

YAMAHA



YM3526

NO.85-05

YM3526

廃番

FM OPERATOR TYPE-L (OPL)

■ OUTLINE

The OPL (FM Operator Type-L) is a newly developed sound generator designed for CAPTAIN (Character and Pattern Telephone Access Information Network) systems and teletext. FM sound generators are used by melody part, and various sounds can be generated under software control. A sound generator with the features of various musical instruments is provided for rhythm part. This sound generator has built-in low frequency oscillators for vibrato and amplitude modulation to reduce software workload.

tion to reduce software workload.

Because OPL output is digital, a D/A converter (YM3014 or equivalent) is required.

■ FEATURES

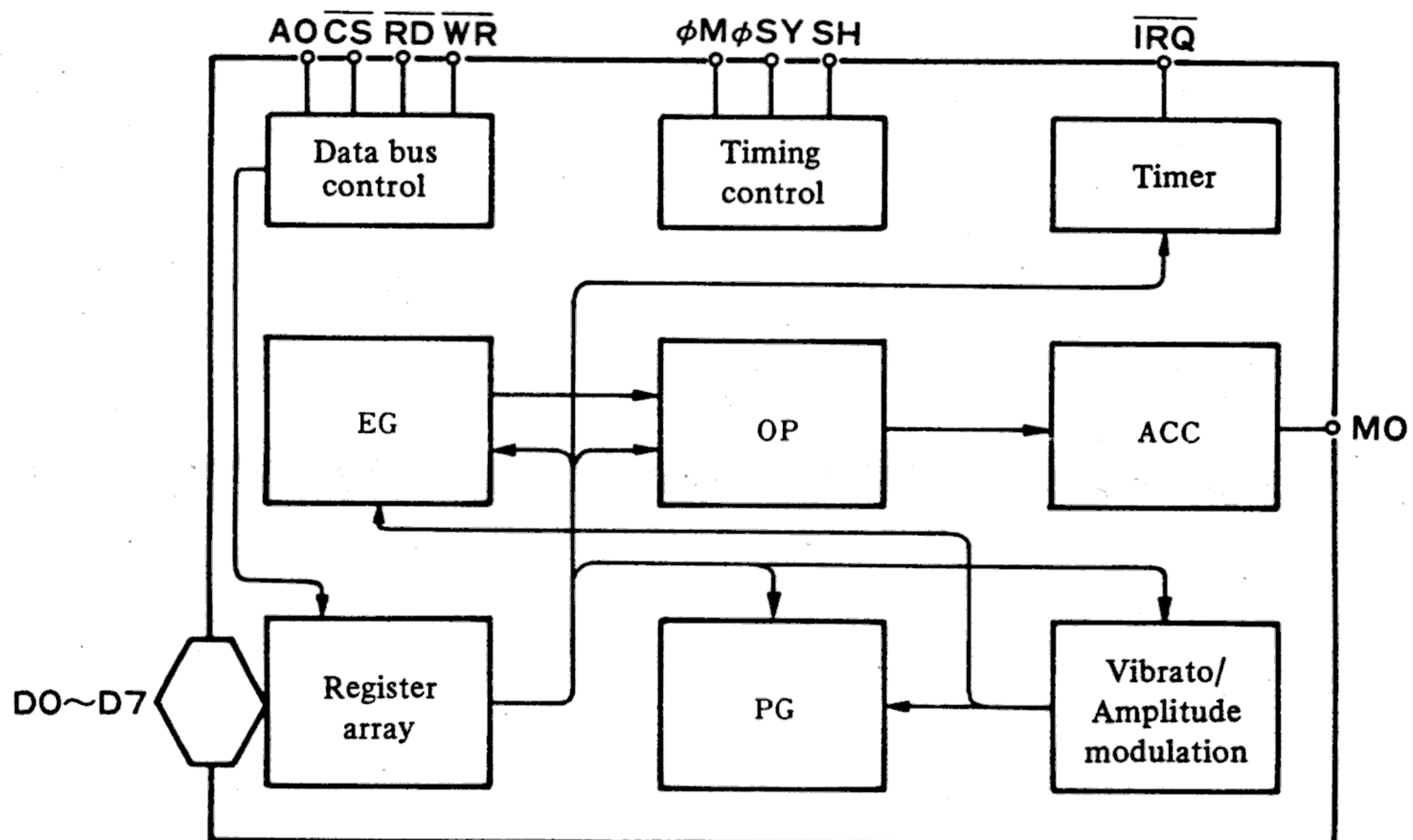
- The FM sound generator is used to produce more realistic sounds.
- The mode selector enables switching between the sounding of all nine tones at one time, and of six melodies and five rhythms. In either case, the tones can varied.
- The vibrato oscillator and amplitude modulation oscillator are built in.
- Two programmable timers are incorporated.
- Composite Sinusoidal Modeling is possible.
- Input and output are TTL compatible.
- Si-gate CMOS LSI.
- 5V single power supply.

■ PIN LAYOUT

VSS	1	24	ϕM
\overline{IRQ}	2	23	ϕSY
\overline{IC}	3	22	NC
AO	4	21	MO
\overline{WR}	5	20	SH
\overline{RD}	6	19	NC
\overline{CS}	7	18	D7
NC	8	17	D6
NC	9	16	D5
DO	10	15	D4
DI	11	14	D3
GND	12	13	D2

*NC : No Connection

■ BLOCK DIAGRAM



■ DESCRIPTION OF TERMINAL FUNCTIONS

1. ϕM

This is the master clock of OPL. The input frequency is 3.58 MHz.

2. $\phi SY, SH$

These are the clock (ϕSY) and synchronizing signals (SH) for driving the D/A converter that converts digital output of the FM sound generator to analog values.

3. D0 ~ D7

This is an 8-bit bidirectional bus that send and receive data between OPL and the processor.

4. $\overline{CS}, \overline{RD}, \overline{WR}, AO$

These control bidirectional bus D0 ~ D7.

\overline{CS}	\overline{RD}	\overline{WR}	AO	
0	1	0	0	The register address is written to OPL.
0	1	0	1	The contents of the register are written to OPL.
0	0	1	0	The contents of OPL status are read.
0	0	1	1	The data on the bus are not guaranteed.
1	x	x	x	Bus lines of D0 ~ D7 have high impedance.

