MAXIM

Fixed And Programmable Timer/Counters

ICM7240/42/50/60

General Description

The Maxim ICM7240/50/60 are programmable timer/counters and the Maxim ICM7242 is a fixed timer/counter. They require only 120μA of supply current, while generating delays from microseconds to days. Each device combines a counter with an internal oscillator whose period is controlled by an external resistor and capacitor. The oscillator can be inhibited and an external clock applied to the TB I/O terminal. The programmable counters in the ICM7240/50/60 can be programmed using thumbwheel switches, jumpers, and analog switches.

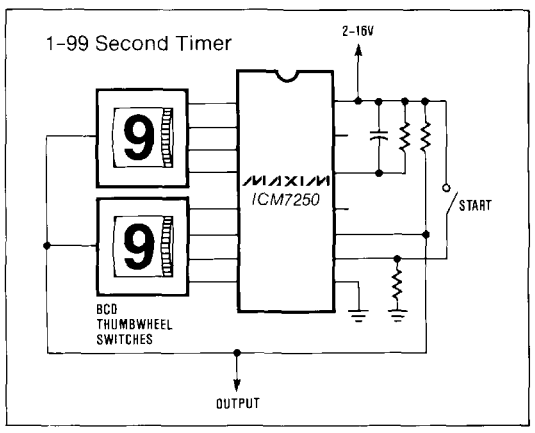
The ICM7240 has an 8 bit programmable counter and can generate time delays from 1 to 255 RC time constants. The ICM7250 has a two digit programmable BCD counter and can generate time delays from 1 to 99 RC time constants. The ICM7260 is used for "real time" applications and has a modulo 60 programmable divider, producing time delays from 1 to 59 RC time constants. The ICM7242 has an 8 bit fixed counter and can generate a time delay of 1 and 128 RC time constants. These four devices are easily cascaded and can operate in either astable or monostable configurations, using the on-chip control flip-flop with Trigger and Reset inputs.

Applications

The ICM7240/42/50/60 family is suitable for a wide variety of timing and control applications.

ON/OFF Delay Timers
Batch Timer/Sequencers
Cycle Timers
Programmable Timers
Frequency Synthesizers
Ultra-Long Time Delay Generators

Typical Operating Circuit



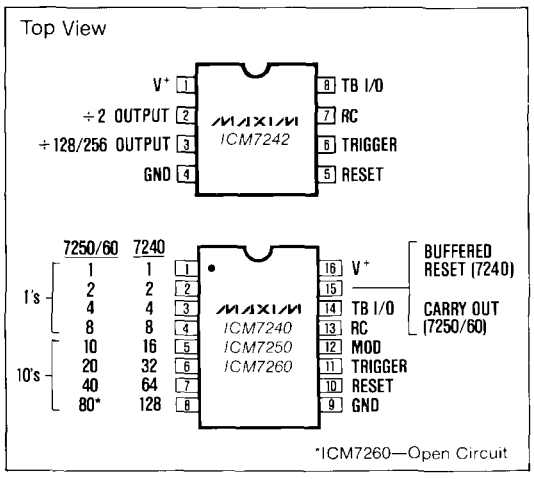
Features

- **Improved Second Source! (See 3rd page for "Maxim Advantage™.")**
- **Low Supply Current: 120μA**
- **Timing from μs to Days**
- **Shutdown Current less than 10μA**
- **Programmable Fixed Count**
- **Cascadable for Long Range Timing**
- **Monostable or Astable Operation**
- **Low Power CMOS**

Ordering Information

PART	TEMP. RANGE	PACKAGE
ICM7240IPE	-20°C to +85°C	16 Lead PLASTIC DIP
ICM7240IJE	-20°C to +85°C	16 Lead CERDIP
ICM7240C/D	0°C to +70°C	Dice
ICM7242IPA	0°C to +85°C	8 Lead PLASTIC DIP
ICM7242IJA	-20°C to +85°C	8 Lead CERDIP
ICM7242C/D	0°C to +70°C	Dice
ICM7250IPE	-20°C to +85°C	16 Lead PLASTIC
ICM7250IJE	-20°C to +85°C	16 Lead CERDIP
ICM7250C/D	0°C to +70°C	Dice
ICM7260IPE	-20°C to +85°C	16 Lead PLASTIC
ICM7260IJE	-20°C to +85°C	16 Lead CERDIP
ICM7260C/D	0°C to +70°C	Dice

Pin Configuration



The "Maxim Advantage™" signifies an upgraded quality level. At no additional cost we offer a second-source device that is subject to the following: guaranteed performance over temperature along with tighter test specifications on many key parameters; and device enhancements, when needed, that result in improved performance without changing the functionality.

