capacitance



TL/W/5476-8

ypical AC Performance Characteristics (See Schematic Diagram) Unless otherwise specified = 25°C, $V_{AC} = 7.75$ Vrms, $V_{SS} = 0V$, and $V_{LED} = 3.5$ Vrms

Typical LED Supply Current vs LED Supply Voltage

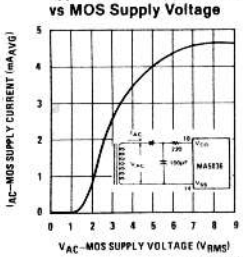


TL/W/5476-9

CONDITIONS:

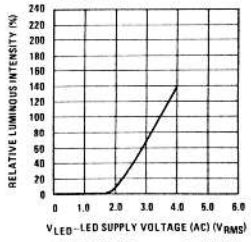
1) Lamp Test (all segments driven)
2) $R_b = 0\Omega$, i.e. pin 21 = V_{DD} (Max. Brightness)

Typical MOS Supply Current vs MOS Supply Voltage



TL/W/5476-10

Typical Relative Luminous Intensity vs LED Supply Voltage

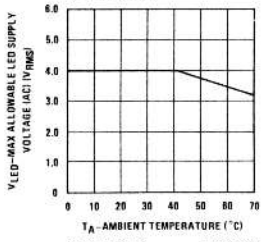


TL/W/5476-11

CONDITIONS:

1) Lamp Test (all segments driven)
2) $R_b = 0\Omega$, i.e. pin 21 = V_{DD}

Maximum Allowable LED Supply Voltage vs Ambient Temperature



TL/W/5476-12

CONDITIONS:

1) 6.5 Vrms $\leq V_{AC} \leq$ 9.0 Vrms
2) $R_b = 0\Omega$, i.e. pin 21 = V_{DD}

Functional Description

The various display modes and their priorities are listed in Table I. The functions of the setting controls in combination with the selected display mode are summarized in Table II.

INPUTS

Display Mode Select Inputs (Pins 4, 5, 6): In the absence of any of these inputs (i.e., pin open), time-of-day (hours : minutes) information is displayed. All three inputs (DISPLAY SECONDS, DISPLAY ALARM, DISPLAY SLEEP) have internal pull-up resistors to V_{DD}. Connection of any combination of these inputs to V_{SS} results in one of the five display modes. Their priorities and functions are listed in Table I. For example, Seconds may be displayed by connecting pin 4 to V_{SS}; however, connecting pins 4 and 5 to V_{SS} results in the Alarm Time being displayed. Note that DISPLAY SLEEP (pin 6) and DISPLAY ALARM (pin 5) have equal priorities and when connected to V_{SS}, all display drivers are turned on, providing a lamp test display mode.

Time Setting Inputs (Pins 3, 12): Both FAST SET (pin 3) and SLOW SET (pin 12) inputs may be applied either singly or in combination to obtain the control functions listed in Table II. Internal pull-up resistors to V_{DD} are provided as well as switch debounce circuitry on each input. Application of either or both inputs is made by connecting the appropriate pin to V_{SS}. Note that the control functions are dependent on the selected display mode. For example, a Time Reset function to 12:00:00 AM may be made by selecting either Time or Seconds Display Mode and connecting pins 3, 12 and 11 to V_{SS}. However, if Sleep were the selected display mode, the contents of the Sleep Counter would be displayed and reset to :59 minutes.

Time Set Allow Input (Pin 11): This input is used to enable Fast or Slow setting of time when the selected display mode is Time or Seconds. An internal pull-up resistor is provided on the input. To set time, one must connect pin 11 to V_{SS} in combination with pin 3 and/or 12 (provided that Time or Seconds is the selected display mode). When the selected display mode is Alarm or Sleep, the TIME SET ALLOW input does not inhibit setting of either the alarm or sleep counters (i.e., pin 11 may be left open to set alarm or sleep time).

50/60 Hz Select Input (Pin 16): A programmable prescale counter divides the 50/60 Hz input frequency by either 50 or 60 to obtain a 1 pps time base. This counter is programmed to divide by 60 by simply leaving pin 16 unconnected, as a pull-up resistor to V_{DD} is provided. 50 Hz operation is programmed by connecting pin 16 to V_{SS}.

