MM5316 digital alarm clock

general description

The MM5316 digital alarm clock is a monolithic MOS integrated circuit utilizing p-channel low-threshold, enhancement mode and ion-implanted depletion mode devices. It provides all the logic required to build several types of clocks and timers. Four display modes (time, seconds, alarm and sleep) are provided to optimize circuit utility. The circuit interfaces directly with seven-segment fluorescent tubes or liquid crystal displays, and requires only a single power supply. The time-keeping function operates from either a 50 or 60 Hz input, and the display format may be either 12 hours (with leading-zero blanking and AM/PM indication) or 24 hours. Outputs consist of display drives, sleep (e.g., timed radio turn-off), and alarm enable. Power failure indication is provided to inform the user that incorrect time is being displayed. Setting the time cancels this indication. The device operates over a power supply range of 8 to 29 volts and does not require a regulated supply. The MM5316 is packaged in a 40-lead dual-in-line package.

features

- 50 or 60 Hz operation
- Single power supply
- Low power dissipation (32 mW at 8V)
- 12 or 24 hour display format
- AM/PM outputs } 12-hour format
- Leading-zero blanking } 12-hour format
- 24-hour alarm setting
- All counters are resettable
- Fast and slow set controls
- Power failure indication
- Blanking/brightness control capability
- Elimination of illegal time display at turn-on
- Direct interface to fluorescent tubes or liquid crystal displays
- 9-minute snooze alarm
- Presettable 59-minute sleep timer

applications

- Alarm clocks
- Desk clocks
- Clock radios
- Automobile clocks
- Stopwatches
- Industrial clocks
- Military clocks
- Portable clocks
- Photography timers
- Industrial timers
- Appliance timers
- Sequential controllers

block and connection diagrams

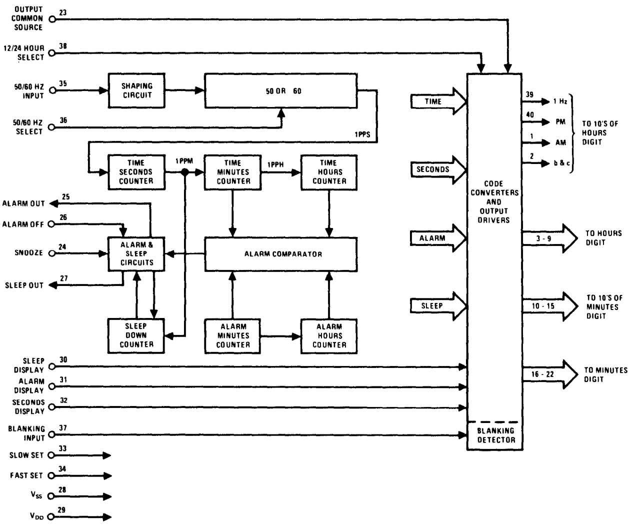
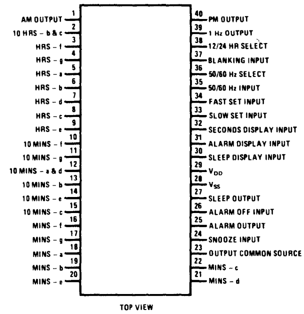


FIGURE 1. MM5316 Digital Alarm Clock, Block Diagram

Dual-In-Line Package



Order Number MM5316D
See Package 8
Order Number MM5316N
See Package 20

FIGURE 2. Connection Diagram

absolute maximum ratings

Voltage at Any Pin	V_{SS} +0.3 to V_{SS} −29V
Operating Temperature	−25°C to +70°C
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 sec)	300°C

