

**MMC 351**

AUTO CLOCK

GENERAL DESCRIPTION

The MMC 351 is a metal gate CMOS integrated circuit that provides or controls all signals needed for a 3 1/2-digit LED watch. The display format is 12 hours, with an AM/PM indicator. The circuit time base is a 32768 Hz crystal controlled oscillator. The time base frequency is successively divided to provide drive signals for a multiplexed 7-segment display. In order to drive the display, the watch requires a BCD-to-7 segment decoder (the MMC4511, for example). The device operates from a single 3V to 18V supply. The MMC351 is available in a 16-lead dual-in-line package.

FEATURES

- 32768 Hz crystal controlled oscillator
- wide supply voltage range: 3 to 18V
- low current consumption (3mA)
- 12 hours display format
- on-chip oscillator

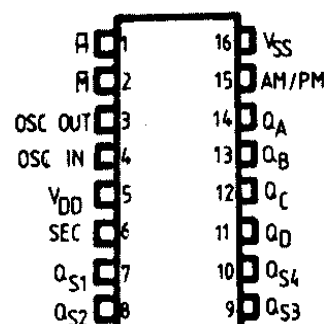
ABSOLUTE MAXIMUM RATINGS

V_{DD}	Supply voltage	-0.5 ...	18 V
V_I	Input voltage	-0.5 ...	$V_{DD} + 0.5$ V
P_D	Total power dissipation	200 mW	
T_A	Operating temperature	-40 ...	+ 85 °C
T_S	Storage temperature range	-65 ...	+ 155 °C

RECOMMENDED OPERATING CONDITIONS

V_{DD}	Supply voltage	3 ...	15 V
V_I	Input voltage	0 ...	V_{DD}
T_A	Operating temperature	-40 ...	+ 85 °C

CONNECTION DIAGRAM



STATIC ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$, $f_{osc} = 32\,768\text{ Hz}$)

PARAMETER		TEST CONDITIONS				VALUES		UNIT
		V _I (V)	V _O (V)	I _O (μA)	V _{DD} (V)	25°C		
						min.	max.	
I _L	Quiescent current	0/ 5 0/10 0/15			5 10 15		1400 1600 1800	μA
V _{OH}	Output low voltage	0/ 5 0/10 0/15		< 1 < 1 < 1	5 10 15	4.95 9.95 14.95		V
V _{OL}	Output low voltage	5 /0 10/0 15/0		< 1 < 1 < 1	5 10 15		0.05 0.05 0.05	V
V _{IH}	Input high voltage		0.5/4.5 1/9 1.5/13.5	< 1 < 1 < 1	5 10 15	3.5 7 11		V
V _{IL}	Input low voltage		4.5/0.5 9/1 13.5/1.5	< 1 < 1 < 1	5 10 15		1.5 3.0 4.0	V
I _{IH} , I _{IL}	Input leakage current	0/15			15		±0.3	μA
I _{OH}	Drive current on BCD outputs	0/ 5 0/ 5 0/10 0/15	2.5 4.6 9.5 13.5		5 5 10 15		0.5 0.5 1.5 3.0	mA
I _{OL}	Sink current on BCD outputs	0/ 5 0/10 0/15	0.4 0.5 1.5		5 10 15		0.5 1.5 3.0	mA
I _{OH}	Drive current on digit outputs	0/ 5 0/ 5 0/10 0/15	2.5 4.6 9.5 13.5		5 5 10 15		0.5 0.5 1.5 3.0	mA
I _{OL}	Sink current on digit outputs	0/ 5 0/10 0/15	0.4 0.5 1.5		5 10 15		0.14 0.5 0.9	mA
I _{OH}	Drive current on AM/PM, SEC outputs	0/ 5 0/ 5 0/10 0/15	2.5 4.6 9.5 13.5		5 5 10 15		0.1 0.1 0.2 0.4	mA
I _{OL}	Sink current on AM/PM, SEC outputs	0/ 5 0/10 0/15	0.4 0.5 1.5		5 10 15		0.1 0.2 0.4	mA
I _{OH}	Drive current on OSC OUT outputs	0/ 5 0/ 5 0/10 0/15	2.5 4.6 9.5 13.5		5 5 10 15		0.5 0.5 1.5 3.0	mA
I _{OL}	Sink current on OSC OUT outputs	0/ 5 0/10 0/15	0.4 0.5 1.5		5 10 15		0.5 1.5 3.0	mA
C _i	Input capacitance	Any input					7.5	pF

```

graph LR
    OSC_IN[OSC IN] --> OSC[OSC]
    OSC --> OSC_OUT[OSC OUT]
    OSC --> B3[13 STAGE DIVIDER]
    B3 --> FREQ[FREQ SELECT AND 2 STAGE DIVIDER]
    FREQ --> SEC[SEC]
    SEC --> SECS[SECONDS COUNTER]
    SEC --> MIN[MINUTES COUNTER]
    SEC --> HRS[HOURS COUNTER]
    SECS --> MIN
    MIN --> HRS
    SECS --> AMPM[AM/PM]
    SECS --> DCL[DISPLAY CONTROL LOGIC AND BUFFERS]
    MIN --> AMPM
    MIN --> CSL[COUNTER SELECT LOGIC AND BUFFERS]
    HRS --> AMPM
    HRS --> CSL
    DCL --> CS[Display: a_s1, a_s2, a_s3, a_s4]
    CSL --> DCL
    DEB[DEBOUNCE AND SET CONTROL LOGIC] --> FREQ
    DEB --> CS
    DEB --> a_s1
    DEB --> a_s4
    VDD[VDD] --- DEB
    VSS[VSS] --- DEB
  
```

Closure of the 'M' switch will advance minutes at a 2 Hz rate, with no advance of the hours counter and with seconds counter in 00. Closure of the 'H' switch will advance hours counter at a 1 Hz rate. When POWER ON, minutes counter must be set first.