Fixed and Programmable Timer/Counters

ABSOLUTE MAXIMUM RATINGS

Supply Voltage 18V
Input Voltage (Note 1)
  ICM7240/50/60,
    pins 10,11,12,13,14 ..... (Gnd-0.3V) to (V^+ +0.3V)
  ICM7242
    pins 5,6,7,8 ..... (Gnd-0.3V) to (V^+ +0.3V)
Output Voltage
  ICM7240/50/60
    pins 1,2,3,4,5,6,7,8 ..... (Gnd-0.3V) to +18V
    pins 14,15 ..... (Gnd-0.3V) to (V^+ 0.3V)
Output Voltage
  ICM7242
    pins 2,3,8 ..... (Gnd-0.3V) to (V^+0.3V)
Maximum Continuous Output
  Current (each output) 50mA
Power Dissipation 200mW
  Derate at -2mW/°C above 25°C.
Operating Temperature Range ..... -20°C to +85°C
Storage Temperature Range ..... -55°C to +125°C
Lead Temperature (soldering, 10 seconds) ..... +300°C

Note 1: Due to the SCR structure inherent in the CMOS process, connecting any terminal (except pins 1 through 8 on the ICM7240/50/60) to voltages greater than V^+ or less than Ground may cause destructive device latchup. For this reason, it is recommended that no inputs from external sources be applied to the device before the supply is established. In multiple supply systems, the supply to ICM7240/42/50/60 should be turned on first. Pins 1 through 8 in the ICM7240/50/60 are open drain devices and are rated to withstand 18Volts with respect to ground (pin 9).

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V^+=+5V, T_A=+25°C, R=10kΩ, C=0.1μF, unless otherwise specified.)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Guaranteed Supply Voltage	V^+		2		16	V
Supply Current	I^+	*Reset*		125		μA
7240,50,60		Operating, R = 10kΩ, C = 0.1μF		300	700	μA
		Operating, R = 1MΩ, C = 0.1μF		120	500	μA
		TB Inhibited, RC Connected to GND		125		μA
7242		Operating, R = 10kΩ, C = 0.1μF		340	800	μA
		Operating, R = 1MΩ, C = 0.1μF		220	600	μA
		TB Inhibited, RC Connected to GND		225		μA
Timing Accuracy				5		%
RC Oscillator Frequency Temperature Drift	$\Delta f/\Delta T$	(Exclusive of RC Drift)		250		ppm/°C
Time Base Output Voltage	V_{OTB}	I_{SOURCE} = 1 mA	3.5	4.2		V
		I_{SINK} = 3.2 mA		0.25	0.6	V
Time Base Output *Leakage Current*	I_{TBLK}	RC = Ground			25	μA
Mod Voltage Level	V_{MOD}	V^+ = 5V		3.5		V
7240/50/60		V^+ = 15V		11.0		V
Trigger Input Voltage	V_{TRIG}	V^+ = 5V		1.6	2.0	V
		V^+ = 15V		3.5	4.5	V
Reset Input Voltage	V_{RST}	V^+ = 5V		1.3	2.0	V
		V^+ = 15V		2.7	4.0	V
Max Count Toggle Rate	f_t	V = 2V ┐		1		MHz
7240, 7242		V = 5V ├ Counter/Divider Mode	2	6		MHz
		V = 15V ┘		13		MHz
		50% Duty Cycle Input with Peak to Peak Voltages Equal to V^+ and GND				
Max Counter Toggle Rate, 7250, 7260	f_t	V^- = 5V (Counter/Divider Mode)	1.5	5		MHz
Max Count Toggle Rate 7240, 7250, 7260	f_t	Programmed Timer — Divider Mode			100	kHz
Output Saturation Voltage	V_{SAT}	All Outputs except TB Output V^+ = 5V, I_{OUT} = 3.2 mA		0.22	0.4	V
Output Leakage Current	I_{OLK}	V^+ = 5V, per Output			1	μA
Output Sourcing Current 7242	I_{SOURCE}	V^- = 5V Terminals 2 & 3, V_{OUT} = 1V		300		μA
MIN Timing Capacitor	C_t		10			pF
Timing Resistor Range	R_t	$V^+ \leq 5.5V$			22M	Ω
		$V^- \leq 16V$			22M	Ω

The electrical characteristics above are a reproduction of a portion of Intersil's copyrighted (1983, 1984) data book. This information does not constitute any representation by Maxim that Intersil's products will perform in accordance with these specifications. The Electrical Characteristics Table along with the descriptive excerpts from the manufacturer's data sheet have been included in this data sheet solely for comparative purposes.