5. \overline{IRQ}

This interrupt signal output from two timers. It can be masked by the program.

6. \overline{IC}

When set to low levels, the system is reset. The contents of the register array become "0."

7. MO

This is the digital output of the FM sound generator. An external D/A converter is required.

8. VCC

+5 V power terminal.

9. GND

Grounding terminal.

■ DESCRIPTION OF FUNCTIONS

OPL has two sounding modes: nine melodies, and a combination of six melodies and five rhythms. This mode selection can be controlled by the program. For melodies, the same FM sound generator as used in the Yamaha DX-7 synthesizer is used for creating excellent sound quality.

For this reason, this LSI is the most suitable for sound generators for new media-related equipment, including CAPTAIN systems and teletex.

Frequency modulation for this LSI is obtained by the following expressions. Either sine waves synthesis (1) or frequency modulation (2) can be programmed for individual sounds.

$$F_1 = I_1 \sin w_1 t + I_2 \sin w_2 t \dots \dots (1)$$

$$F_2 = I_2 (w_1 t + I_2 \sin w_2 t) \dots \dots (2)$$

A noise generator and synthesizer are provided for rhythmic sounds. Sounding requires no special external control. Five rhythmic sounds: bass drum (BD), snare drum (SD), high-hat cymbals (HH), top cymbal (TC) and tom-tom (TOM) can be generated.

The internal parts of OPL are functionally divided into nine blocks to perform the following:

(a) Register array:

OPL is controlled by the register array contents and the shape of the envelope and phase data are determined.

(b) Phase generator (PG):

A phase of the FM sound generator at each time step is generated. This receives and accumulates phases from the register array, thereby calculating a phase at each time step.

(c) Envelope generator (EG):

This generates an envelope and modulation index for each sound. This generator receives instructions for such items as slope (rate) and offset (total level) from the register array to generate an envelope.

(d) Operator (OP):

The operator receives phase information (θ) from PG and envelope information (E) from EG, and calculates $E\sin\theta$.

(e) Accumulator (ACC):

The accumulator is used to accumulate each sound at each sampling time (50 KHz) in order to convert data to match the D/A converter.

(f) Vibrato oscillator/amplitude modulation oscillator:

Low frequency oscillators for vibrato and amplitude modulation. The oscillation frequency is 6.4 Hz for vibrato and 7 Hz for amplitude modulation.

(g) Timers:

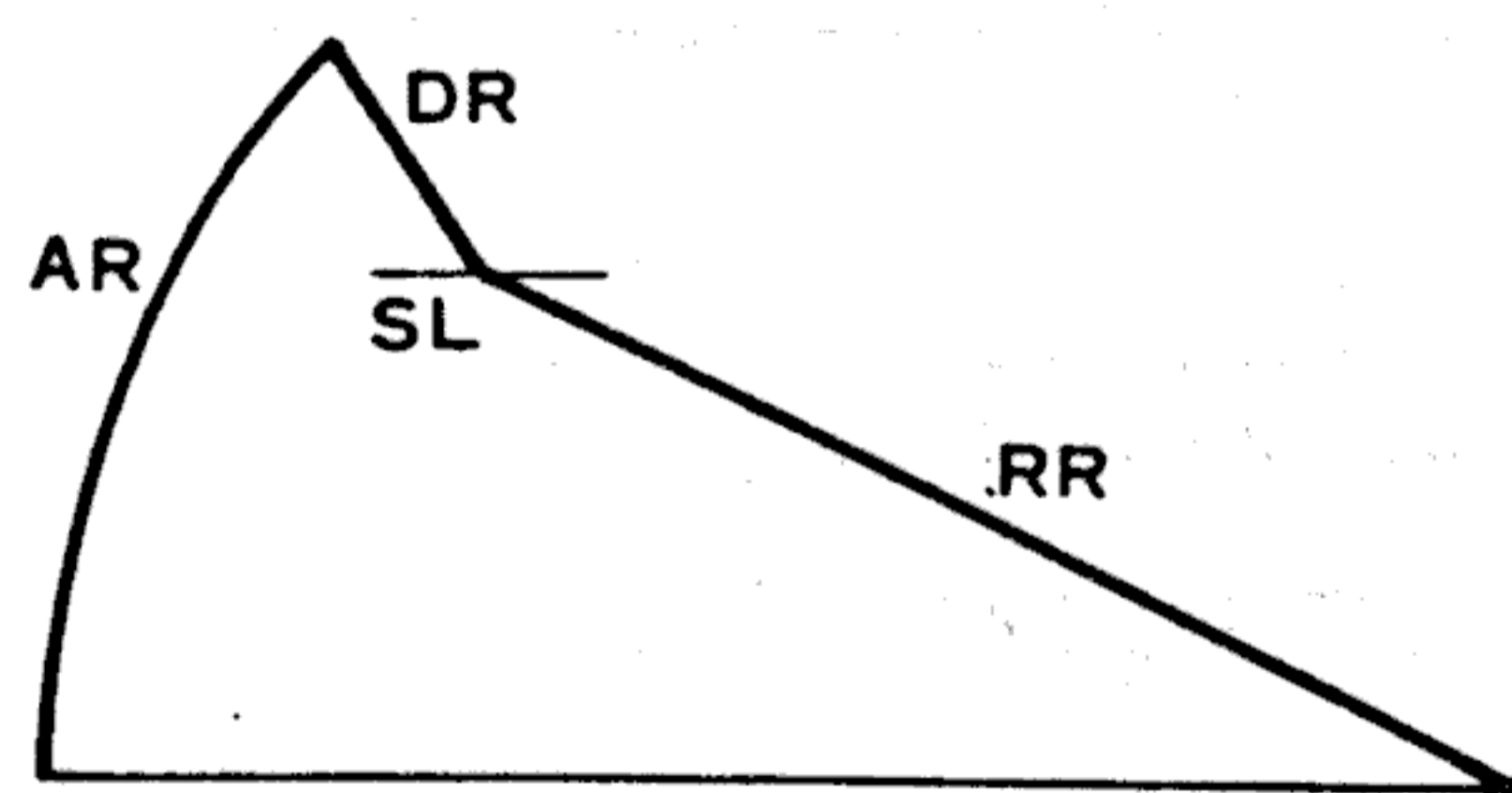
There are two types for general-purpose timers for long and short.