Colon Control Input (Pin 1): This input is used to select between a flashing or non-flashing colon. If left open or connected to V_{DD}, the colon will flash at a 1 Hz rate. Connection to V_{SS} will produce a non-flashing (always ON) colon. An internal pull-up resistor to V_{DD} on the input is provided.

12/24-Hour Select Input (Pin 2): This input is used to select between 12 and 24-hour display formats. If left open or connected to V_{DD}, the 12-hour format is chosen, in which case the PM indicator (in the upper left corner of the display) is used to distinguish between AM and PM.

selected, and PM indication is not active. An interr pull-up resistor to V_{DD} is provided on the input.

Snooze Input (Pin 9): Momentarily connecting pin 9 V_{SS} disables the sleep output, thus turning off the sle transistor and the associated radio power supply. If t alarm has sounded just prior to this, the alarm output also disabled and the sleep counter is reset to 9 minute Both outputs will be disabled for between 8 and minutes (depending upon the contents of the secon counter) after which the alarm will again be sounded. T snooze feature may be used repeatedly during the minutes in which the alarm latch remains set. An interr pull-up resistor to V_{DD} is provided on the input.

Alarm Off Input (Pin 10): Connecting pin 10 to V disables the alarm and sleep outputs from coming on alarm time, thereby silencing the alarm and/or the rad Momentary connection to V_{SS} also readies the ala latch for the next alarm time, in which case the ala and/or radio will sound again in 24 hours (or at a n alarm setting). If it is desired to silence the alarm fo day or more, the ALARM OFF input should remain at V This input is also returned to V_{DD} by an internal resist An alarm ON indicator in the lower right hand corner the display is provided to show the state of the input.

Brightness Input (Pin 2): The LED display segment c rent may be varied by connecting the input to V through a variable or fixed resistor, R_b. This simple o pin operation thereby controls the brightness of the LE display. Typical segment current equals 20 times t reference current set through R_b. Internal resistance included to limit the maximum current.

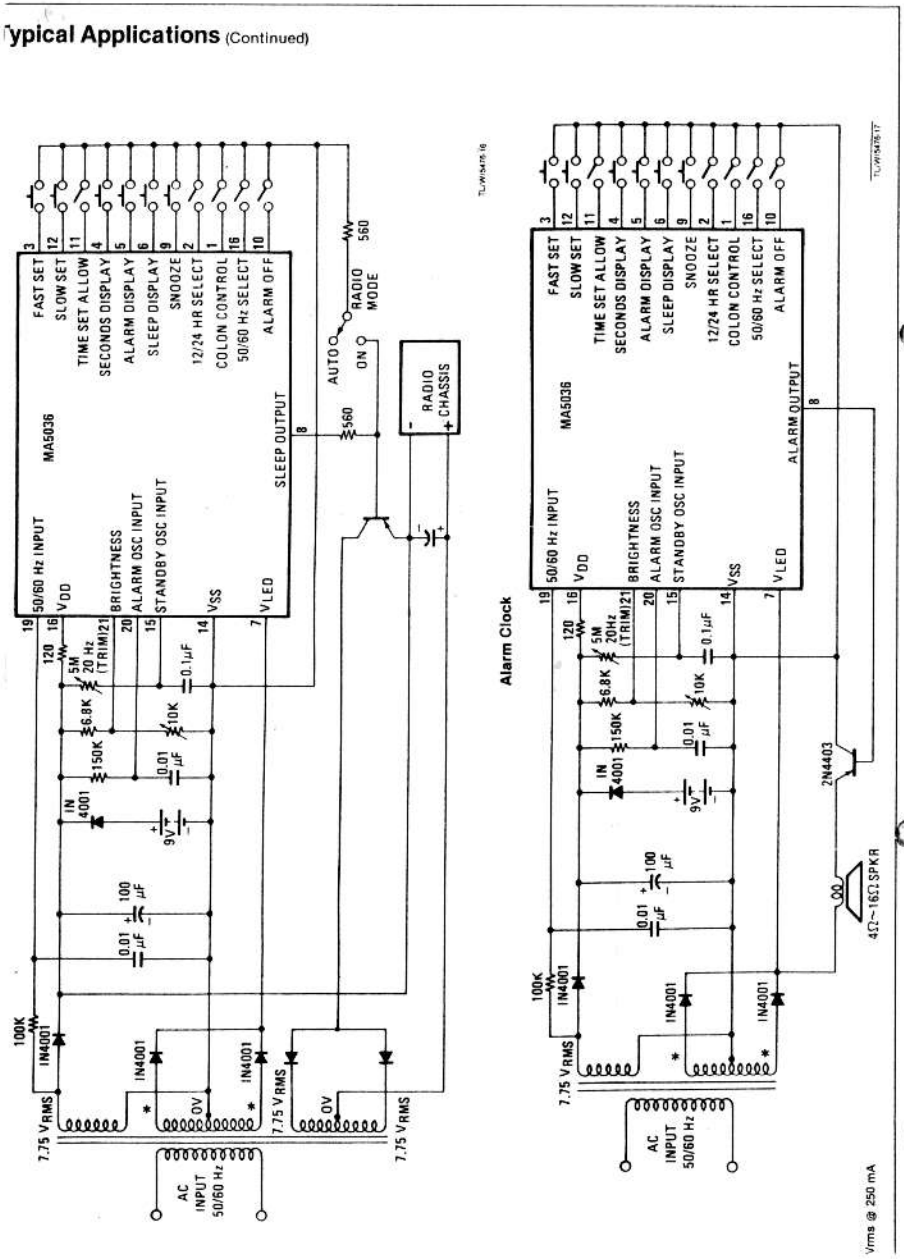
Alarm Oscillator Input (Pin 20): The alarm tone generated by an internal alarm oscillator and its f quency is determined by an external RC time consta connected to the ALARM OSCILLATOR INPUT (S Typical DC Performance Characteristics). This squa wave tone is then frequency divided by two and gated a 2 Hz square wave signal before being enabled at t ALARM OUTPUT (pin 13).

