"C^2MOS" DIGITAL INTEGRATED CIRCUIT

TCP4620BP

SILICON MONOLITHIC

TENTATIVE

CMOS 4-BIT SINGLE CHIP MICROCOMPUTER

GENERAL DESCRIPTION

This is the specification for TCP4620BP in TLCS-46A family.

TCP4620BP is one version of TLCS-46A developed for the purpose of reducing the power consumption at hold operation so as to correspond to the applications having utilized the features of a CMOS microcomputer. TCP4620BP has realized the following charactristics.

Supply Current in hold operation	I_{DDHS} TYP.=0.1μA (V_{DDHS}=2V)
Hold voltage in hold operation	V_{DDHS} = 2V to 6V

TCP4620BP is a version of TCP4620AP to which the oscillation control (stop/start) function of a clock generator in hold operation has been added. There are some differences in function, pin description, electrical characteristics, and mask option concering hold operation and oscillation contril between TCP4620BP and TCP4620AP; however, other functions, electrical characteristics, instructions, and pin connections are compatible.

When using and examining TCP4620BP, therefore, it is recommended that this specification be used together with the technical data on TCP4620AP.

Main differences with TCP4620AP are as follows:

1. Function

- o In hold operation, the input level of PI_{60} terminal makes possible the oscillation control (stop/start) of the oscillator, and the oscillation stop enables the power consumption to be reduced.

  Supply Current in hold operation (Oscillation stop)

  I_{DDHS} TYP.=0.1μA (Ta=25°C, V_{DDHS}=2V)

  Hold Voltage in hold operation (Oscillation stop)

  V_{DDHS} =2 V to 6 V

2. Pin Description

o In hold opeartion, PI_{60} terminal will function as an oscillation control terminal.

PI_{60} = "H" ..... Oscillation stop

PI_{60} = "L" ..... Oscillation start (Continued.)

o In either case of normal operation/hold operation, PI_{60} terminal is the reset input terminal of the divider (2).

PI_{60} = "H" ..... The divider (2) is reset.

PI_{60} = "L" ..... The divider (2) is not reset. (Reset is released.)

o No Schmitt circuits are built in the following two terminals:

PI_{60}, $\overline{INT}$

3. Mask Option

The contents only indicated on the mask option sheet of TCP4620BP can be designated., 400 KHz ceramic oscillator/IFT oscillator can be used.

PIN NAMES AND PIN DESCRIPTION

Pin Name	Input/Output	Function
P_{03} P_{00}	Input/Output	4-bit general purpose I/O port (I/O is designated by a programe). Can be used as a dedicated output port. (Designated by mask options.)
P_{13} P_{10}	Output	4-bit general purpose output port.
P_{23} P_{20}	Input or Output	4-bit general purpose Input/Output port. Input/Output is designated by mask options.
P_{43} P_{40}	Input or Output	4-bit general purpose Input/Output port.
P_{54} P_{50}	Output	5-digit output port for display. (Can be used as the general purpose output port.)
P67 P60	Output	8-segment output port for display. (Can be used as the general purpose 8-bit output port (4-bit x 2))
PI_{53} PI_{50}	Input	4-bit general purpose input port.
PI_{60}*	Input	1-bit general purpose input port/reset input of divider(2) [Note 1] (without Schmitt circuit). During hold operation this input functions as an input for stopping the oscillation and for controlling restart of the oscillator. *
$\overline{RESET}$	Input	Reset signal input
$\overline{INT}$	Input	Interrupt request signal input (without Schmitt circuit).
X_{IN}	Input	Oscillator connecting terminal.
X_{OUT}	Output	Oscillator connecting terminal.
CK	Output	External timing output.
TEST	Input	LSI test signal input, used by connection to GND.
V_{DD}		Power Supply
GND		GND

Note 1) In either case of normal operation or hold operation, the divider (2) is reset at "H" level input.

Note 2) * denotes the differences between TCP4620BP and TCP4620AP/TCP4630AP.

HOLD OPERATION

The hold operation of TCP4620BP is performed by setting "1" to H flag. In other words, immediately when "1" is set to H flag by execution of SBS, IBS, and LSM instructions, the internal timing signals ϕs and ϕ are stopped and TCP4620BP begins hold operation. (Refer to Figs. 1 and 3.)