electrical characteristics

T_A within operating range, V_{SS} = +8 to +29V, V_{DD} = 0V, unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Power Supply Voltage:	V_{SS} (V_{DD} = 0V)	+8		+29	V
Power Supply Current:	no output loads				
	V_{SS} = +8V		2	4	mA
	V_{SS} = +29V		3	5	mA
50/60 Hz Input:					
Frequency		DC	50 or 60	30k	Hz
Voltage					
Logical High Level		$V_{SS}-1$		V_{SS}	V
Logical Low Level		V_{DD}		$V_{DD}+1$	V
Blanking Input Voltage:					
Logical High Level		$V_{SS}-2$		V_{SS}	V
Logical Low Level		V_{DD}		$V_{SS}-4$	V
All Other Input Voltages:					
Logical High Level		$V_{SS}-1$		V_{SS}	V
Logical Low Level	Internal 2.5 MΩ Resistor to V_{DD}	V_{DD}	V_{DD}	$V_{DD}+2$	V
Power Failure Detect Voltage:	(V_{SS} Voltage)	9		20	V
Output Currents:	V_{SS} = +21 to +29V, V_{DD} = 0V				
1 Hz Display					
Logical High Level	$V_{OH} = V_{SS} - 2V$	1500			μA
Logical Low Level	$V_{OL} = V_{DD}$			1	μA
10's of Hours (b&c), 10's of Minutes (a&d)					
Logical High Level	$V_{OH} = V_{SS} - 2V$	1000			μA
Logical Low Level	$V_{OL} = V_{DD}$			1	μA
All Other Display, Alarm and Sleep Outputs					
Logical High Level	$V_{OH} = V_{SS} - 2V$	500			μA
Logical Low Level	$V_{OL} = V_{DD}$			1	μA

...nctional description

A block diagram of the MM5316 digital alarm clock is shown in Figure 1. The various display modes provided by this clock are listed in Table 1. The functions of the setting controls are listed in Table 2. Figure 2 is a connection diagram. The following discussions are based on Figure 1.

50 or 60 Hz Input (pin 35): A shaping circuit (Figure 3) is provided to square the 50 or 60 Hz input. This circuit allows use of a filtered sinewave input. The circuit is a Schmitt trigger that is designed to provide about 6V of hysteresis. A simple RC filter, such as shown in Figure 7, should be used to remove possible line-voltage transients that could either cause the clock to gain time or damage the device. The input should swing between V_{SS} and V_{DD}. The shaper output drives a counter chain which performs the timekeeping function.

50 or 60 Hz Select Input (pin 36): A programmable prescale counter divides the input line frequency by either 50 or 60 to obtain a 1-pps time base. This counter is programmed to divide by 60 simply by leaving pin 38 unconnected; pull-down to V_{DD} is provided by an internal 2.5 MΩ resistor. Operation at 50 Hz is programmed by connecting pin 38 to V_{SS}.

Display Mode Select Inputs (pins 30 thru 32): In the absence of any of these three inputs, the display drivers present time-of-day information to the appropriate display digits. Internal 2.5 MΩ pull-down resistors allow use of simple SPST switches to select the display mode. If more than one mode is selected, the priorities are as noted in Table 1. Alternate display modes are selected by applying V_{SS} to the appropriate pin. As shown in Figure 1 the code converters receive time, seconds, alarm and sleep information from appropriate points in the clock circuitry. The display mode select inputs control the gating of the desired data to the code converter inputs and ultimately (via output drivers) to the display digits.

Time Setting Inputs (pins 33 and 34): Both fast and slow setting inputs are provided. These inputs are applied either singly or in combination to obtain the control functions listed in Table 2. Again, internal 2.5 MΩ pull-down resistors are provided; application of V_{SS} to these pins effects the control functions. Note that the control functions proper are dependent on the selected display mode. For example, a hold-time control function is obtained by selecting seconds display and actuating the slow set input. As another example, the clock time may be reset to 12:00:00 AM, in the 12-hour format (00:00:00 in the 24-hour format), by selecting seconds display and actuating both slow and fast set inputs.

Blanking Control Input (pin 37): Connecting this Schmitt trigger input to V_{DD} places all display drivers in a non-conducting, high-impedance state, thereby inhibiting the display. See Figures 3 and 4. Conversely, V_{SS} applied to this input enables the display.

Output Common Source Connection (pin 23): All display output drivers are open-drain devices with all sources common to pin 23 (Figure 4). When using fluorescent tube displays, V_{SS} or a display brightness control voltage is permanently connected to this pin. Since the brightness of a fluorescent tube display is dependent on the anode (segment) voltage, applying a variable voltage to pin 23 results in a display brightness control. This control is shown in Figure 7. However, when using liquid crystal displays, the lifetime of the display device is optimized when AC drive voltages are provided. The common source connection of the MM5316 output drivers facilitates generating AC drive voltages. An interface circuit for driving liquid crystal displays is shown in Figure 5.