Standby Oscillator Input (Pin 15): This input is similar the ALARM OSCILLATOR INPUT (pin 20). By supplying external capacitor and variable resistor from the input V_{SS} and V_{DD} respectively, and trimming the input f quency to 20 Hz, the standby oscillator can be used as timekeeping reference when the normal 50/60 Hz li power fails. A 9V battery is used for back-up power for t MOS/LSI circuit. Although the LED display will rema OFF during power failure, the correct time is held by t time counters and the counting continues. When li power resumes, the display returns to norm brightness, displaying the correct time without flashir The input must be connected to V_{SS} when not in use.

50/60 Hz Input (Pin 19): A shaping circuit is provided square the 50/60 Hz INPUT. An external RC filter (100 0.01 µF typ) must be used to remove possible line volta transients that could either cause the clock to gain tir or damage the device. The input should swing betwe V_{SS} and V_{DD}. The shaper circuit drives a counter cha which performs the timekeeping function.

OUTPUTS

Typical Applications (Continued)

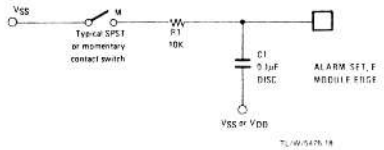


Recommended Display Processing

The multidigit series display is constructed on a standard printed circuit board substrate and covered with a plastic lens. The edge connector tab will stand a temperature of 230°C for 5 seconds. The display lens area must not be elevated in temperature above 80°C. To do so will result in permanent damage to the display. Since the display is not hermetic, immersion of the entire package during flux and clean operations may cause condensation of flux or cleaner on the underside of the lens. It is recommended that only the edge connectors be immersed. Only rosin core solder, solid core solder, and low activity organic fluxes are recommended. Cleaning solvents are Freon TF, Isopropanol, Methanol, or Ethanol. These solvents are recommended only at room temperature and for short time periods. The use of other solvents or elevated temperature use of the recommended solvents may cause permanent damage to the lens or display.