- **Synchronous High Speed Operation**
- **No False Clocking**
- **Increased Toggle Rate**
- **Supply Current Guaranteed Over Temperature**
- **Standby Current Less Than 10μA**
- **Significantly Improved ESD Protection (Note 1)**
- **Maxim Quality and Reliability**

ABSOLUTE MAXIMUM RATINGS: These devices conform to the Absolute Maximum ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS: Specifications below satisfy or exceed all "tested" parameters on adjacent page.
(V^+=+5V, T_A=+25°C, Test circuit: R=10kΩ, C=0.1μF, unless otherwise specified).

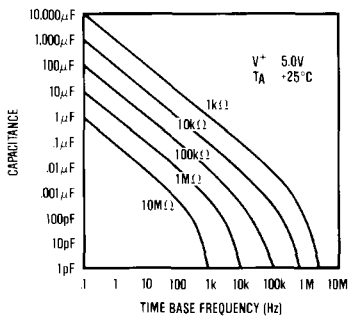
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Guaranteed Supply Voltage	V^+		2		16	V
Supply Current	**I^+**	**Reset, -20°C ≤ T_A ≤ +85°C**		**125**	**700**	**μA**
		Operating, R = 10kΩ, C = 0.1μF, T_A = 25°C		**300**	**700**	**μA**
		-20°C ≤ T_A ≤ +85°C			**800**	**μA**
		Operating, R = 1MΩ, C = 0.1μF (Note 2)		**120**	**500**	**μA**
		TB Inhibited, RC Connected to GND				
		-20°C ≤ T_A ≤ +85°C			**10**	**μA**
Timing Accuracy		V^+ = +5V, R = 10kΩ, C = 0.1μF		5		%
RC Oscillator Frequency Temperature Drift	Δf/ΔT	(Exclusive of RC Drift)		250		ppm/°C
Time Base Output Voltage	V_{OTB}	I_{SOURCE} = 1 mA	3.5	4.2		V
		I_{SINK} = 3.2 mA		0.25	0.6	V
Time Base Output Leakage Current	**I_{TBLK}**	**RC = Ground**			**5**	**μA**
Timebase Input Voltage	**V_{IL}**				**0.8**	**V**
	V_{IH}		**3.5**			**V**
Mod Voltage Level 7240,50,60	V_{MOD}	V^+ = 5V		4.0		V
		V^+ = 15V		12		V
Trigger Input Voltage	**V_{TRIG}**	**V^+ = 5V**	**0.8**	**1.6**	**2.0**	**V**
		V^+ = 15V	**0.8**	**3.5**	**4.5**	**V**
Reset Input Voltage	**V_{RST}**	**V^+ = 5V**	**0.8**	**1.3**	**2.0**	**V**
		V^+ = 15V	**0.8**	**2.7**	**4.0**	**V**
Trigger/Reset Input Current	I_{TRIG} I_{RESET}	-20°C ≤ T_A ≤ +85°C		0.1	10	μA
Max Count Toggle Rate 7240, 7242 7250, 7260	**f_t**	**V^+ = 2V** **Fixed Counter/**		**1**		**MHz**
		V^+ = 5V **Divider Mode**	**3**	**8**		**MHz**
		V^+ = 15V		**15**		**MHz**
		50% Duty Cycle Input with Peak to Peak Voltages Equal to V^+ and GND				
Max Count Toggle Rate 7240, 7250, 7260	**f_t**	**Programmable Divide Mode (Note 2)**	**200**			**kHz**
Carry Out Source						
Source Output Current	**I_{COH}**	**V_{OH} = V^+ - 1V**	**300**			**μA**
Sink Output Current		**V_{OL} = +0.4 Volts**	**3.2**			**mA**
Output Saturation Voltage	V_{SAT}	All Outputs except TB Output V^+ = +5V, I_{SINK} = 3.2 mA		0.22	0.4	V
Output Leakage Current	I_{OLK}	V^+ = +5V, per Output			1	μA
Output Sourcing Current 7242	**I_{SOURCE}**	**V^+ = +5V terminals 2,8,3 V_{OUT} = V^+ - 1V**	**300**			**μA**
MIN Timing Capacitor	C_t		10			pF
Timing Resistor Range	R_t	$V^+ \leq 5.5V$	1k		22M	Ω
		$V^+ \leq 16V$	1k		22M	Ω
RC Input Leakage	**I_{RC}**	**RC = 2.5V**			**10**	**nA**

Note 1: All pins are designed to withstand electrostatic discharge (ESD) levels in excess of 2000V (Mil STD 883C Method 3015.2 Test Circuit).