12 or 24 Hour Select Input (pin 38): By leaving this pin unconnected, the outputs for the most-significant display digit (10's of hours) are programmed to provide a 12-hour display format. An internal 2.5 MΩ pull-down resistor is again provided. Connecting this pin to V_{SS} programs the 24-hour display format. Also, the output connections (pins 1, 2, 39 and 40) are different for each format. Figure 6 illustrates these differences. In addition to displaying 10's of hours, this digit provides an AM/PM indication (12-hour format only) and the power failure indication. In the 12-hour format, AM indication is provided by segment "f"; PM indication by segment "e." The power failure indication consists of a flashing of the AM or PM indicator at a 1-Hz rate. A fast or slow set input resets an internal power failure latch and returns the display to normal. In the 24-hour format, the power failure indication consists of flashing segments "c" and "f" for times less than 10 hours, and of a flashing segment "c" for times equal to or greater than 10 hours but less than 20 hours; and a flashing segment "g" for times equal to or greater than 20 hours.

Alarm Operation and Output (pin 25): The alarm comparator (Figure 1) senses coincidence between the alarm counters (the alarm setting) and the time counters (real time). The comparator output is used to set a latch in the alarm and sleep circuits. The latch output enables the alarm output driver (Figure 4), the MM5316 output that is used to control the external alarm sound generator. The alarm latch remains set for 59 minutes, during which the alarm will therefore sound if the latch output is not temporarily inhibited by another latch set by the snooze alarm input (pin 24) or reset by the alarm off input (pin 26).

Snooze Alarm Input (pin 24): Momentarily connecting pin 24 to V_{SS} inhibits the alarm output for between 8 and 9 minutes, after which the alarm will again be sounded. This input is pulled-down to V_{DD} by an internal 2.5 MΩ resistor. The snooze alarm feature may be repeatedly used during the 59 minutes in which the alarm latch remains set.

functional description (con't)

Alarm Off Input (pin 26): Momentarily connecting pin 26 to V_{SS} resets the alarm latch and thereby silences the alarm. This input is also returned to V_{DD} by an internal 2.5 MΩ resistor. The momentary alarm off input also readies the alarm latch for the next comparator output, and the alarm will automatically sound again in 24 hours (or at a new alarm setting). If it is desired to silence the alarm for a day or more, the alarm off input should remain at V_{SS}.

Sleep Timer and Output (pin 27): The sleep output at pin 27 can be used to turn off a radio after a desired time interval of up to 59 minutes. The time interval is chosen by selecting the sleep display mode (Table 1) and setting the desired time interval (Table 2). This automatically results in a current-source output via pin 27, which can be used to turn on a radio (or other appliance). When the sleep counter, which counts downwards, reaches 00 minutes, a latch is reset and the sleep output current drive is removed, thereby turning off the radio. This turn-off may also be manually controlled (at any time in the countdown) by a momemtary V_{SS} connection to the snooze input (pin 24). The output circuitry is the same as the other outputs (Figure 4).

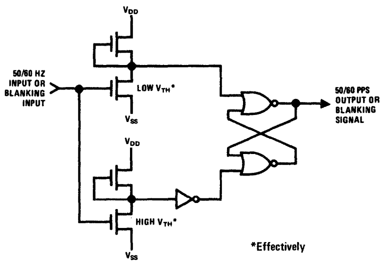


FIGURE 3. 50/60 Hz or Blanking Input Shaping Circuits

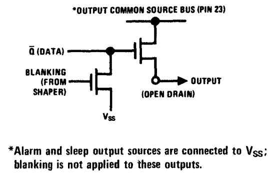
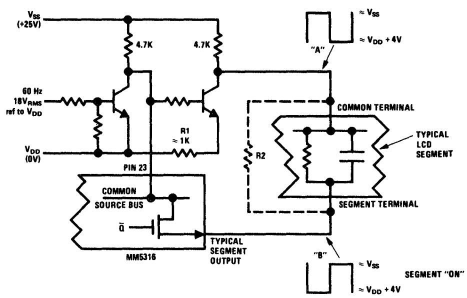


FIGURE 4. Output Circuits



Note 1: R1 should be chosen for equal peak-to-peak swings at points "A" and "B," so there is no dc component placed on the segment.