Handling and Packaging Guidelines

MA5036 clock modules are manufactured using an MOS integrated circuit. As shown in the Schematic and Application Diagram, many of the MOS inputs are directly accessible at the edge connector of the modules, therefore these modules must be handled in the same manner as any MOS device during transport, storage, IQC and production assembly. Also, it is recommended, in accordance with acceptable engineering practice, tha module user provides adequate protection against s discharge in the design of his finished product. S each module user may utilize unique packaging design techniques for this end product, some ge guidelines are offered. It is generally good practi connect the "lever" of control switches to V_{SS} inste to the MOS inputs. Since the energy in static discha exhibits a wide frequency spectrum, a resistor an type ceramic disc capacitor low pass filter network be used to help protect the directly accessible inputs. Place this RC network in close proximity t module edge contact to obtain maximum protecti typical RC filter is shown in the figure below:



Good practice dictates that metal buttons or meta buttons not be used as they provide a path for s discharge leading closer to the internal circuitry, a ty application would use a plastic button with pl pusher rod to the switch contacts located within the

Absolute Maximum Ratings

Voltage at All Pins Except 7	V_{SS} − 0.3V to V_{SS} + 12V
Voltage at Pin 7	V_{SS} − 3V to V_{SS} + 6V
Operating Temperature Range	0°C to + 70°C
Storage Temperature Range	− 20°C to + 70°C
Lead Temperature (Soldering, 5 seconds)	230°C

DC Electrical Characteristics

Unless otherwise specified $T_A = 25°C$, $V_{DD} = 9V$, $V_{SS} = 0V$, $V_{LED} = 2.5V$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{DD}	MOS Supply Voltage	Fully Operational Clock Power Fail Detect (Note 1)	7	9 3	11 5	V_{DC} V_{DC}
I_{DD}	MOS Supply Current	(See Typical DC Performance Characteristics)		5	10	mA_{DC}
V_{LED}	LED Supply Voltage	(Notes 2 and 3)		2.5	3.2	V_{DC}
I_{LED}	LED Supply Current	Lamp Test, Pin 21 = V_{DD} (Max Bright), (See Typical DC Performance Characterstics)		300		mA_{DC}
V_{BATT}	MOS Supply Voltage	$V_{AC} = 0$, $V_{LED} = 0$ Timekeeping Maintained Only	7.5	9.0	12.0	V_{DC}
I_{BATT}	MOS Supply Current	$V_{BATT} = 9\ V_{DC}$ (See Typical DC Performance Characteristics)		5	10	mA_{DC}
	50/60 Hz Input Frequency Logical Low Level Logical High Level Input Current	 $V_{INPUT} = V_{SS}$	 DC V_{SS} $V_{DD} - 1$	 50/60	 10k $V_{SS} + 0.5$ V_{DD} − 1.0	 Hz V V μA
	Control Inputs (Pins 1-6, 9-12 & 16) Logical Low Level Logical High Level Input Current	 Internal Resistance to V_{DD} $V_{INPUTS} = V_{SS}$	 V_{SS} $V_{DD} - 3$		 $V_{SS} + 0.5$ V_{DD} − 10	 V V μA
	Alarm/Sleep Output Current Alarm/Sleep ON, Sink Current Alarm/Sleep OFF, Sink Current	 $V_{OL} = V_{SS} + 2V$ $V_{OH} = V_{DD} - 0.25V$	 5		 − 40	 mA μA
	24-Hour Output Current AM ON, Sink Current PM OFF, Source Current	 $V_{OL} = V_{SS} + 2V$ $V_{OH} = V_{DD} - 0.25V$	 400		 − 100	 μA μA
	Alarm Oscillator Frequency Tolerance	$T_A = 0°C$ to 70°C, $V_{DD} = 7.0$ to 11 V_{DC} (Note 5)			± 20	%
	Standby Oscillator Frequency Tolerance	$T_A = 0°C$ to 70°C, $V_{BATT} = 7.5\ V_{DC}$ to 12.0 V_{DC}, $V_{DD} = 0V$, $V_{LED} = 0V$ (Note 5)			± 20	%

AC Electrical Characteristics

Unless otherwise specified $T_A = 25°C$, $V_{AC} = 7.75$ Vrms, $V_{SS} = 0V$, $V_{LED} = 3.5$ Vrms; V_{AC} and V_{LED} (AC) measurements made at transformer secondary winding.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{AC}	MOS Supply Voltage	Fully Operational Clock Power Fail Detect (Note 1)	6.5	7.75 3	9.0 6	Vrms Vrms
I_{AC}	MOS Supply Current	(See Typical AC Performance Characteristics		5	10	mA_{AVG}
V_{LED} (AC)	LED Supply Voltage	(Notes 2 and 3)	3.0	3.5	4.0	Vrms × 2
I_{LED} (AC)	LED Supply Current	Lamp Test, Pin 21 = V_{DD}		315		mA_{AVG}

