PROGRAMMABLE TIMER

The HEF4541B is a programmable timer which consists of a 16-stage binary counter, an integrated oscillator to be used with external timing components, an automatic power-on reset and output control logic. The frequency of the oscillator is determined by the external components R_t and C_t within the frequency range 1 Hz to 100 kHz. This oscillator may be replaced by an external clock signal at input RS, the timer advances on the positive-going transition of RS. A LOW on the auto reset input ($\overline{AR}$) and a LOW on the master reset input (MR) enables the internal power-on reset. A HIGH level at input MR resets the counter independent on all other inputs. Resetting disables the oscillator to provide no active power dissipation.

A HIGH at input $\overline{AR}$ turns off the power-on reset to provide a low quiescent power dissipation of the timer. The 16-stage counter divides the oscillator frequency by 2^8, 2^{10}, 2^{13} or 2^{16} depending on the state of the address inputs (A_0, A_1). The divided oscillator frequency is available at output O. The phase input (PH) features a complementary output signal. If the mode select input (MODE) is LOW or HIGH the timer can be used respectively as a single transition timer or 2^n frequency divider.

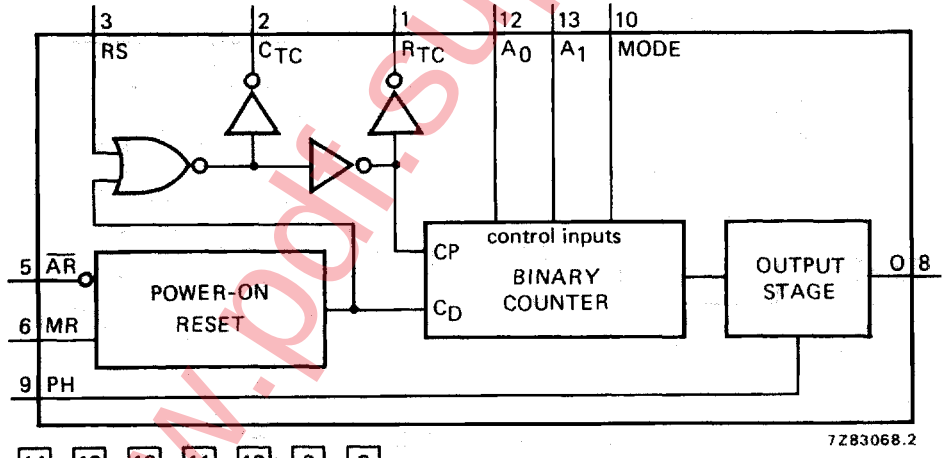


Fig. 1 Functional diagram.

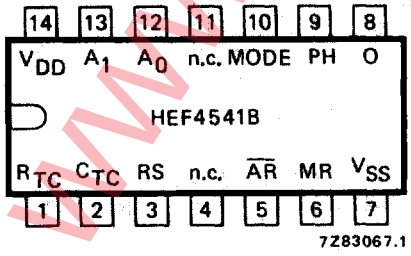


Fig. 2 Pinning diagram.

HEF4541BP(N): 14-lead DIL; plastic (SOT27-1)
HEF4541BD(F): 14-lead DIL; ceramic (cerdip) (SOT73)
HEF4541BT(D): 14-lead SO; plastic (SOT108-1)
( ): Package Designator North America