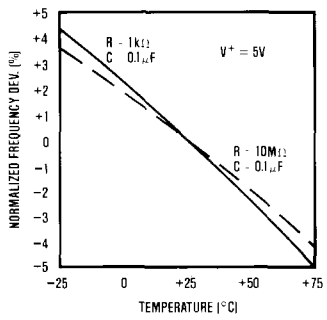
Note 2: Parameter is Q.A. sample tested.

Typical Operating Characteristics

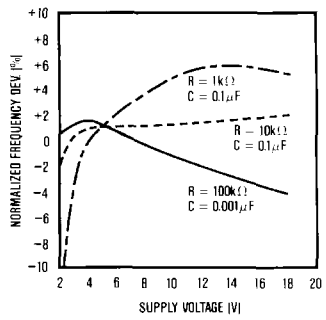
RC OSCILLATOR FREQUENCY vs. R AND C



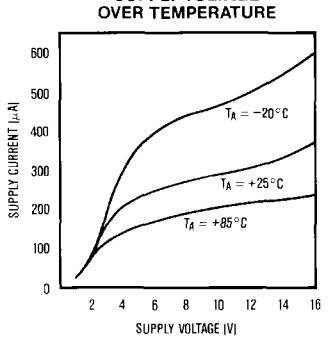
NORMALIZED FREQUENCY vs. TEMPERATURE



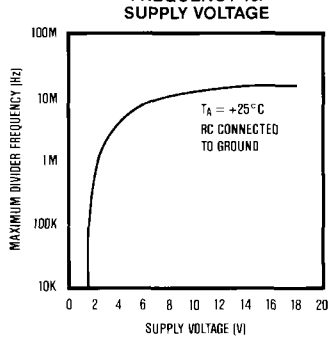
NORMALIZED FREQUENCY vs. SUPPLY VOLTAGE



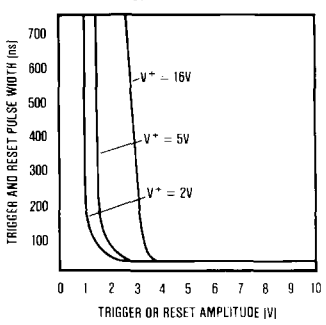
SUPPLY CURRENT vs. SUPPLY VOLTAGE OVER TEMPERATURE



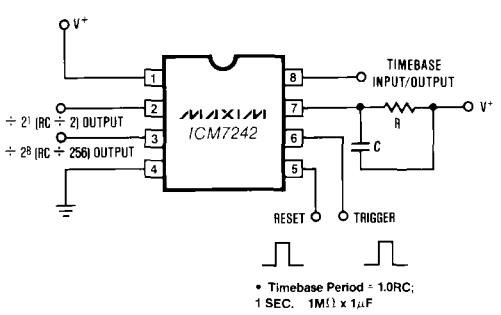
MAXIMUM DIVIDER FREQUENCY vs. SUPPLY VOLTAGE



MINIMUM RESET AND TRIGGER PULSE WIDTH vs. AMPLITUDE

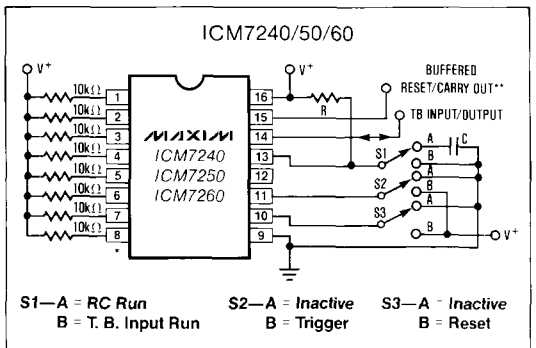


Test Circuits



• Timebase Period = 1.0RC;
1 SEC. 1MΩ x 1µF

Note: Outputs ÷ 2^1 and ÷ 2^8 are inverters and have active pullups.