Optical Characteristics

Unless otherwise specified $T_A = 25°C$, $V_{SS} = 0V$, $V_{LED} = 2.5V$ or V_{LED} (AC) = 3.5 V

Parameter	Conditions	Min	Typ	Max	
Peak Wavelength	Green Display Color Yellow Display Color Red Display Color		555 565 660		
Segment Light Intensity	Green Yellow Red	140 450 170	280 1000 325		
Spectral Width, Half Intensity	Green Yellow Red		25 30 40		
Viewing Angle	Angle From Normal Axis		60		d
Intensity Matching	Display Dim (Pin 18) Open and Closed		± 33		

Note 1: The power fail detect voltage is 0.25V or more above the voltage at which timekeeping data will be lost.

Note 2: The absolute maximum allowable LED supply voltage (V_{LED}) must be derated with ambient temperature over 40°C. See the maximum allowab (V) vs T_A (°C) curve under the Typical Performance Characteristics.

Note 3: To insure normal operation, V_{DD} and V_{LED} or V_{AC} and V_{LED} (AC) min/max specifications should not be exceeded over line voltage and tran voltage variations.

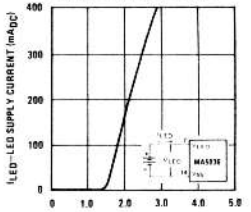
Note 4: Lamp test of display is not meant to be a normal operating display mode, but only a condition of measuring V_{LED} for a given ambient temp

Note 5: Does not include tolerances of components external to NMOS IC.

Typical DC Performance Characteristics

Unless otherwise specified $T_A = 25°C$, $V_{DD} = 9V$, $V_{SS} = 0$ $V_{LED} = 2.5V$

Typical LED Supply Current vs LED Supply Voltage

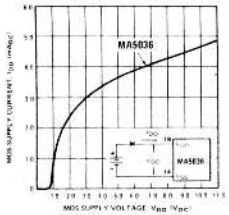


V_{LED}–LED SUPPLY VOLTAGE (V_{DC})

TL/W/5476-2

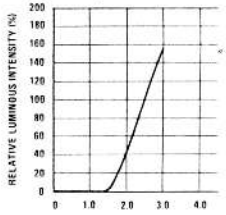
CONDITIONS:
1) Lamp Test (all segments driven)
2) $R_b = 0\Omega$, i.e. pin 21 = V_{DD} (Max. Brightness)

Typical MOS Supply Current vs MOS Supply Voltage



TL/W/5476-3

Typical Relative Lumin Intensity vs LED Suppl Voltage

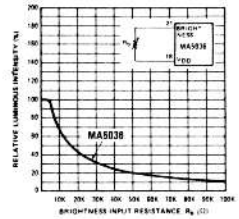


RELATIVE LUMINOUS INTENSITY (%)

V_{LED}–LED SUPPLY VOLTAGE (V_D

CONDITIONS:
1) Lamp Test (all segments d
2) $R_b = 0\Omega$, i.e. pin 21 = V_{DD} (Max. Brightness)

Typical Relative Luminous Intensity vs Brightness Input Resistance

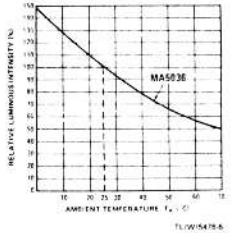


CONDITION: 1) Lamp Test (All Segments Driven)