During hold operation the program counter, instruction register, data memory, and other internal registers hold the contents stored before hold operation. However, the interrupt latch is cleared during hold operation, the waiting interrupt request and a new interrupt request are ignored.

The oscillation of oscillator is suspended by holding PI_{60} terminal to "H" level during hold operation, so that the power consumption may be saved greatly. That is, while H flag $\wedge$ PI_{60} = 1, the oscillation is suspended. (Refer to Fig. 3.)

TCP4620BP is restarted from hold operation due to reset of H flag to "0" by the rising signal of the counter buffer C2 bit.

Since the counter buffer is the output of the divider (2) which is counting the internal basic clock (cp), TCP4620BP is restarted at regular intervals if oscillation is not suspended during hold operation. (Refer to Fig. 2.) This is the same operation as the hold operation of TCP4620AP/TCP4630AP. (However, there is a difference in nothing but restart condition by mask option between them.)

When the oscillation is suspended during hold operations, restart operation begins in the lapse of a certain period of time after a start of oscillation by holding PI_{60} terminal to "L" level. (Refer to Fig. 4.) Special attention should be paid to the fact that in TCP4620BP the divider (2) is reset to "0" by holding PI_{60} terminal to "H" level.

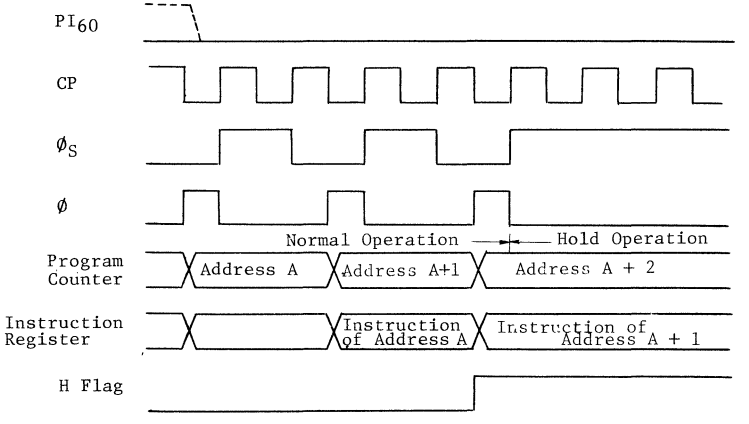


Fig. 1 Timing to Hold Operation (Oscillation Continuity)

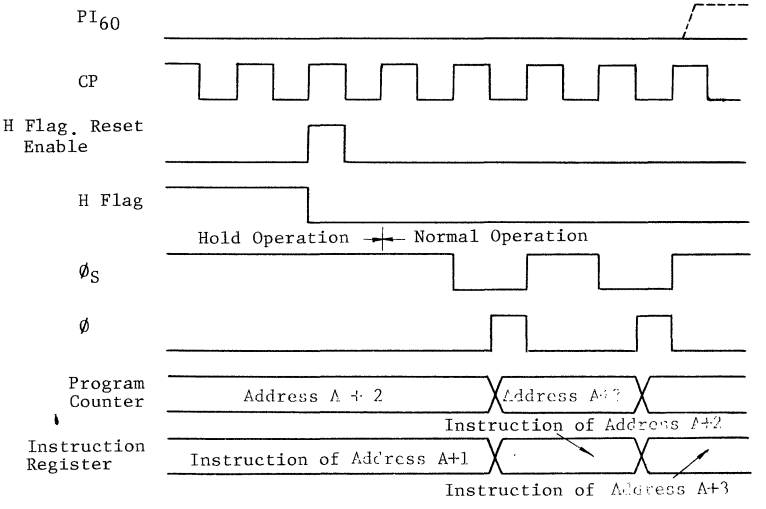


Fig. 2 Restart Timing from Hold Operation (Oscillation Continuity)