FAMILY DATA

see Family Specifications

I_{DD} LIMITS category MSI

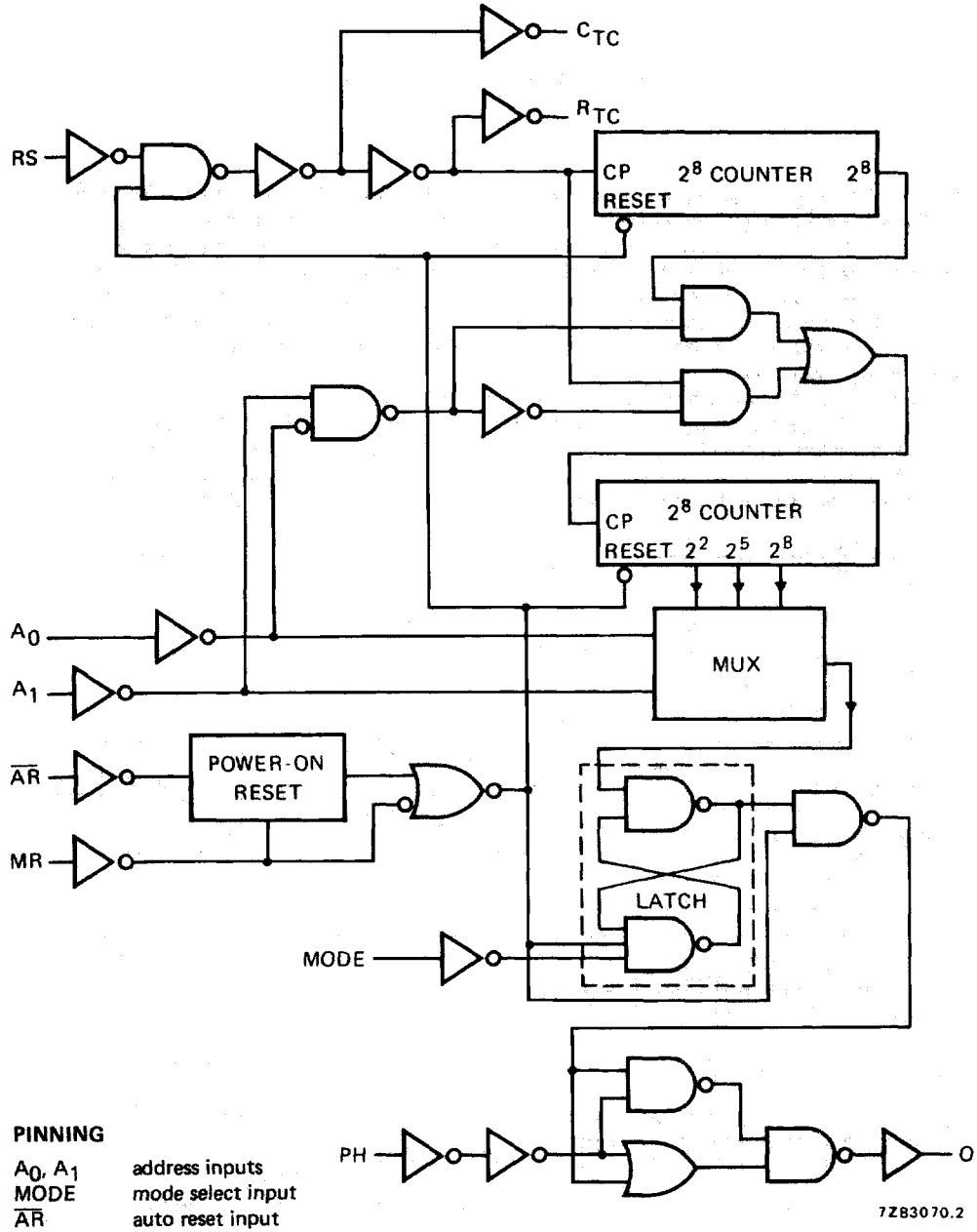


Fig. 3 Logic diagram.

PINNING

A_0, A_1	address inputs
MODE	*mode* select input
$\overline{AR}$	auto reset input
MR	master reset input
PH	phase input
R_{TC}	external resistor connection (R_t)
C_{TC}	external capacitor connection (C_t)
RS	external resistor connection (R_S) or external clock input

FREQUENCY SELECTION TABLE

A_0	A_1	number of counter stages n	$\frac{f_{osc}}{f_{out}} = 2^n$
L	L	13	8 192
L	H	10	1 024
H	L	8	256
H	H	16	65 536

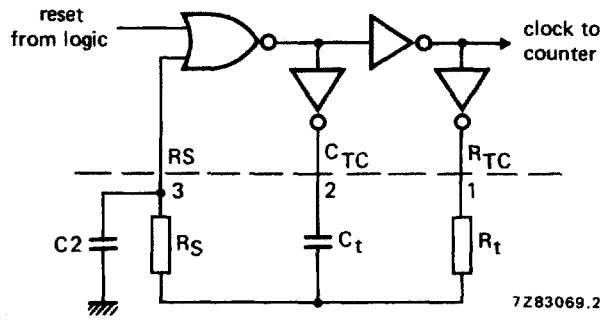
FUNCTION TABLE

inputs				mode
$\overline{AR}$	MR	PH	MODE	
H	L	X	X	auto reset disabled
L	L	X	X	auto reset enabled [1]
X	H	X	X	master reset active
X	L	X	H	normal operation selected division to output
X	L	X	L	single-cycle mode [2]
X	L	L	X	output initially LOW, after reset
X	L	H	X	output initially HIGH, after reset