TL/W/5476-5

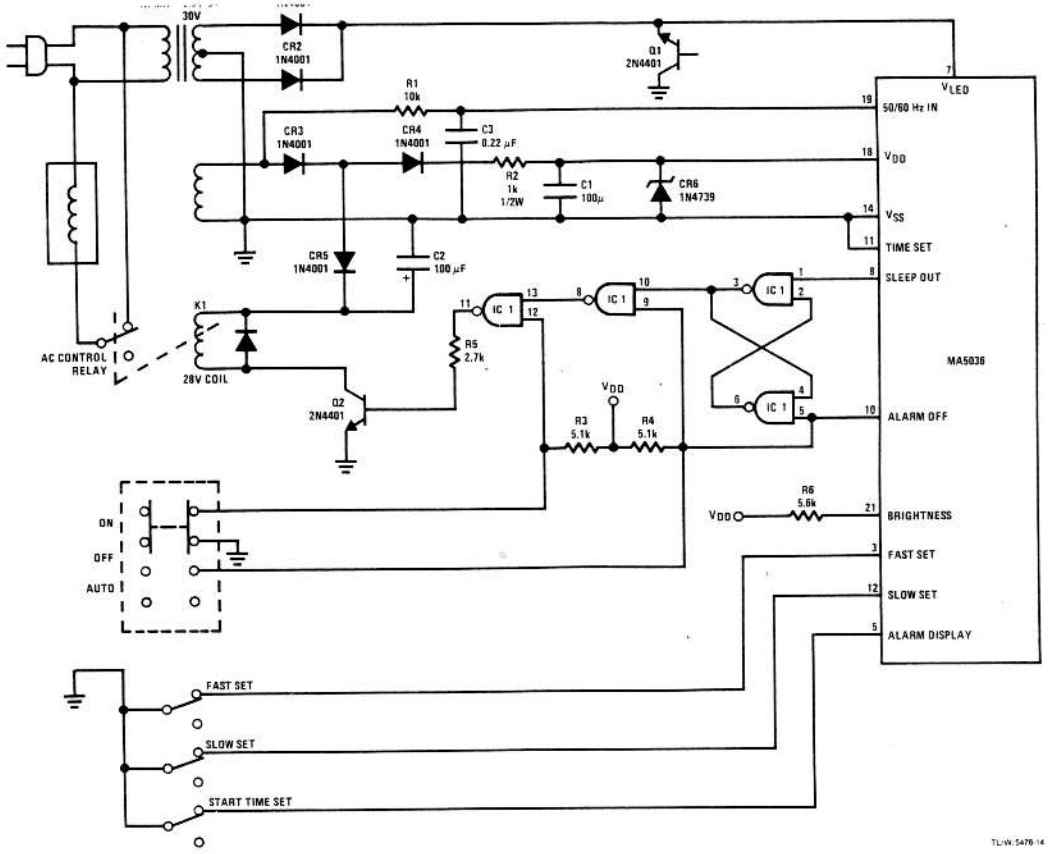
CONDITIONS:

Relative Luminous Intensity vs Ambient Temperature

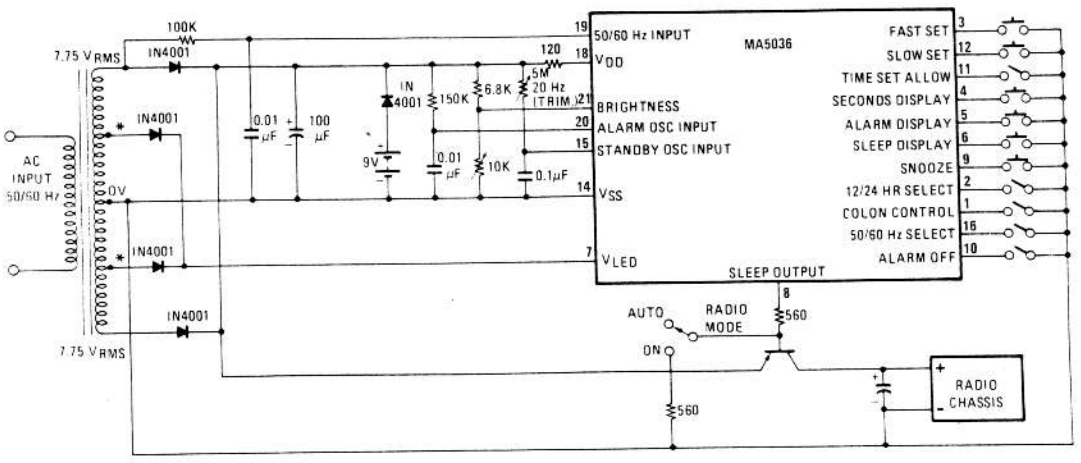


TL/W/5476-6

CONDITIONS:
1) Lamp Test (all segments driven)



Positive Supply Clock-Radio



Vrms @ 250 mA