(h) Data bus control.

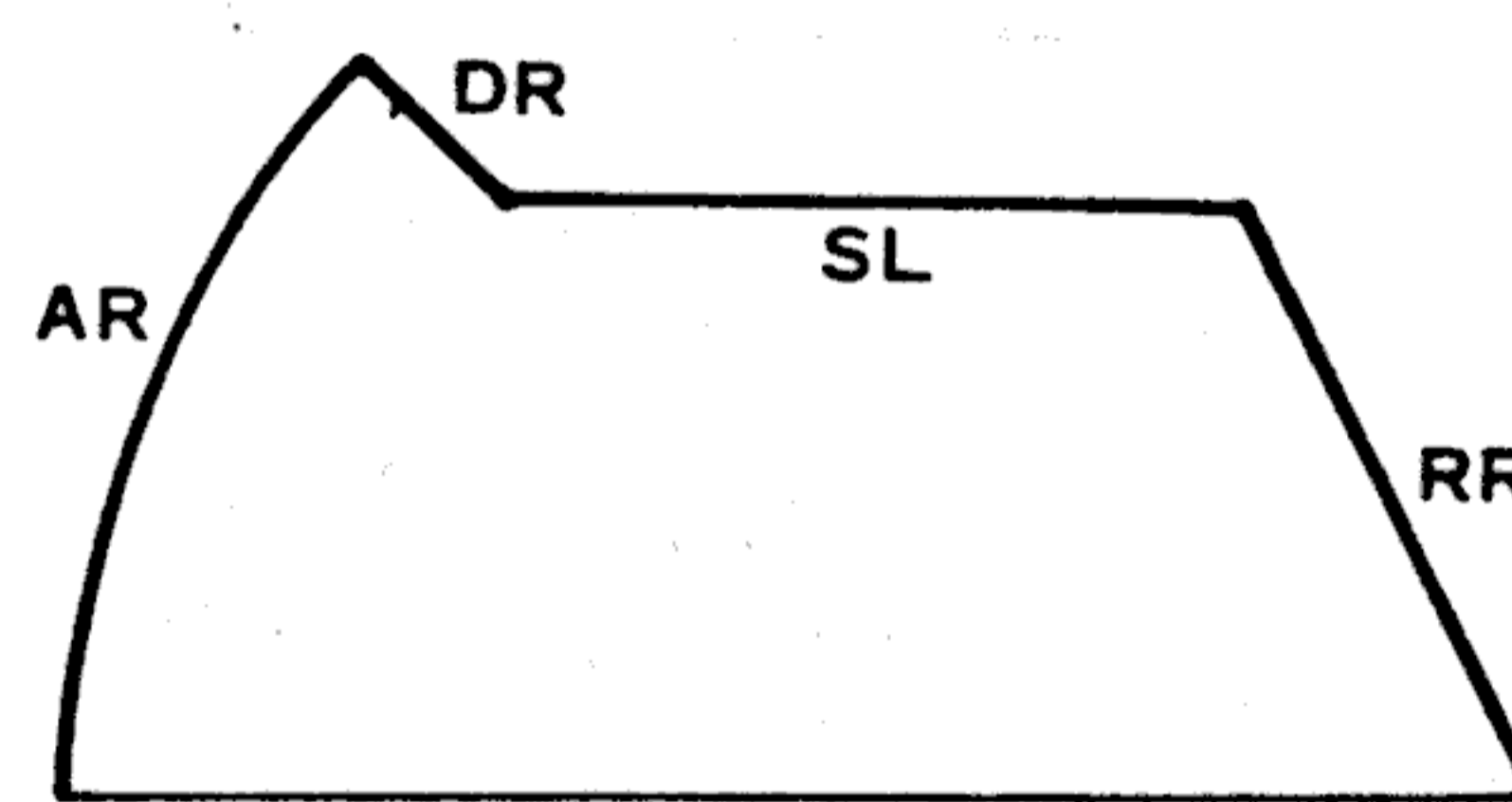
(i) Timing control.

■ CONTENTS OF EACH REGISTER

	Address	
1	01	TEST information. Usually set to "0."
2	02	Time setting on timer 1.
3	03	Time setting on timer 2.
4	04	Controls the operation of timers 1 and 2 and resets interrupt signals.
5	08	CSM is for the CSM speech synthesis mode. NOTE SEL is for switching the keyboard split by using the F-Number.
6	20 ~ 35	MULTI controls the relationship between fundamental waves and harmonics. KSR is key scale of RATE. EG-TYPE is for the switching of Non Percussive Tone and Percussive Tone. 0 is for Percussive Tone and is for Non Percussive Tone. VIB indicates the ON/OFF of vibrato. AM indicates the ON/OFF of modulation.
7	40 ~ 55	TL provides a total level for adjustment of each sound level. KSL is the level key scale.
8	60 ~ 75	DR sets the decay rate at the decay time. AR sets the rate of increase at the attack time.
9	80 ~ 95	RR provides the decay rate at Release/Sustain time. SL. provides the level for shifting from decay to sustain.
10	AO ~ B8	F-Number provides chords within one octave. Block represents octave information for each sound. KON indicates that the sound being generated when it is "1."
11	BD	Controls rhythmic sounds and the corresponding bits for setting the ON/OFF of each rhythm. When the R bit is 1, the system is in the rhythm mode. VIB DEP indicates the depth of vibrato. 0 = 7φ, 1 = 14φ AM DEP indicates the depth of amplitude modulation. 0 = 1dB, 1 = 4.8dB.
12	C0 ~ C8	FB indicates FM feedback factor. C indicates Sin wave synthesis or FM modulation.