Note 2: R2 may or may not be required, depending on the display used and the parasitic circuit capacitance associated with the segment output. This resistor should be just small enough to assure that off segments are not visible.

FIGURE 5. Liquid Crystal Display Interface

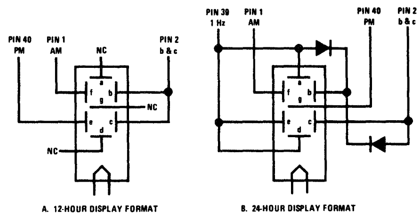


FIGURE 6. Wiring Ten's-of-hours Digit

nctional description (con't)

TABLE 1. MM5316 Display Modes

*SELECTED DISPLAY MODE	DIGIT NO. 1	DIGIT NO. 2	DIGIT NO. 3	DIGIT NO. 4
Time Display	10's of Hours & AM/PM	Hours	10's of Minutes	Minutes
Seconds Display	Blanked	Minutes	10's of Seconds	Seconds
Alarm Display	10's of Hours & AM/PM	Hours	10's of Minutes	Minutes
Sleep Display	Blanked	Blanked	10's of Minutes	Minutes

*If more than one display mode input is applied, the display priorities are in the order of Sleep (overrides all others), Alarm, Seconds, Time (no other mode selected).

TABLE 2. MM5316 Setting Control Functions

SELECTED DISPLAY MODE	CONTROL INPUT	CONTROL FUNCTION
*Time	Slow	Minutes Advance at 2 Hz Rate
	Fast	Minutes Advance at 60 Hz Rate
	Both	Minutes Advance at 60 Hz Rate
Alarm	Slow	Alarm Minutes Advance at 2 Hz Rate
	Fast	Alarm Minutes Advance at 60 Hz Rate
	Both	Alarm Resets to 12:00 AM (12-hour format)
	Both	Alarm Resets to 00:00 (24-hour format)
Seconds	Slow	Input to Entire Time Counter is Inhibited (Hold)
	Fast	Seconds and 10's of Seconds Reset to Zero Without a Carry to Minutes
	Both	Time Resets to 12:00:00 AM (12-hour format)
	Both	Time Resets to 00:00:00 (24-hour format)
Sleep	Slow	Substracts Count at 2 Hz
	Fast	Substracts Count at 60 Hz
	Both	Substracts Count at 60 Hz

*When setting time sleep minutes will decrement at rate of time counter, until the sleep counter reaches 00 minutes (sleep counter will not recycle).

typical application

Figure 7 is a schematic diagram of a general purpose alarm clock using the MM5316 and a fluorescent tube display.

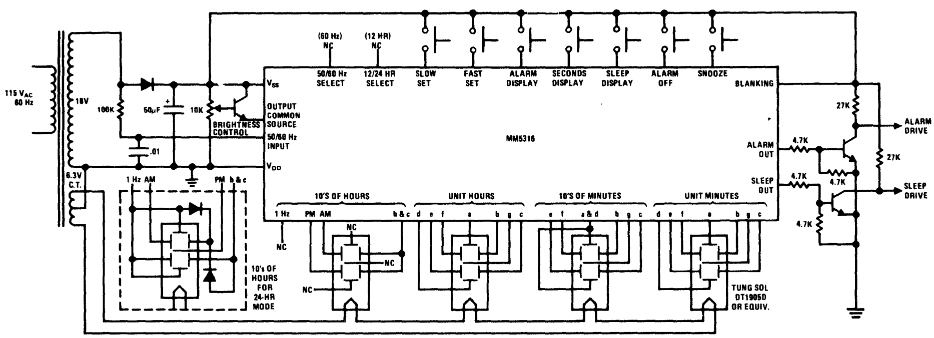


FIGURE 7. Typical Application

10