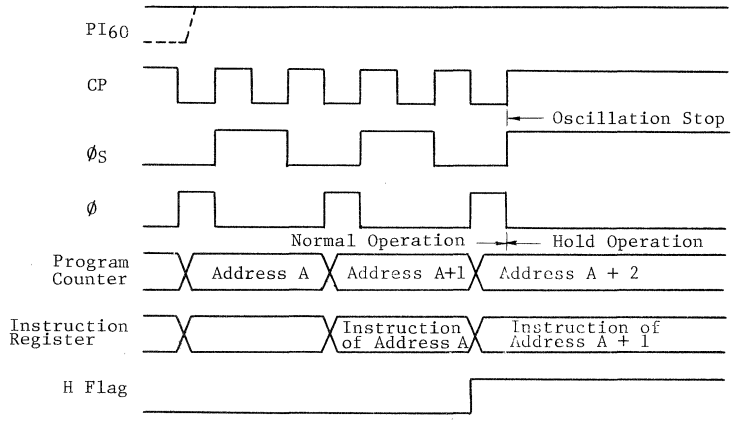


Fig. 3 Timing to Hold Operation (Oscillation Stop)

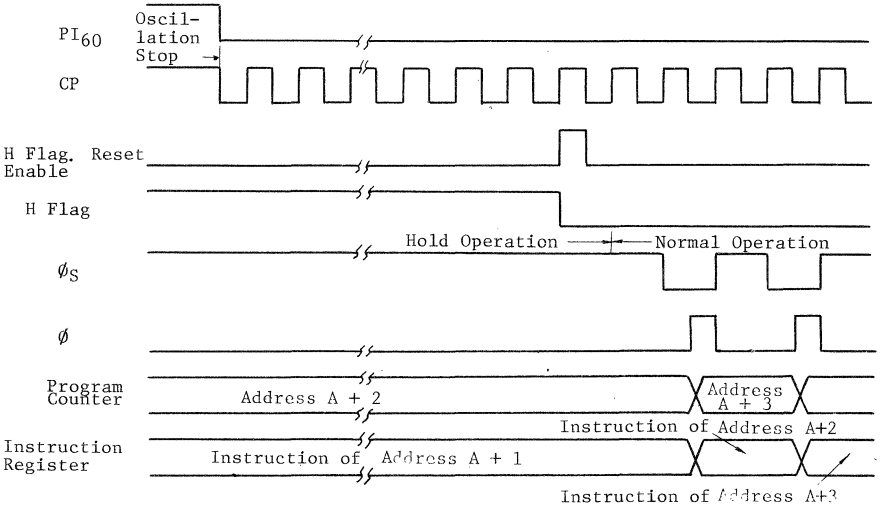


Fig. 4 Restart Timing from Hold Operation (Oscillation Stop)

TCP4620BP MASK OPTION

			TYP011				
Oscillating Frequency		OSC	0 5 0 400K Ceramic IFT				
Frequency division for internal clock		CP	02				
Ext. timing output		CK	CP				
COUNTER	Divider 1 input	PD	CP				
	Divider 3 input	PDR	PD2				
	Reset Timing	PDR	N				
COUNTER BUFFER	Buffer 0 input	CO	PI60				
	Buffer 1 input	C1	RD7				
	Buffer 2 input	C2	RDA				
	Buffer 3 input	C3	RDD				
H Flag		HOLD	H				
Restart Signal		RSTH	C2 Rise				
I/O Port	Port 0	STD	D(PROG)	1 (OUT)			
Input/Output port	Port 2	P2	/F/(OUT)	/F/(OUT)	/0/(IN)	/0/(IN)	/0/(IN)
	Port 4	P4	/F/(OUT)	/3/(IN/OUT)	/F/(OUT)	/3/(IN/OUT)	/0/(IN)
Input resistance (Input port 5)		PI5	0 (UP)	1 (DOWN)			
DECODE MATRIX	Line 0	DECO	/ /				
	Line 1	DEC1	/ /				
	Line 2	DECODER DEC2	/ /				
	Line 3	DEC3	/ /				
	Line 4	DEC4	/ /				
Output Port	6/7	PO6	1(P6/P7)	0 (P6)			
PLA	Line 0	PLA0	/ 0 0 /	/ /			
	Line 1	PLA1	/ 1 1 /	/ /			
	Line 2	PLA2	/ 2 2 /	/ /			
	Line 3	PLA3	/ 3 3 /	/ /			
	Line 4	PLA4	/ 4 4 /	/ /			
	Line 5	PLA5	/ 5 5 /	/ /			
	Line 6	PLA6	/ 6 6 /	/ /			
	Line 7	PLA PLA7	/ 7 7 /	/ /			
	Line 8	PLA8	/ 8 8 /	/ /			
	Line 9	PLA9	/ 9 9 /	/ /			
	Line A	PLAA	/ A A /	/ /			
	Line B	PLAB	/ B B /	/ /			
	Line C	PLAC	/ C C /	/ /			
	Line D	PLAD	/ D D /	/ /			
	Line E	PLAE	/ E E /	/ /			
	Line F	PLAF	/ F F /	/ /			