Percussive Tone



Non Percussive Tone

■ ELECTRIC CHARACTERISTICS

1. Absolute maximum rating

Item	Rated Value	Unit
Terminal voltage	-0.3 ~ 7.0	V
Operating ambient temperature	0 ~ 70	°C
Storage temperature	-50 ~ 125	°C

2. Recommended operating conditions

Item	Symbol	Minimum	Standard	Maximum	Unit
Power voltage	V _{CC}	4.5	5	5.5	V
	GND	0	0	0	V

3. DC characteristics

Item	Symbol	Conditions	Minimum	Standard	Maximum	Unit
Input high-level voltage	All input	V _{IH}	2.0			V
Input low-level voltage	All input	V _{IL}			0.8	V
Input leak current	$\phi M \cdot \overline{WR} \cdot \overline{RD} \cdot AO$	I _L	V _{in} = 0 ~ 5V	-10	10	μA
Three-state (off-state) input current	D ₀ ~ D ₇	I _{TSL}	V _{in} = 0 ~ 5V	-10	10	μA
Output high-level voltage	Output except for \overline{IRQ}	V _{OH1}	I _{OH1} = 0.4mA	2.4		V
		V _{OH2}	I _{OH2} = 40μA	3.3		V
Output low-level voltage	All output	V _{OL}	I _{OL} = 2.0mA		0.4	V
Output leak current (off-state)	\overline{IRQ}	I _{LOFF}	V _{OH} = 0 ~ 5V	-10	10	V
Pull-up resistor	$\overline{IC}, \overline{CS}$	R _{PU}		80	400	KΩ
Input capacity	All input	C _I			10	PF
Output capacity	All output	C _O			10	PF
Power supply current		I _{CC}			30	mA

4. AC characteristics

Item	Symbol	Conditions	Minimum	Standard	Maximum	Unit	
Input clock frequency	ϕM	f _C	Fig. A-1	2.0	3.58	4.0	MHz
Input clock duty	ϕM			40	50	60	%
Input clock rise time	ϕM	T _R	Fig. A-1				ns
Input clock fall time	ϕM	T _F	Fig. A-1				ns
Address setup time	A ₀	T _{AS}	Fig. A-2, Fig. A-3	10			ns
Address hold time	A ₀	T _{AH}	Fig. A-2, Fig. A-3	20			ns
Chip select write width	\overline{CS}	T _{CSW}	Fig. A-2	100			ns
Chip select read width	\overline{CS}	T _{CSR}	Fig. A-3	200			ns
Write pulse write width	\overline{WR}	T _{WW}	Fig. A-2	100			ns
Write data setup time	D ₀ ~ D ₇	T _{DS}	Fig. A-2	20			ns
Write data hold time	D ₀ ~ D ₇	T _{DH}	Fig. A-2	30			ns
Read pulse width	\overline{RD}	T _{RW}	Fig. A-3	200			ns
Read data access time	D ₀ ~ D ₇	T _{ACC}	Fig. A-3			200	ns
Read data hold time	D ₀ ~ D ₇	T _{RDH}	Fig. A-3	10			ns
Output rise time	ϕSY	T _{OR1}	Fig. A-4			100	ns
Output fall time	MO · SH	T _{OR2}	Fig. A-5			150	ns
Output fall time	ϕSY	T _{OF1}	Fig. A-4			100	ns
	MO · SH	T _{OF2}	Fig. A-5			150	ns
Reset pulse width	\overline{IC}	N _{ICW}	Fig. A-6	80			cycle

REGISTER MAP

ADDRESS	D ₇	D ₆	D ₅	D ₄	D ₃	D ₂	D ₁	D ₀	COMMENT
01	TEST								LSI TEST DATA
02	TIMER - 1								TIMER - 1 DATA
03	TIMER - 2								TIMER - 2 DATA
04	RST	MASK T1 T2		/				ST2ST1	IRQ RESET/TIMER CONTROL
08	CSM	SEL	/						CSM speech synthesis mode/Note Select.
20	AM	VIB	EG-TYP	KSR	MULTI				AM/VIB/EG - TYPE/KSR/MULTIPLE
35									
40	KSL		TL						KSL/TOTAL LEVEL
55									
60	AR				DR				ATTACK RATE/DECAY RATE
75									
80	SL				RR				SUSTAIN RATE/RELEASE RATE
95									
A0	F - Number (L)								
A8									
B0	/		KON	BLOCK			F-Num (H)		KON/BLOCK/F - Number
B8									
BD	DEP AM VIB		R	BD	SD	TOM	TC	HH	DEPTH (AM/VIB)/RHYTHM (BD·SD·TOM·TC·HH)
C0	/				FB		C		FEEDBACK/CONNECTION
C8									

STATUS REGISTER

IRQ	FLAG T1 T2		/						IRQ/FLAG (T1, T2)
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■ TIMING CHART (For setting the timing, use $V_{IH} = 2.0V$, $V_{IL} = 0.8V$ as reference values.)