S1—A = RC Run
B = T. B. Input Run

S2—A = Inactive
B = Trigger

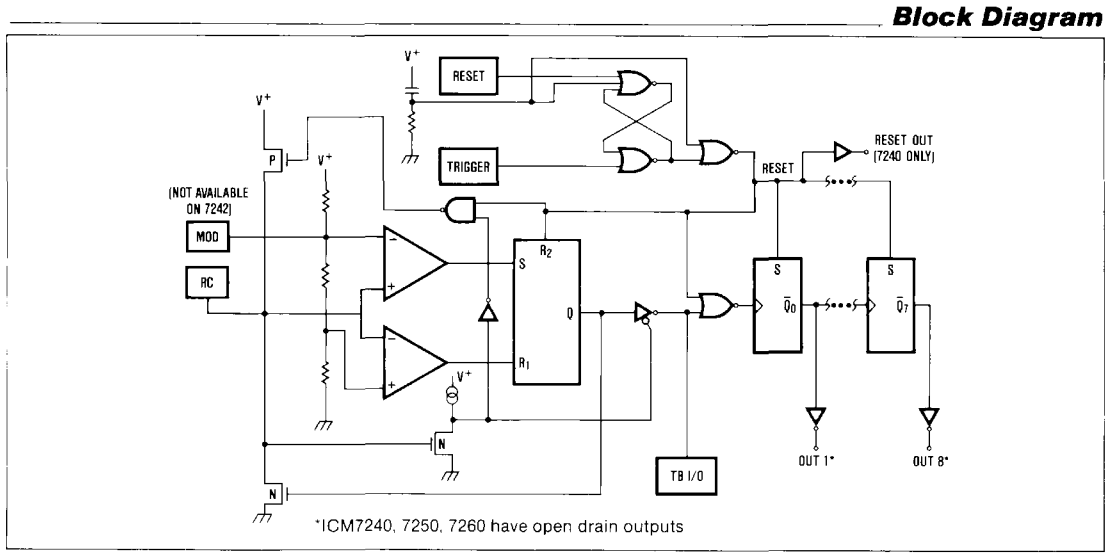
S3—A = Inactive
B = Reset

Note: S1-B inhibits the timebase section, allowing terminal 14 to become the counter input.
***Note:** Terminal 8 is open circuit for 7260.
****Note:** *Terminal 15 is open circuit for 7250/60 devices.*

Table 1. PIN DESCRIPTIONS

PIN NAME	PIN # ICM7240/50/60	PIN # ICM7242	DESCRIPTION
V^+	16	1	Positive power supply pin.
GND	9	4	Ground
RC	13	7	RC timing node. If this pin is grounded, the TB I/O pin is an external clock input. An external resistor and capacitor connected to this pin sets the frequency of the internal oscillator to 1/RC.
Trigger	11	6	The Trigger input sets the internal control flip-flop to the Run state. If the counter is reset and TB I/O is low, a high on Trigger will clock the counter to the all 0s count and counting will begin. If the counter is reset and TB I/O is high, a high level on Trigger will only set the control flip-flop. The counter will clock to the all 0s count on the next falling edge of TB I/O, provided the control flip-flop is set.
Reset	10	5	A high input on Reset while Trigger is low will reset the counter, force all counter outputs high, and stop the counter by resetting the control flip-flop. The Reset input has no effect if Trigger is high.
TB I/O	14	8	The TB I/O pin is an external clock input if the RC pin is grounded. If RC is not grounded the TB I/O pin is the timebase oscillator output. The Maxim TB I/O output is fully buffered and can drive up to 1000pF of capacitance.
Carry Out	15 (ICM 7250/60 only)	—	Carry goes high during the last 10 counts—50 through 59 in the ICM 7260, 90 through 99 in the ICM7250. To cascade two ICM 7250/60s, drive the TB I/O pin of one ICM7250/60 with the Carry Out of the other. (Use the ÷ 128 output to cascade ICM7240 and ICM7242.)
Buffered Reset	15	—	Buffered output of the Reset input of the control flip-flop. (Maxim ICM7240 only)
Counter Outputs	1-8		The ICM7240/50/60 outputs are open drain n-channel outputs which sink current when on and are open circuits when off. These outputs are TTL and CMOS compatible if a pullup resistor is connected to V^+.
Counter Outputs	—	2,3	The ICM7242 outputs are logic outputs which both sink and source currents. The ICM7242 outputs are both TTL and CMOS compatible and do not require pullups. The ÷ 2 output is a square wave at ½ the frequency of the onboard oscillator or external timebase. The ÷ 128/256 output is a square wave with a period 256 times the oscillator or external timebase period. This pin goes high 128 clock cycles after the counter is triggered.
MOD	12	—	Similar to the Control input of an ICM7555, this pin is connected to the resistor string that sets the oscillator thresholds. The internal resistor divider drives the Modulation (MOD) pin to 80% of V^+. Varying the MOD voltage will adjust the oscillator frequency.