H = HIGH state (the more positive voltage)
L = LOW state (the less positive voltage)
X = state is immaterial

1. For correct power-on reset, the supply voltage should be above 8.5 V. For $V_{DD} < 8.5$ V, disable the autoreset and connect $\overline{AR}$ to V_{DD}.
2. The timer is initialized on a reset pulse and the output changes state after 2^{n-1} counts and remains in that state (latched). Reset of this latch is obtained by master reset or by a LOW to HIGH transition on the MODE input.

RC oscillator



Typical formula for oscillator frequency:

$$f_{osc} = \frac{1}{2{,}3 \times R_t \times C_t}$$

Fig. 4 External component connection for RC oscillator; $R_S \approx 2R_t$.

Timing component limitations

The oscillator frequency is mainly determined by R_tC_t, provided $R_t \ll R_S$ and $R_SC2 \ll R_tC_t$. The function of R_S is to minimize the influence of the forward voltage across the input protection diodes on the frequency. The stray capacitance C2 should be kept as small as possible. In consideration of accuracy, C_t must be larger than the inherent stray capacitance. R_t must be larger than the LOCMOS 'ON' resistance in series with it, which typically is 500 Ω at V_{DD} = 5 V, 300 Ω at V_{DD} = 10 V and 200 Ω at V_{DD} = 15 V.

The recommended values for these components to maintain agreement with the typical oscillation formula are:

$C_t \geqslant 100$ pF, up to any typical value,
10 kΩ $\leqslant R_t \leqslant$ 1 MΩ.

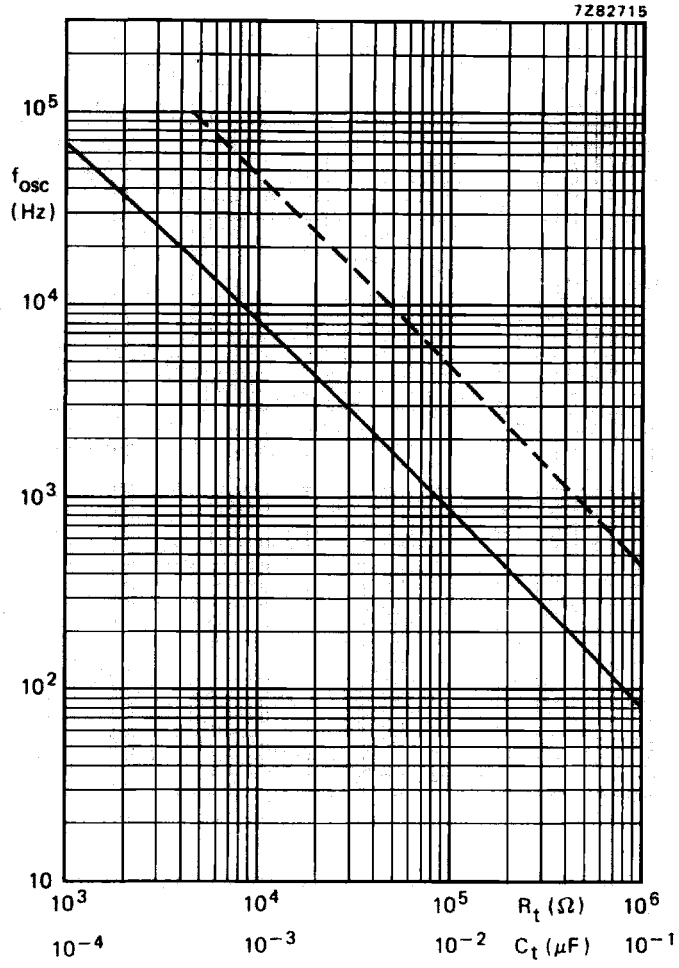


Fig. 5 RC oscillator frequency as a function of R_t and C_t at V_{DD} = 5 to 15 V; T_{amb} = 25 °C.