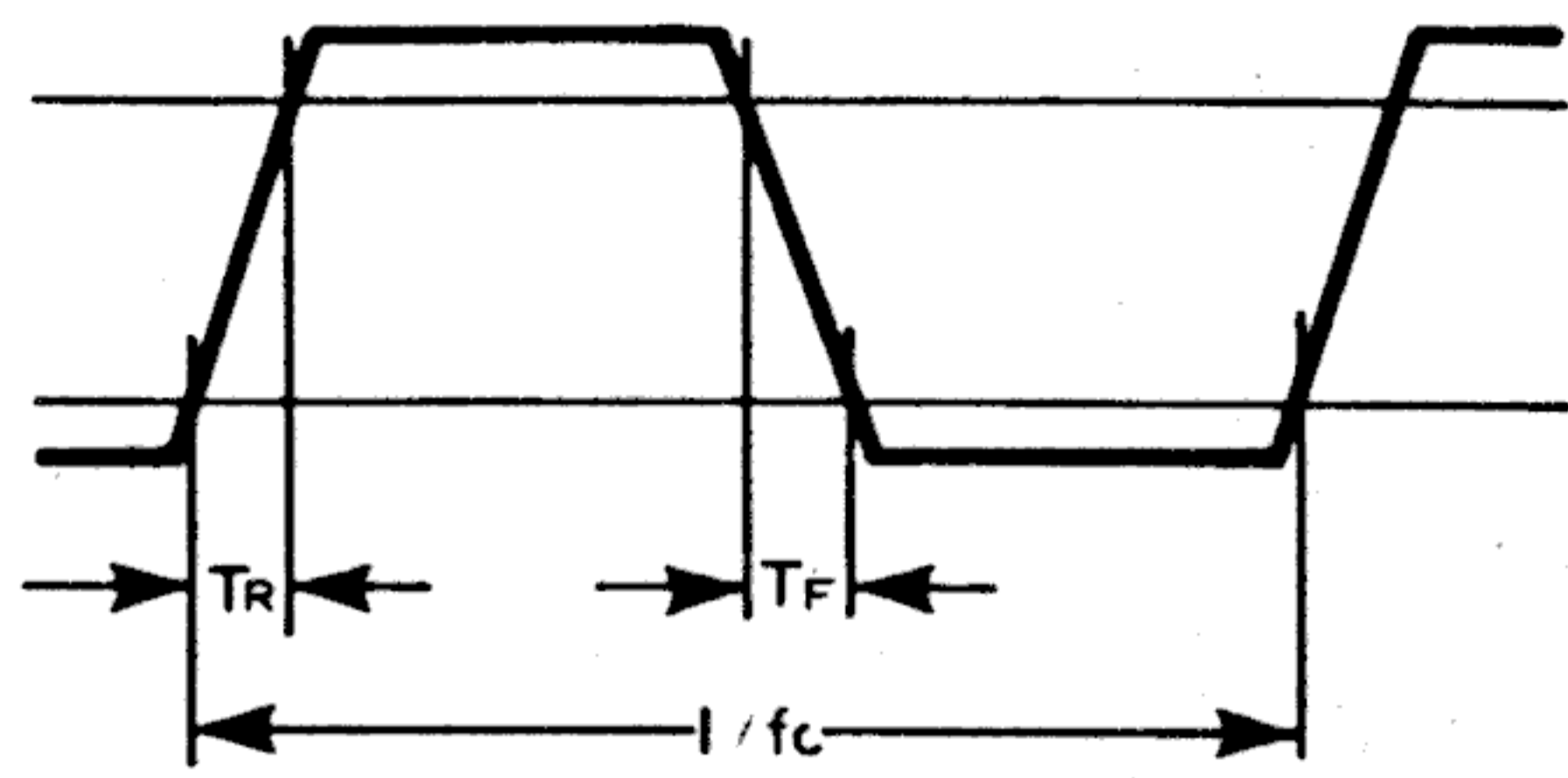


Fig. A-1. Clock timing

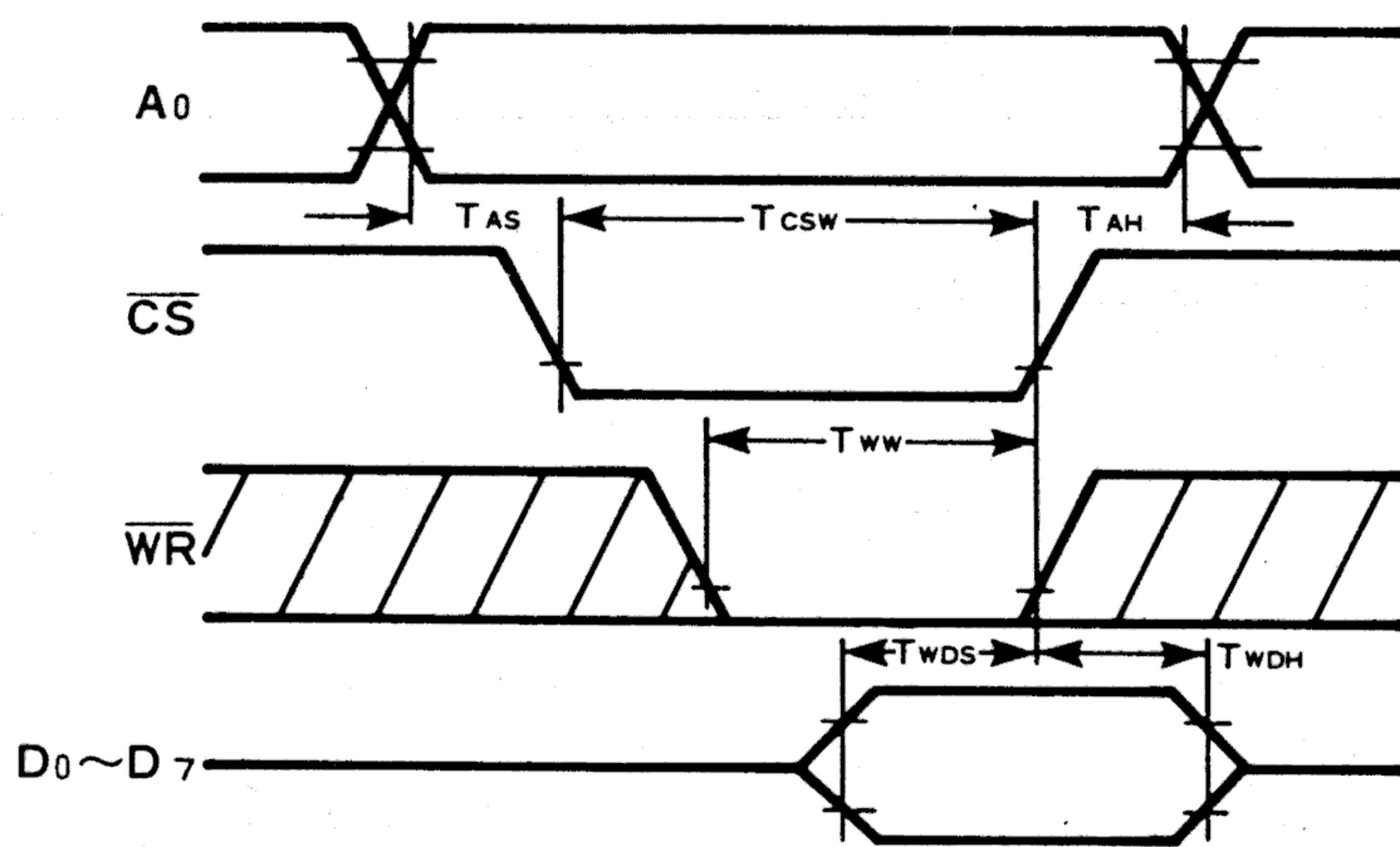


Fig. A-2. Write timing

(Note)
 T_{CSW} , T_{WW} and T_{WDH} are based on whether \overline{CS} or \overline{WR} is set at a high level.

