



## MM5375XX series clocks

### general description

MM5375XX series 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 give a 4 or 6-digit 12-hour or 24-hour display from a 50 or 60 Hz input. An auxiliary counter allows various options. Available options have been listed under features. Power failure indication is provided to inform the user that incorrect time is being displayed. Setting time cancels this indication. MM5375XX is available in a 24-lead dual-in-line epoxy package.

### features

- Single power supply
- Low power dissipation
- All counters resettable
- Fast and slow set controls
- Power failure indication

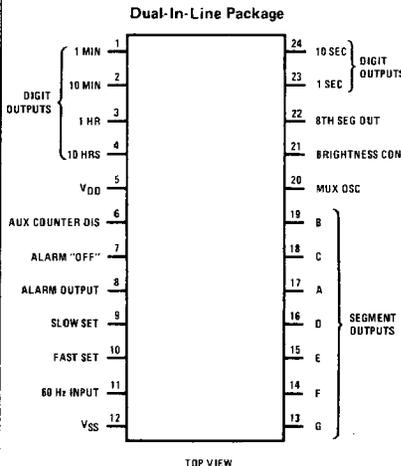
- Brightness control capability
- No illegal time display at turn-on
- Simple interface to gas discharge displays and LED's
- Internal digit multiplex oscillator
- Leading zero blanking
- Activity indicator
- 4 to 6-digit operation
- Available options†

### application

- Alarm clocks
- Desk clocks
- Automobile clocks
- Industrial clocks
- Date clocks
- Minute timer clocks
- Seconds timer clocks

### connection diagram

### available options table†



FEATURE	FUNCTION	OPTION NAME								
		AA	AB	AC	AD	AE	AG	AH	AI	AJ
Input Frequency	60 Hz 50 Hz	•	•	•	•	•	•	•	•	•
Time Display	12-Hour 24-Hour	•	•	•	•	•	•	•	•	•
Auxiliary Counter	Alarm Counter Date Counter Minute Timer Second Timer	•	•	•	•	•	•	•	•	•
Alarm Signal	Tone * DC Level	•	•	N/A	N/A	N/A	•	N/A	•	•
Alarm Output	Modulated at 2 Hz Not Modulated	•	•	N/A	N/A	N/A	•	N/A	•	•
Alarm at Power Failure	"ON" "OFF"	•	•	N/A	N/A	N/A	•	N/A	•	•
Segment Output Polarity	VSS for Display VDD for Display	•	•	•	•	•	•	•	•	•
AM or PM Indication	"OFF" During Time Display Displayed at All Times	•	•	N/A	N/A	N/A	•	•	N/A	N/A
8th Segment Blanked During Alarm Display	Yes No	•	•	N/A	N/A	N/A	•	N/A	•	•

\*Tone is 1/6 multiplex frequency

Order Number MM5375XXN  
See Package 22

**absolute maximum ratings**

Voltage at Any Pin	$V_{SS} + 0.3V$ to $V_{SS} - 30V$
Voltage at Any Display Output Pin	$V_{SS} + 0.3V$ to $V_{SS} - 55V$
Operating Temperature	$-25^{\circ}C$ to $+70^{\circ}C$
Storage Temperature	$-65^{\circ}C$ to $+150^{\circ}C$
Lead Temperature (Soldering, 10 seconds)	$300^{\circ}C$