- o $\overline{INT}$ and PI60 are normal input terminal containing no Schmitt circuit.
- o In Hold operation, oscillation is stopped at PI60="H" and started at PI60="L".
- o Divider (2) is reset at PI60="H".

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

SYMBOL	ITEM	RATING
V_{DD}	Supply Voltage	-0.3V to +7.0V
V_{IN}	Input Voltage	-0.3V to V_{DD}+0.3V
V_{OUT}	Output Volatge	-0.3V to V_{DD}+0.3V
P_D	Power Dissipation	600 mW
T_{sol}	Soldering Temperature	260°C(10 SEC)
T_{stg}	Storage Temperature	-55°C to +125°C
T_{opr}	Operating Temperature	-30°C to + 85°C

ALLOWABLE OPERATING CONDITIONS

SYMBOL	ITEM	CONDITION
V_{DD}	Supply Voltage	4V to 6V
Ta	Ambient Temperature	-30°C to +85°C
V_{OH}	Output High Voltage	Min. V_{DD} -3.5V($\geq$1.5V)
V_{OL}	Output Low Voltage	Max. 3V
f_X	Xtal Operating Frequency	40KHz to 400KHz
tcy	Cycle Time	10μs to 100μs
V_{DDHS}	Hold Voltage at Hold Operation (Oscillation Stop)	2V to 6V

Normal Operation

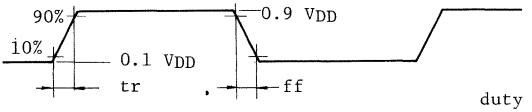
DC CHARACTERISTICS (Ta=-30°C to +85°C, V_{DD}=4V to 6V)

SYMBOL	PARAMETER	TEST CONDITION	MIN.	TYP. (Notel)	MAX.	UNIT
V_{IH}	Input High Voltage		V_{DD}x0.7	-	V_{DD}	V
V_{IHS}	Input High Voltage (Schmitt)		V_{DD}x0.85	-	V_{DD}	
V_{IHC}	Input High Voltage (X_{IN})		V_{DD}x0.75	-	V_{DD}	
V_{IL}	Input Low Voltage		0	-	V_{DD}x0.3	
V_{ILS}	Input Low Voltage (Schmitt)		0	-	V_{DD}x0.15	
V_{ILC}	Input Low Voltage (X_{IN})		0	-	V_{DD}x0.25	
I_{IH}	Input High Current	V_{DD}=6V, V_{IN}=6V	-	-	20	µA
I_{IL}	Input Low Current	V_{DD}=6V, V_{IN}=0V	-	-	-20	
R_{IN}	Input Resistance (PI5)	V_{DD}=5V	75	150	350	kΩ
V_{OH}	Output High Voltage	V_{DD}=5V, Output Open	4.7	4.9	-	V
V_{OL}	Output Low Voltage		-	0.1	0.3	
I_{OH}	Output High Current	V_{DD}=4.5V, V_{OH}=2.4V	-0.7	-2	-	mA
I_{OH1}	Output High Current (P05, P06)		-2.5	-6	-	
		V_{DD}=5V, V_{OH}=4.2V	-1.1	-2.5	-	
I_{OL}	Output Low Current	V_{DD}=4.5V, V_{OL}=0.45V	1.6	4	-	
I_{OL1}	Output Low Current (P05, P06)		3.5	8	-	
I_{DDO}	V_{DD} Supply Current in Normal Operation	V_{DD}=6V, fx=400kHz V_{IN}=5.9V/0.1V PI5 Open, CL=50pF (Note 3)	-	400	1200	µA
I_{DDH}	V_{DD} Supply Current in Hold operation (Oscillation Cont.)		-	150	450	

Note : Typical values are at Ta=25°C

Note : Output characteristic excludes X_{OUT} terminal.