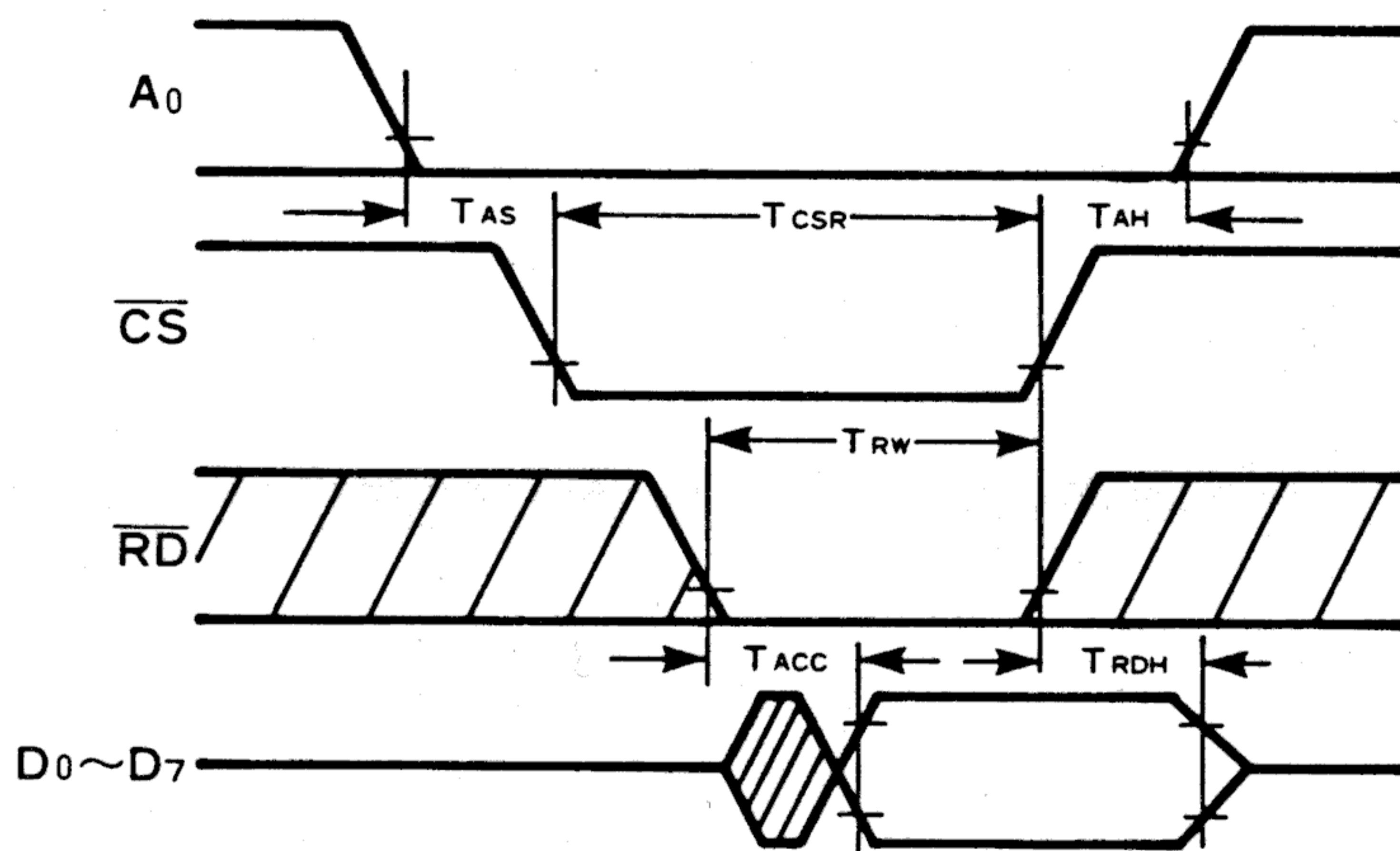


Fig. A-3. Read timing

(Note)
 T_{ACC} is based on either \overline{CS} or \overline{RD} , depending on which reaches a low level next.
 T_{CSR} , T_{RW} and T_{RDH} are based whether \overline{CS} or \overline{RD} is set at a high level.