**electrical characteristics**

$T_A$  within operating range,  $V_{SS} = 0V$ ,  $V_{DD} = -21V$  to  $-29V$  unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Power Supply Voltage ( $V_{DD}$ )	Excluding Outputs	-8.0		-29	V
	Outputs Driving Displays	-21		-29	V
Power Supply Current	Excluding Outputs			8.0	mA
60 Hz Input					
Frequency		DC	50/60	30k	Hz
Logical High		$V_{SS}-1.0$	$V_{SS}$	$V_{SS}$	V
Logical Low		$V_{DD}$	$V_{DD}$	$V_{DD}+1.0$	V
Brightness Control Range	Determined by External R and C, (Figure 2)	0		95	%
% of Digit Time					
Multiplex Oscillator Frequency Input	Determined by External R and C, (Figure 2)	DC		30	kHz
All Other Input Voltages					
Logical High Level		$V_{SS}-1.0$	$V_{SS}$	$V_{SS}$	V
Logical Low Level		$V_{DD}$	$V_{DD}$	$V_{DD}+2.0$	V
Power Failure Detect Voltage	( $V_{DD}$ Voltage)	-1.0		-8.0	V
Output Current	$V_{DD} = -21V$ to $-29V$				
Digit Select Outputs	$V_{SS} = 0V$				
Logical High, Source	$V_{OH} = V_{SS} - 5V$	8.0			mA
Logical Low, Leakage	$V_{OL} = V_{SS} - 45V$			40	$\mu A$
Segment Outputs					
Logical High, Source	$V_{OH} = V_{SS} - 5V$	2.0			mA
Logical Low, Leakage	$V_{OL} = V_{SS} - 45V$			10	$\mu A$
Alarm Output					
Logical High, Source	$V_{OH} = V_{SS} - 2V$	1.5			mA
Logical Low, Sink	$V_{OL} = V_{DD} + 2V$	1			$\mu A$

**functional description**

A block diagram of the MM5375XX series of clocks is shown in Figure 1. The display modes are listed in Table I. The functions of the setting controls are listed in Table II. The following discussions are based on Figure 1.

**60 Hz Input (Pin 11):** A shaping circuit is provided to square the 60 Hz input (50 Hz optional). This circuit allows use of a filtered sinewave input. The circuit is a Schmitt trigger that is designed to provide about 3V of hysteresis. The shaper output drives a counter chain which performs the timekeeping function.

**Time Setting Inputs (Pins 9 and 10):** The time setting control functions are affected by the application of  $V_{SS}$  to these 2 pins, which are internally pulled to the power

supply. Activating Fast Set (pin 10) causes the minutes counter to advance at a 60 Hz rate, thus clocking the hours counter at a rate of 1 hour per second. Slow Set (pin 9) advances the minutes counter at a rate of 2 minutes per second. Activating either Fast Set or Slow Set resets the seconds counter to zero. When Fast Set and Slow Set are activated simultaneously, all counters are reset to 12:00 p.m. and remain in that count until Slow Set is deactivated. The 2 time setting inputs affect only the counters that are displayed (either the timekeeping counters or the alarm counters).

**8-Segment Test (Pin 24):** For testing purposes, all 8-segment output lines may be activated by connecting pin 24 (S10 digit output) to  $V_{SS}$ .

## functional description (Continued)

**Brightness Control (Pin 21):** In LED applications, brightness of the display may be varied by use of an external time constant. This time constant is used in the integrated circuit to control the pulse width or duty cycle of the 6-digit enable outputs, (Figure 2). In gas discharge applications, connect as shown in Figure 3.

**Activity Indication (Pin 23):** When all 6 digits are being used, it is not necessary to blink the colon to indicate operation of the clock, because the seconds digits provide this information. When only 4 digits are in use, the S1 digit (pin 23) may be connected to V<sub>SS</sub>. In this case, the colon flashes at a 1 Hz rate.

**Multiplex Frequency (Pin 20):** Applying an external time constant to this pin allows the multiplex frequency to be adjusted, (Figure 2).

**Power Failure Indication:** If the power to the integrated circuit drops, indicating a momentary ac power failure and possible loss of clock, the AM or PM and colon indicator will flash at a 2 Hz rate. If power drops completely, the clock will reset itself (on resumption of power) to a legal state, and the AM or PM and colon indicators will flash at a 2 Hz rate. In addition to the flashing AM or PM and colon indicator, if a power failure occurs when alarm "OFF" (pin 7) is at V<sub>DD</sub> (logical "0"), the alarm output will be activated (non-activated optional). A logical "1" (V<sub>SS</sub>) on pin 7 will deactivate the alarm signal.

**8-Segment Outputs (Pins 13–19 and 22):** These outputs contain multiplexed information for the display of 7-segment numerical readouts. The 8th segment is for the activation of AM/PM and colon(s) as included in the gas discharge displays for which these outputs are designed.