Note : X_{IN} input waveform at the time of measuring V_{DD} Supply Curren



duty = 50%

tr, tf < 50ns

Normal Operation

AC CHARACTERISTICS (Ta=-30°C to +85°C, V_{DD}=4V to 6V)

SYMBOL	PARAMETER	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
t_{WXIN}	XIN Pluse Width	External Input $V_{IN}=V_{IHC}/V_{ILC}$	0.4/fx	-	0.6/fx	SEC
t_{WRESET}	$\overline{RESET}$ Pulse Width	$V_{IN}=V_{IHS}/V_{ILS}$	2 tcy	-	-	μs
t_{WINT}	$\overline{INT}$ Pulse Width	$V_{IN} = V_{IH}/V_{IL}$	2 tcy	-	-	
t_{WPI60}	PI60 Pulse Width (Note 1)		2tcy	-	-	

Note 1 : PI_{60} terminal used for general purpose input port.

Hold Operation (Oscillation stop)

DC CHARACTERISTICS (Ta=-30°C to 85°C, V_{DD}=2V to 6V)

SYMBOL	PARAMETER	TEST CONDITION	MIN.	TYP. (Note1)	MAX.	UNIT
V_{DD}	Hold Voltage in Hold operation		2.0	-	6.0	V
I_{DDHS}	V_{DD} Supply Current in Hold Mode	V_{DDHS}=2V, V_{IN}=1.9V/0.1V PI5 Open $V_{\overline{RESET}}=V_{DDHS}$	-	0.1	T.B.D.	μA
		V_{DDHS}=5V, V_{IN}=4.9V/0.1V PI5 Open $V_{\overline{RESET}}=V_{DDHS}$	-	0.2	T.B.D.	
V_{IHHS}	Input High Voltage (PI60)	V_{DDHS}=2V	1.9	-	-	V
R_{IN}	Input Registance (PI5)		75	150	350	KΩ
I_{OHHS}	Output High Current	V_{DDHS}=2V, V_{OH}=1V	-	-0.4	-	mA
I_{OH1HS}	Output High Current (PI5, PI6)	V_{DDHS}=2V, V_{OH}=1V	-	-0.9	-	mA
I_{OLHS}	Output High Current	V_{DDHS}=2V, V_{OL}=0.45V	-	2.0	-	mA
I_{OL1HS}	Output High Current (PO5, PO6)	V_{DDHS}=2V, V_{OL}=0.45V	-	3.5	-	mA

Note 1 : Typical values are at Ta=25°C.

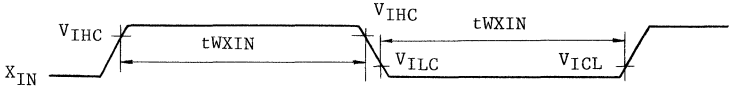
Note 2 : The limits of V_{1HHS}, I_{OHHS}, I_{OLHS} and I_{OL1HS} are equal to the limits of VIH, IOH, IOH1, IOC and IOC1 in Normal Operation respectively. (V_{DDHS} 4V)

AC CHARACTERISTICS (Ta=-30°C to 85°C)

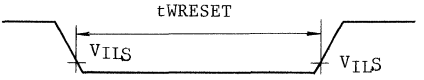
SYMBOL	PARAMETER	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
t_{WRST}	Restort Internal from Hold operation	$V_{IN}=V_{IH}/V_{IL}$ V_{DD}=4V to 6V	-	2050tcy	-	μS