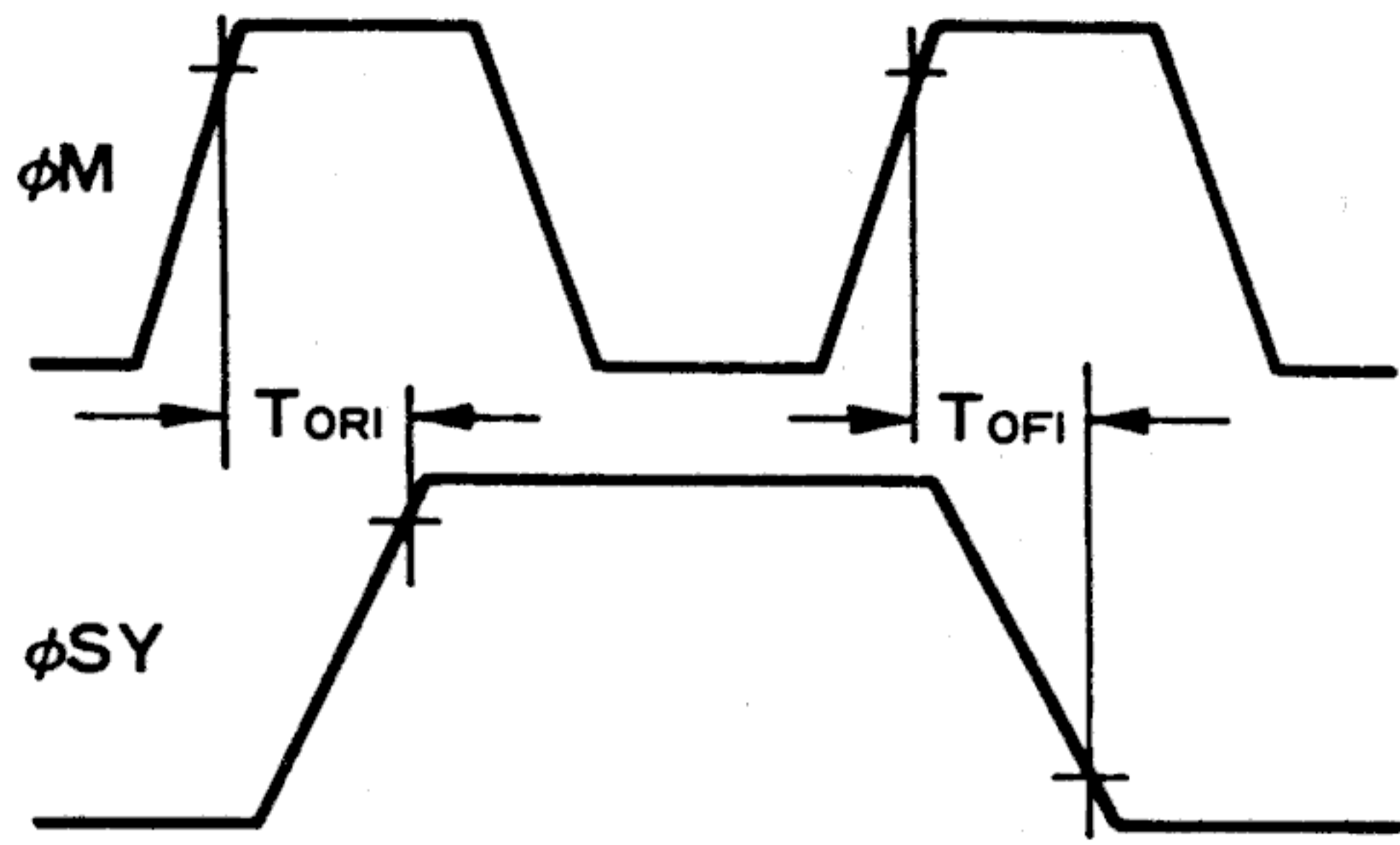


Fig. A-4. ϕM and ϕSY

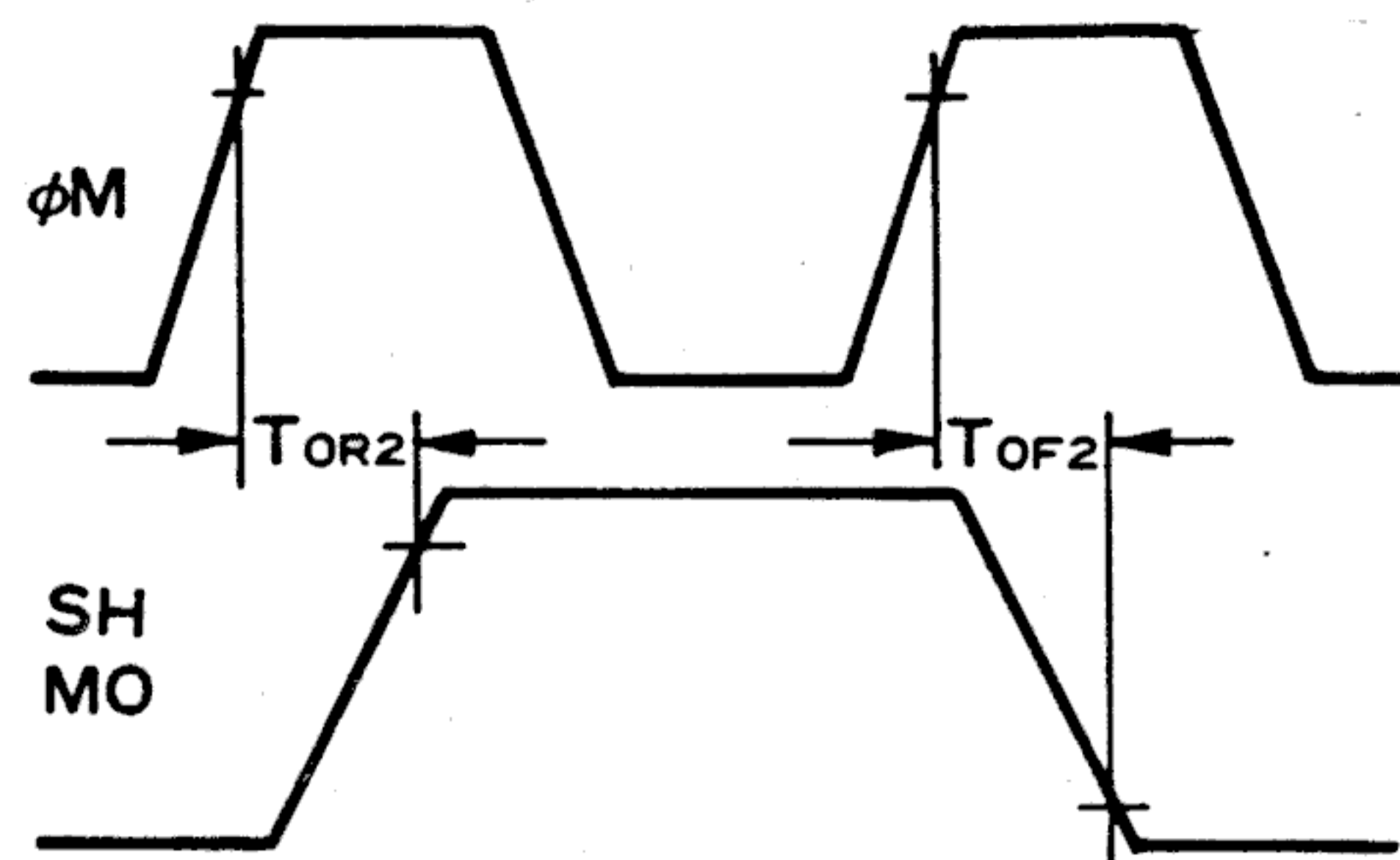


Fig. A-5. ϕM and SH · MO

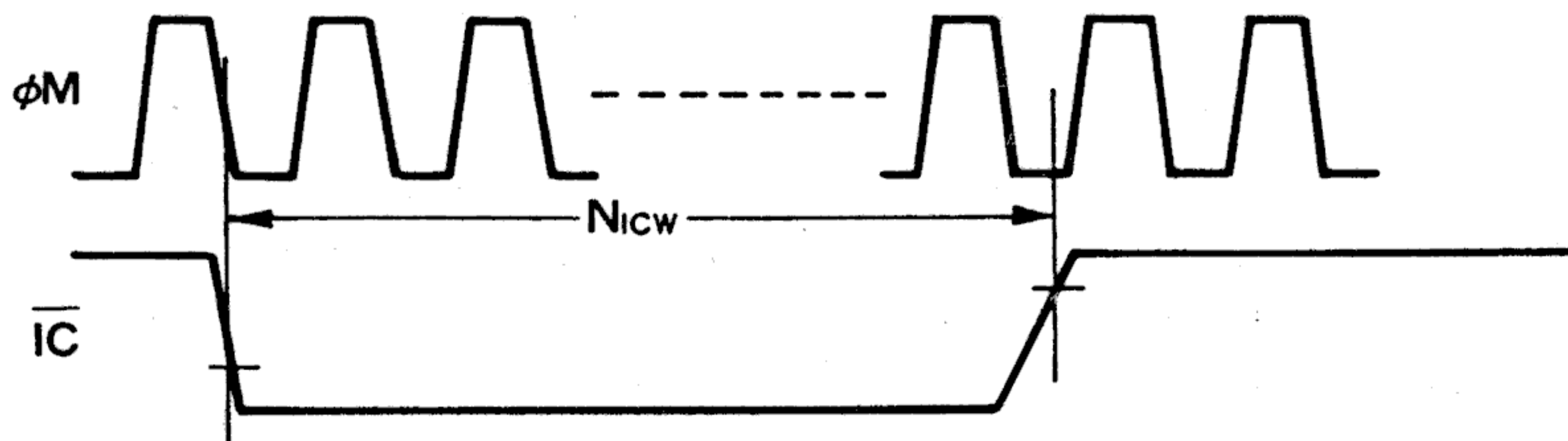
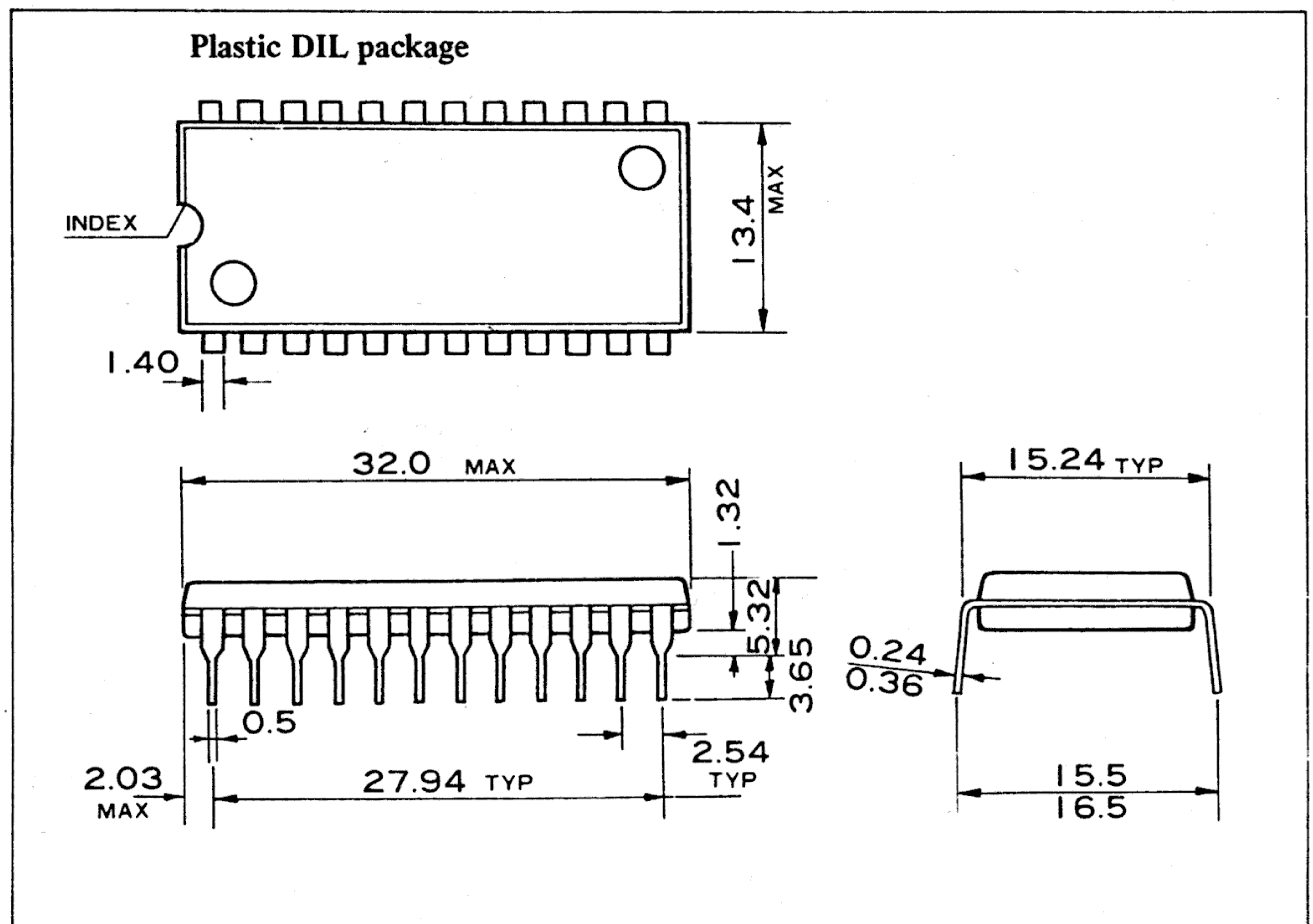


Fig. A-6. Reset pulse

■ DIMENSIONS



* Specifications subject to change for improvement without notice.

_____ AGENCY _____

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