**4-Digit Operation:** Connect pin 23 to V<sub>SS</sub>.

**Digit Enable Outputs (Pin 1–4, 23 and 24):** These outputs are used to select the 6 digits and are synchronized with the segment outputs. If pin 23 is grounded, segment outputs will be blanked during the scanning of the seconds digits.

**Auxiliary Counter: Alarm Counter Option:** In this option, the auxiliary counter is programmed and used as an alarm counter. Pin 6 serves as both alarm display and snooze input pin. Alarm counter is displayed when pin 6 is held at V<sub>SS</sub>. Alarm setting (Table II) is done using alarm display, Fast Set (pin 10) and Slow Set (pin 9). If the alarm "OFF" input (pin 7) is open and whenever

the real time matches with the alarm time, the alarm comparator sets the alarm latch. This latch activates the alarm output (pin 8). The alarm will remain activated until the alarm "OFF" input is connected to V<sub>SS</sub> temporarily. This readies the alarm latch for next comparison. To deactivate the alarm output for more than 24 hours, the alarm "OFF" input is held at V<sub>SS</sub> for that long. When the alarm output is active, connecting pin 6 to V<sub>SS</sub> will interrupt the alarm signal for 6 to 8 minutes (snooze function).

**Auxiliary Counter: Date Counter Option:** In this option, the auxiliary counter is programmed and used as a month and day counter. The day counter counts up to 31 days and increments the month counter. The day counter rolls over from 31 to 1. The month counter counts up to 12 and rolls over to 1. The date counter can be displayed by connecting date display (pin 6) to V<sub>SS</sub>. The effects of Fast and Slow Set controls are shown in Table II. In this option, do not use the alarm output (pin 8).

**Auxiliary Counter: Timer Option:** In this option, the auxiliary counter is programmed and used as a timer counter. When the display pin 6 is connected to V<sub>SS</sub>, the elapsed time from the previous setting is displayed. The following sequence describes the use of the product as a minute (or seconds) timer.

1. Hold display pin 6 at V<sub>SS</sub>.
2. Hold both Fast and Slow Set controls at V<sub>SS</sub>.  
Note: This will reset the timer counter to 12:00 in 12-hour mode and 00:00 in 24-hour mode.
3. Release both the Fast and Slow Set controls simultaneously.  
Note: The timer counter starts counting minutes (or seconds).
4. If it is required to monitor elapsed time continuously, retain the display pin 6 at V<sub>SS</sub>. Otherwise, release pin 6.
5. Elapsed time can be displayed any time by holding pin 6 at V<sub>SS</sub>.

In this option, the clock can be used for up to 12 hours (12 minutes in seconds timer) of elapsed time in 12-hour mode and 24 hours (24 minutes in seconds timer) of elapsed time in 24-hour mode. The effect of Fast and Slow Set controls are listed in Table II. In these options, do not use the alarm output (pin 8).

**Accuracy of Elapsed Time:** Elapsed time = displayed time ± 1 minute (or second).

TABLE I. Display Modes

SELECTED DISPLAY MODE	DIGIT NO. 1	DIGIT NO. 2	DIGIT NO. 3	DIGIT NO. 4	DIGIT NO. 5	DIGIT NO. 6
Time Display	10's of Hours	Units Hours	10's of Minutes	Units Minutes	10's of Seconds	Units Seconds
Alarm Display	10's of Hours	Units Hours	10's of Minutes	Units Minutes	φ	φ
Date Display	Month	Month	Date	Date	φ	φ
Minute Timer Display	10's of Hours	Units Hours	10's of Minutes	Units Minutes	φ	φ
Second Timer Display	10's of Minutes	Units Minutes	10's of Seconds	Units Seconds	φ	φ