—— C_t curve at R_t = 56 kΩ; R_S = 120 kΩ.
– – – R_t curve at C_t = 1 nF; $R_S = 2R_t$.

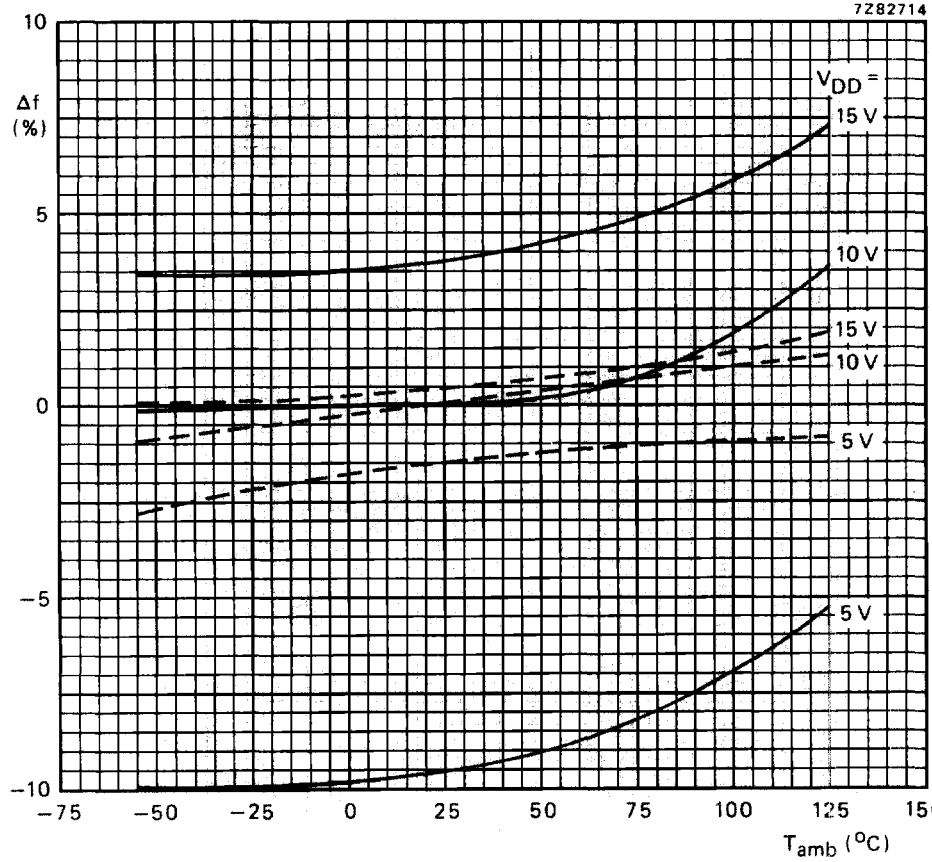


Fig. 6 Frequency deviation (Δf) as a function of ambient temperature; referenced at : f_{osc} at T_{amb} = 25 °C and V_{DD} = 10 V.

——— R_t = 56 kΩ; C_t = 1 nF; R_S = 0.
– – – R_t = 56 kΩ; C_t = 1 nF; R_S = 120 kΩ.

D.C. CHARACTERISTICS

V_{SS} = 0 V

	V_{DD} V	V_{OL} V	V_{OH} V	symbol	T_{amb} (°C)							
					−40		+ 25			+ 85		
					min.	max.	min.	typ.	max.	min.	max.	
Supply current power-on reset enabled (note)	5			I_D	–	80	–	20	80	–	230	μA
	10				–	750	–	250	600	–	700	μA
	15				–	1600	–	500	1300	–	1500	μA
Supply voltage for automatic reset initialization (note)				V_{DD}	–	–	8,5	5	–	–	–	V
Output current HIGH; C_{TC}, R_{TC}	5		4,6	$-I_{OH}$	0,5	–	0,4	–	–	0,3	–	mA
	10		9,5		1,4	–	1,2	–	–	0,95	–	mA
	15		13,5		4,8	–	4,0	–	–	3,2	–	mA
	5		2,5	$-I_{OH}$	1,4	–	1,2	–	–	0,95	–	mA
Output current LOW; C_{TC}, R_{TC}	5	0,4		I_{OL}	0,33	–	0,27	–	–	0,20	–	mA
	10	0,5			1,00	–	0,85	–	–	0,68	–	mA
	15	1,5			3,20	–	2,70	–	–	2,30	–	mA

Note
All inputs at 0 V or V_{DD}, except input $\overline{AR}$ = input MR = 0 V (power-on reset active).