TIMING WAVEFORMS

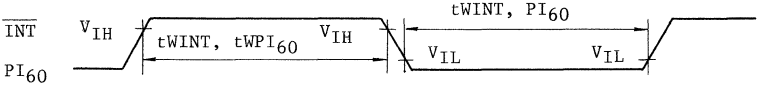
(1) X_{IN} Input Waveform



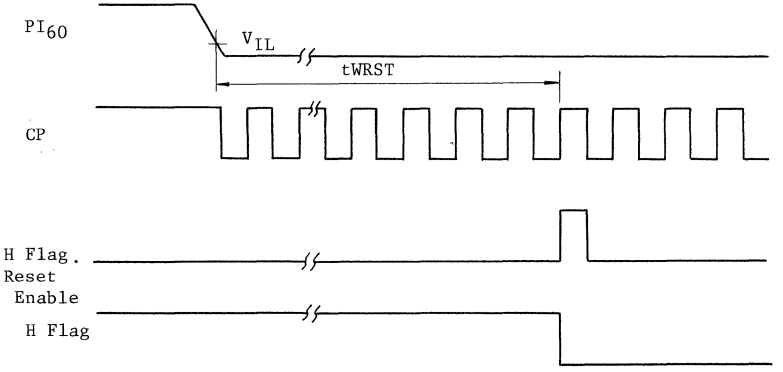
(2) $\overline{RESET}$ Input Waveform



(3) $\overline{INT}$, PI_{60} Input Waveform



(4) Restart timing from Hold Operation after Oscillation Stop.



APPLICATION EXAMPLES

[1] Battery Backup

It is thinkable that there is a backup method which utilizes a battery and a capacitor, as application of the system required to uninterruptedly resume the process before cutting-off of the power supply when the power supply has been restored after the power supply was cut off during the operation of the system.

Fig. 1 shows the example of utilizing a battery and Fig. 2 shows the example of utilizing a capacitor. In both the cases, the operations are almost identical. Let us explain the circuit operation of the example (Fig. 1) of utilizing a battery.

Under the condition of "Main Power Voltage > Backup Voltage," the power (V_{DD}) of TCP420BP is supplied from the main power supply. When Q1 is ON, "L" level is applied to PI_{60} terminal.

In other words, the oscillator is in oscillation state, and the operation of TCP4620BP depends on a program.
Under the condition of "Main Power Voltage < Backup Voltage," the power (V_{DD}) of TCP4620BP is supplied from the battery, and when Q1 comes into OFF state, "H" level is applied to PI_{60} terminal.

In other words, the oscillator depends on the operating state of TCP4620BP, and if it is in hold state, oscillation is stopped.

When TCP4620BP is put to hold state immediately after the power supply has been cut off, the oscillation is stopped, permitting a backup for a long period time.

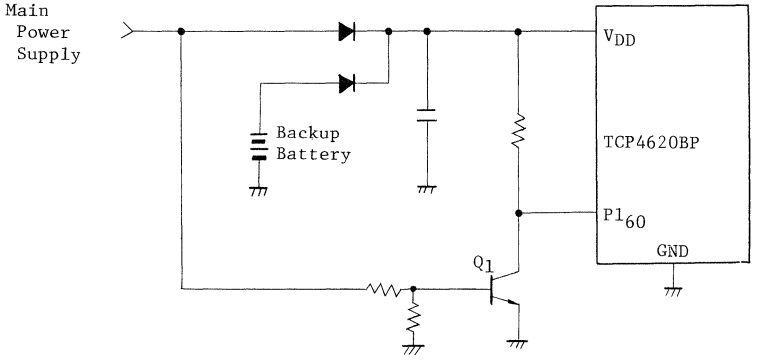


Fig. 1 Example of Backup Circuit by Use of Battery

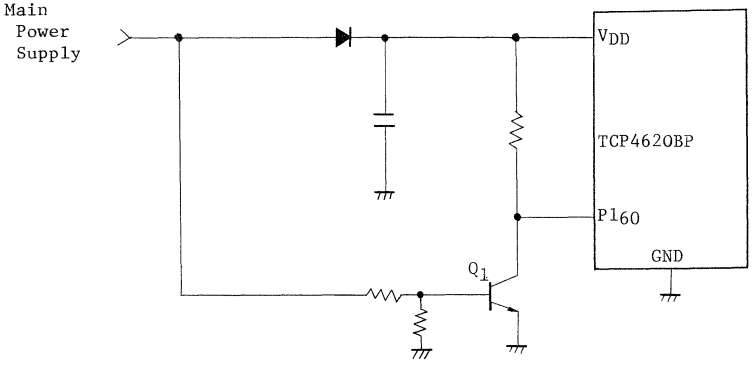


Fig. 2 Example of Backup Circuit by Use of Capacitor

[2] Restart by Key Input

The possibility of a remote control system utilizing TCP4620BP can be considered as application of a system which operates only when the key is fed.