## functional description (Continued)

TABLE II. Setting Control Functions

SELECTED DISPLAY MODE	CONTROL INPUT	CONTROL FUNCTION
Time Display	Slow	Minutes advance at 2.0 Hz rate and seconds are held at a reset (00) condition
	Fast	Minutes advance at 60 Hz rate and seconds are held at a reset (00) condition
	Both	Time resets to 12:00:00 p.m. (12-hour mode) or 00:00:00 (24-hour mode)
Alarm Display	Slow	Alarm minutes advance at a 2.0 Hz rate
	Fast	Alarm minutes advance at a 60 Hz rate
	Both	Alarm resets to 12:00 p.m. (12-hour mode) or 00:00 (24-hour mode)
Date Display	Slow	Date advances at a 2.0 Hz rate
	Fast	Date advances at a 60 Hz rate
	Both	Date counter resets to 12:00
Minute Timer Display	Slow	Minutes (auxiliary counter) advance at a 2.0 Hz rate
	Fast	Minutes (auxiliary counter) advance at a 60 Hz rate
	Both	Timer counter resets to 12:00 (12-Hour mode) or 00:00 (24-hour mode)
Second Timer Display	Slow	Seconds (auxiliary counter) advance at a 2.0 Hz rate
	Fast	Seconds (auxiliary counter) advance at a 60 Hz rate
	Both	Timer counter resets to 12:00 (12-hour mode) or 00:00 (24-hour mode)

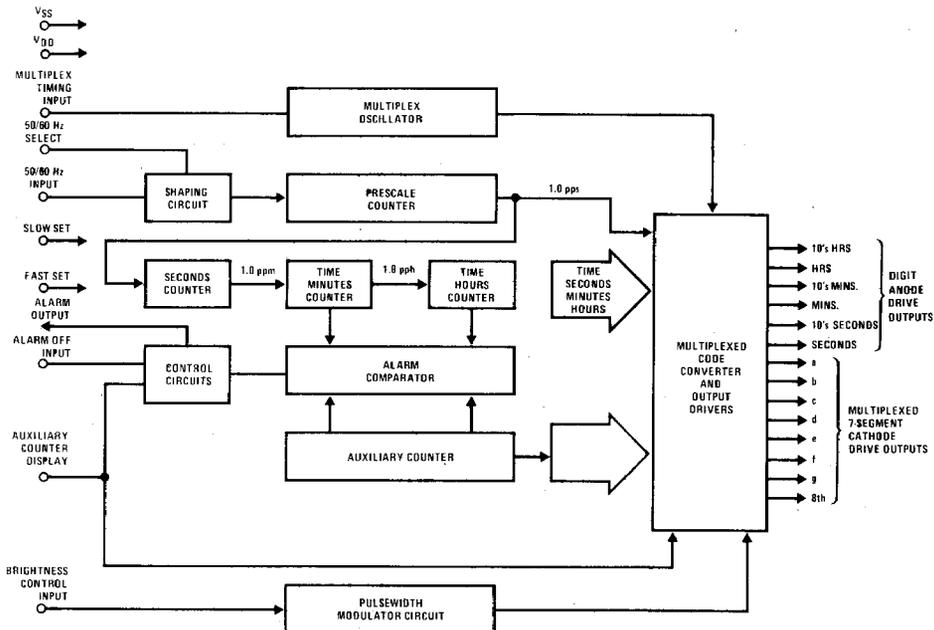


FIGURE 1. Block Diagram



functional description (Continued)

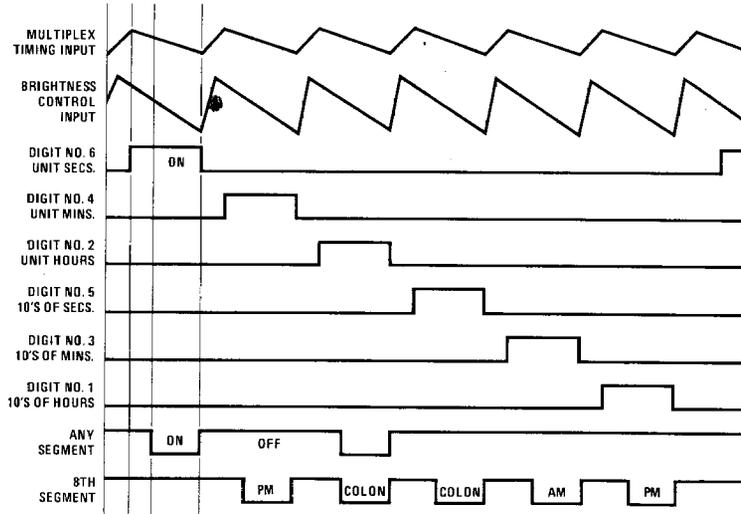


FIGURE 5. Output Timing Diagram