A.C. CHARACTERISTICS

V_{SS} = 0 V; T_{amb} = 25 °C; input transition times ⩽ 20 ns

	V_{DD} V	typical formula for P (μW)*
Dynamic power dissipation per package (P)	5	$1\,300\ f_i + f_o C_L V_{DD}^2$
	10	$5\,300\ f_i + f_o C_L V_{DD}^2$
	15	$12\,000\ f_i + f_o C_L V_{DD}^2$
Total power dissipation when using the on-chip oscillator (P)	5	$1\,300\ f_{osc} + f_o C_L V_{DD}^2 + 2C_t V_{DD}^2 f_{osc} + 10\ V_{DD}$
	10	$5\,300\ f_{osc} + f_o C_L V_{DD}^2 + 2C_t V_{DD}^2 f_{osc} + 100\ V_{DD}$
	15	$12\,000\ f_{osc} + f_o C_L V_{DD}^2 + 2C_t V_{DD}^2 f_{osc} + 400\ V_{DD}$

* where:

f_i = input frequency (MHz)
f_o = output frequency (MHz)
C_L = load capacitance (pF)
V_{DD} = supply voltage (V)
C_t = timing capacitance (pF)
f_{osc} = oscillator frequency (MHz)

A.C. CHARACTERISTICS

V_{SS} = 0 V; T_{amb} = 25 °C; C_L = 50 pF; input transition times ⩽ 20 ns

	V_{DD} V	symbol	min.	typ.	max.	typical extrapolation formula
Propagation delays						
RS → O						
2^8 selected						
HIGH to LOW	5	t_{PHL};		375	750 ns	348 ns + (0,55 ns/pF) C_L
LOW to HIGH	10	t_{PLH}		150	300 ns	139 ns + (0,23 ns/pF) C_L
	15			110	220 ns	102 ns + (0,16 ns/pF) C_L
RS → O						
2^{10} selected						
HIGH to LOW	5	t_{PHL};		425	850 ns	398 ns + (0,55 ns/pF) C_L
LOW to HIGH	10	t_{PLH}		165	330 ns	154 ns + (0,23 ns/pF) C_L
	15			120	240 ns	112 ns + (0,16 ns/pF) C_L
RS → O						
2^{13} selected						
HIGH to LOW	5	t_{PHL};		510	1020 ns	483 ns + (0,55 ns/pF) C_L
LOW to HIGH	10	t_{PLH}		190	380 ns	179 ns + (0,23 ns/pF) C_L
	15			135	270 ns	127 ns + (0,16 ns/pF) C_L
RS → O						
2^{16} selected						
HIGH to LOW	5	t_{PHL};		575	1150 ns	548 ns + (0,55 ns/pF) C_L
LOW to HIGH	10	t_{PLH}		210	420 ns	199 ns + (0,23 ns/pF) C_L
	15			150	300 ns	142 ns + (0,16 ns/pF) C_L
Minimum clock	5		60	30	ns	
pulse width; LOW	10	t_{WRSL}	30	15	ns	
	15		24	12	ns	
Minimum reset	5		60	30	ns	
pulse width; HIGH	10	t_{WMRH}	30	15	ns	
	15		24	12	ns	
Maximum clock	5		8	16	MHz	
pulse frequency	10	f_{max}	15	30	MHz	
	15		18	36	MHz	
Oscillator frequency	5			90	kHz	R_t = 5 kΩ
	10	f_{osc}		90	kHz	C_t = 1 nF
	15			90	kHz	R_S = 10 kΩ
Oscillator frequency	5			8	kHz	R_t = 56 kΩ
	10	f_{osc}		8	kHz	C_t = 1 nF
	15			8	kHz	R_S = 120 kΩ