Block Diagram



*ICM7240, 7250, 7260 have open drain outputs

Fixed And Programmable Timer/Counters

Circuit Description

The timing cycle is controlled by the internal control flip-flop. This set-reset flip-flop is set to the Run state by a high level on the Trigger input. A high level on the Reset input puts the control flip-flop into the Reset state, provided Trigger is low. Trigger overrides Reset: if both Trigger and Reset are high the control flip-flop is set to the Run state.

When the control flip-flop is set to the run state the counter is set to all 0s (all outputs low), the timebase input is also enabled, and the counter will increment with each negative-going edge at TB I/O.

A high level on the Reset input while Trigger is low resets the control flip-flop. The flip-flop resets the counter forcing all the counter outputs high, inhibiting the counter from being incremented, and unless in the external timebase mode, turns on the internal pullup connected to the RC pin.

The RC oscillator period is set by an external resistor and capacitor. The external resistor charges the capacitor to 80% of V^+. This voltage is detected at the RC terminal, TB I/O goes low, the counter increments one count, and the internal discharge transistor rapidly discharges the capacitor to 45% of V^+. When the capacitor voltage goes below 45% of V^+ the internal discharge transistor turns off, TB I/O goes high, and the external capacitor again starts to charge through the external resistor. The period of each oscillator cycle is 1.0 RC.

In many applications, one or more of the counter outputs can be used to reset the counter after a programmed count is completed. With no outputs connected back to the Reset pin, the circuit operates in the astable (free running) mode.

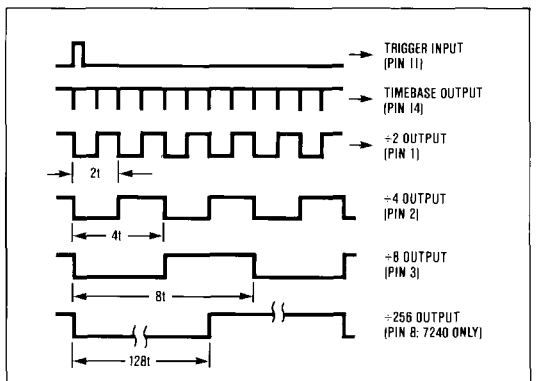
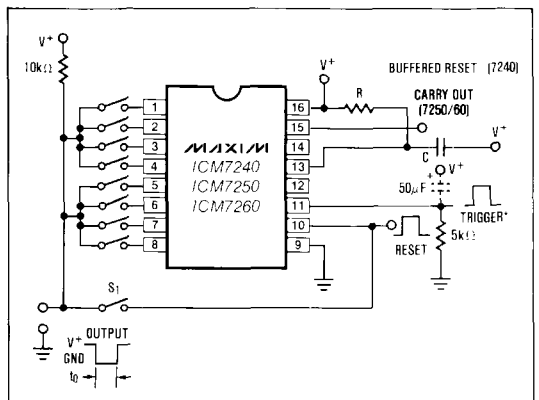


Figure 1. Timing Diagram for ICM7240/50/60.

Applications

Programmable Time Delay

Figure 2 shows a basic programmable time delay. When the circuit is triggered all outputs go low. When the programmed count is reached, the Reset input is pulled high by the 10kΩ resistor, resetting the counter. The programming can be achieved by using either mechanical switches such as thumbwheel or DIP switches, or analog switches such as the CD4016 and CD4066.



Note: For power up triggering (t_w = 185ms) use circuit shown and omit external pulse.
Note: Programming achieved by solder connections, DIP thumbwheel or analog switches.