Let us explain the example of application in Fig. 3. Usually TCP4620BP is in hold state, and only when the key is fed, the hold state is released to perform the process according to the input data.

In other words, TCP4620BP is put to hold state after data X'F' has been output (putting SW1 to SW16 to selection state) to its output port 1 (P1).

When the keys (SW1 to SW16) are depressed in this state, "L" level is applied to PI_{60} terminal and the hold state is released after certain period of time.

The keys are scanned after the release of hold state, and the process is performed according to the key input data. After processing, the data output (X'F') to the output port 1 (P1) and a hold state are established.

In such an application, TCP4620BP operates only when a key is depressed, permitting a sharp reduction in power consumption and a better display of the functions of TCP4620BP.

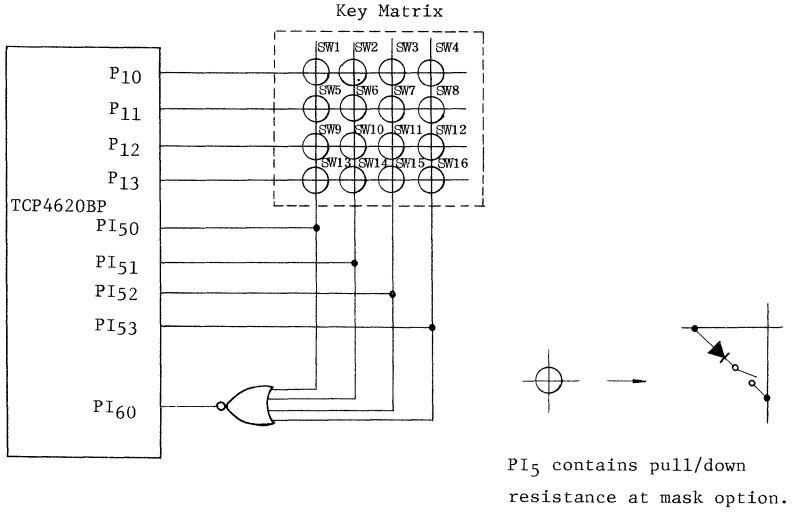


Fig. 3 Example of Restart Circuit by Key Input

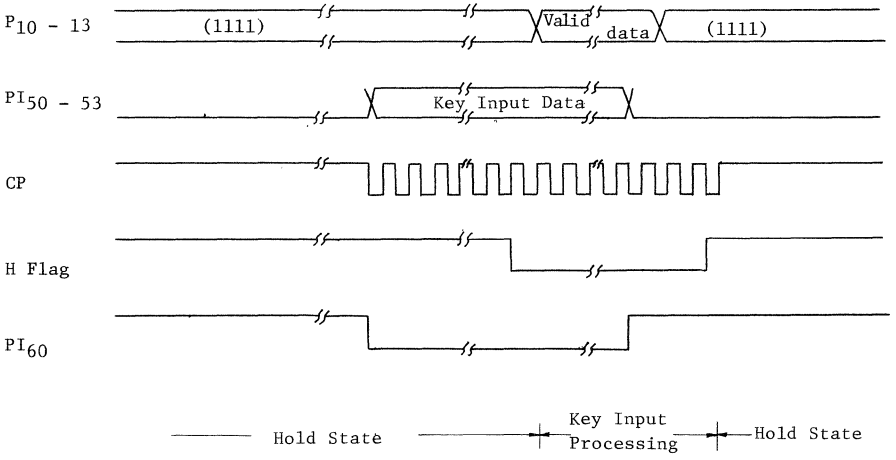


Fig. 4 Example of Circuit (Fig. 3) Timing Chart