Figure 2. Generalized Circuit for Timing Applications (Switch S_1 open for astable operation, closed for monostable operation)

Output Count Programming (ICM7240/50/60)

The counter outputs on the ICM7240/50/60 are open-drain-channel FETs, enabling a "wired-OR" connection to be achieved by shorting together the desired outputs with a common pull-up resistor. In this way, the timing cycle can be programmed from:

1RC to 255RC (ICM7240)
1RC to 99RC (ICM7250)
1RC to 59RC (ICM7260)

Programming the ICM7240/50/60 can achieved by hard wiring, DIP switches, or standard thumbwheel switches.

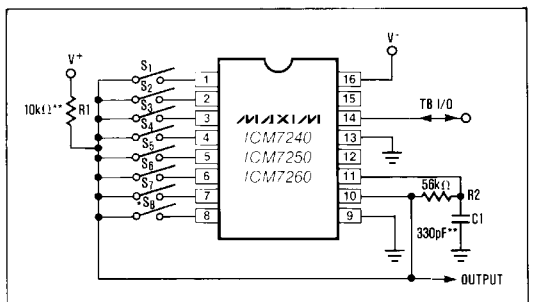
ICM7242 Counter Outputs

The ICM7242 is a non-programmable timer/counter. The outputs on the ICM7242 are inverters which both source and sink current, unlike the open drain N-channel outputs of the ICM7240/50/60 which only sink current. The ICM7242 output inverters eliminate the need for external pull-up resistors.

Outputs on pins 2 and 3 are $\div 2$ and $\div 2^8$ respectively. To use the 8 bit counter without the timebase, connect pin 7 (RC) to ground and drive pin 8 (TB I/O) with an external timebase. For monostable applications connect the $\div 2^8$ output to the reset pin.

Programmable Divider

With the addition of an RC network betweeen the Reset and Trigger inputs, the circuit of Figure 3 becomes a programmable divider. The output period is N times the oscillator (or external input) period, where N is the number programmed into the thumbwheel switches. The 56kΩ and 30pF RC network drives the Trigger high approximately 7μs after Reset goes high, retriggering the counter and starting the cycle again. For high speed operation the capacitor should be reduced to 39pF and the 10kΩ pullup resistor reduced to 2.2kΩ.



* **Note:** S_2 not used on ICM7260.
****Note:** For high-speed operation replace resistor R1 with 2.2 kΩ and capacitor C1 with 39pF.

Figure 3. Programming the Counter Section of the ICM7240/50/60

Competitive Comparison

Maxim's ICM7240/42/50/60 devices are upwardly compatible with Intersil's devices. The counters used in Maxim's parts are synchronous versus the ripple-type used in Intersil's parts. In the programmable divider mode, the maximum frequency of operation is limited by the propagation delay across the counter and the reset delay of the flip-flop. These delays must be less than one half the timebase period, for reliable operation.

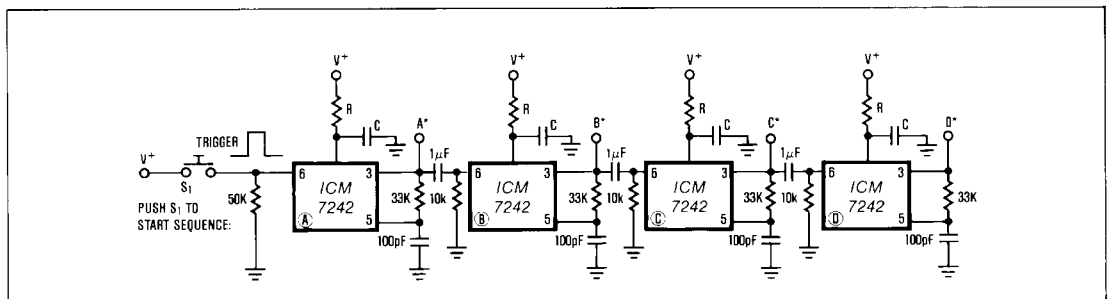
Maxim's ICM7240 has a Buffered Reset Output on pin 15 versus a No Connection on Intersil's part. This output is a buffered output from the reset line for the counters contained within the ICM7240, so that when the device is being used in the programmable divider mode, the output can be used as the divider count output.

When Maxim's devices are operated with the time-base inhibited (RC pin grounded) and the counter is reset, the supply current for the Maxim part is guaranteed to be no more than 10μA versus a possible 8mA at +5Volts and 20mA at +16Volts for the Intersil part.

The TB I/O output has significantly improved drive capability and can drive up to 1,000pF of load capacitance versus 50pf for the Intersil part. Maxim's devices are also less sensitive than Intersil's to the rate of change of the input waveform at TB I/O when in the external clock mode. This reduces the possibility of false triggering on slow falling clock waveforms.

Sequence Timer

Figure 4 shows how to cascade multiple counters to perform more complex control functions.



***Note:** Select RC values to desired "ON time" for each ICM7242.

Figure 4. Sequence Timer Using ICM7242

Fixed And Programmable Timer/Counters

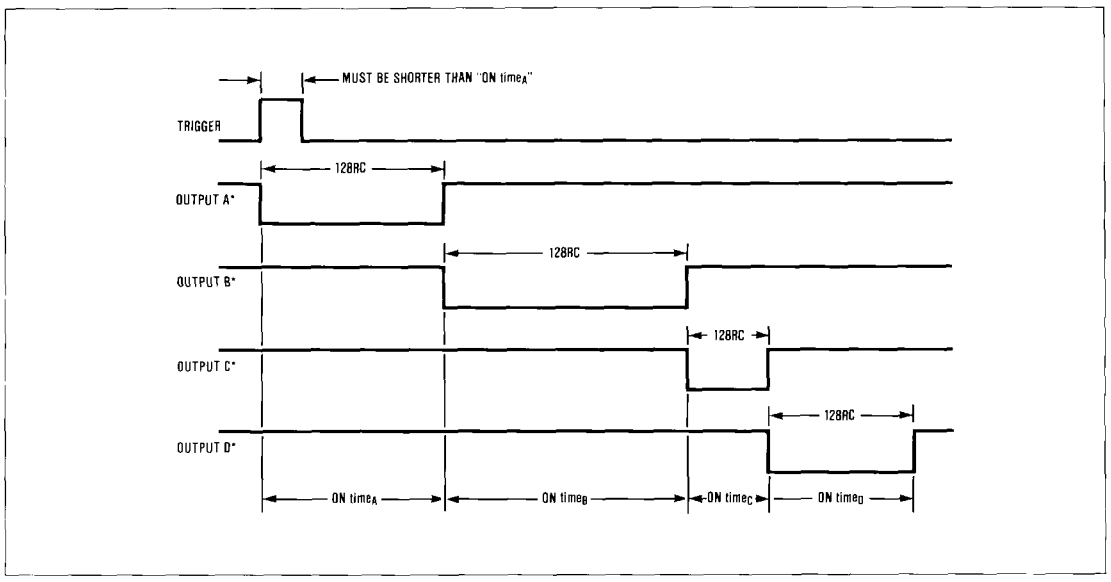
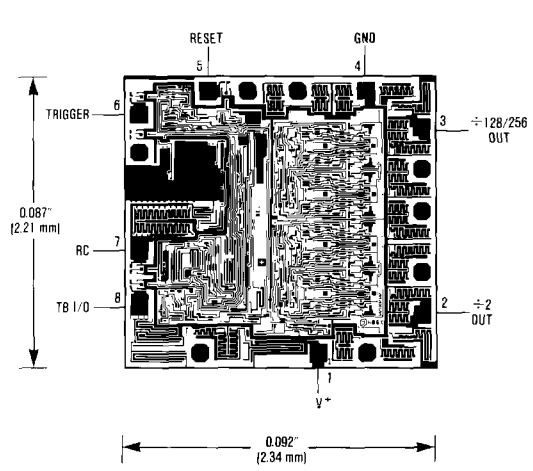
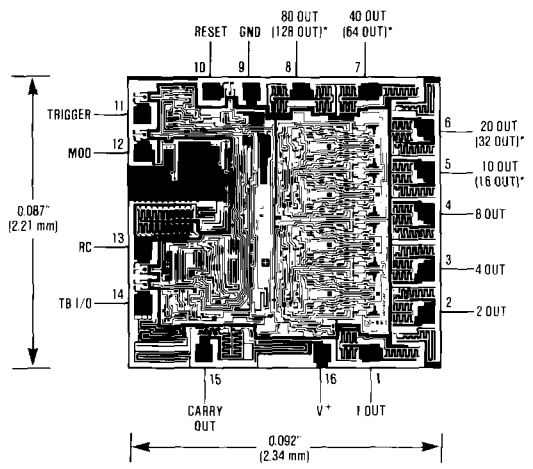


Figure 5. Timing Diagram for Sequence Timer of Figure 4.

Chip Topography



ICM 7242



ICM7240/50/60

***Note:** Pin descriptions in parentheses refer to ICM7240.