TC9169AP, TC9170AP

T-77-21

## ELECTRONIC VOLUME FOR GRAPHIC EQUALIZER

Unit in mm

The TC9169/70AP is an optimum C^2MOS IC which has been designed for electronization of graphic equalizer of audio equipment with the following features.

. Allows 13-step variable control form -6 to 0 to $+6$.

. 2 channels have been built in.

. The TC9169AP is capable of control by means of the built-in oscillator and the up/down terminals.

. The TC9170AP is capable of optionally setting control position when specified data are externally supplied to the data, clock and storobe input terminals.

. Being in C^2-MOS structure, the operating voltage range is wide and current consumption is low.

$V_{DD}=6 \sim 12V$ (Backup is possible down to 4V)
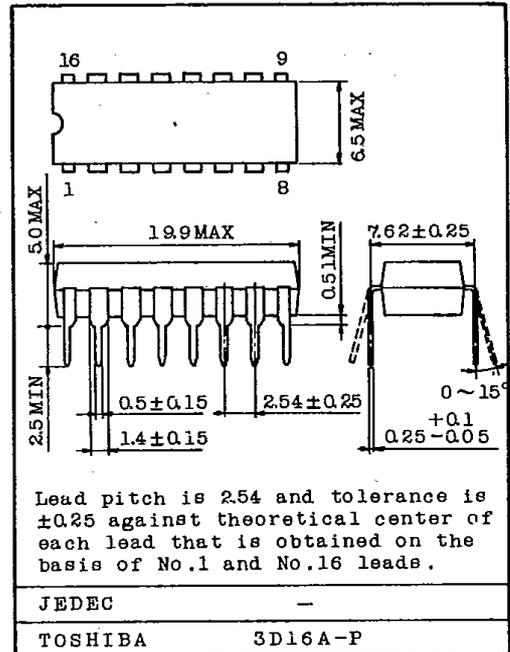
Lead pitch is 2.54 and tolerance is ±0.25 against theoretical center of each lead that is obtained on the basis of No.1 and No.16 leads.

JEDEC	—
TOSHIBA	3D16A-P

Weight : 1.0g

PIN CONNECTIONS

TC9169AP

TC9170AP
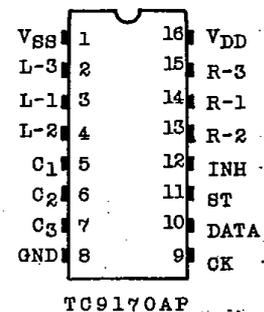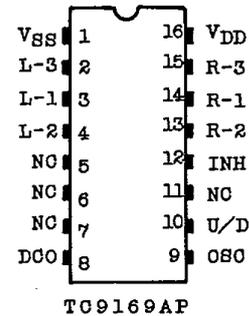
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	13	V
Input Voltage	V_{IN}	$V_{SS}-0.3 \sim V_{DD}+0.3$	V
Power Dissipation	P_D	150	mW
Operating Temperature	T_{opr}	$-30 \sim 75$	°C
Storage Temperature	T_{stg}	$-55 \sim 125$	°C

TC9169AP,
TC9170AP

BLOCK DIAGRAM

TC9169AP
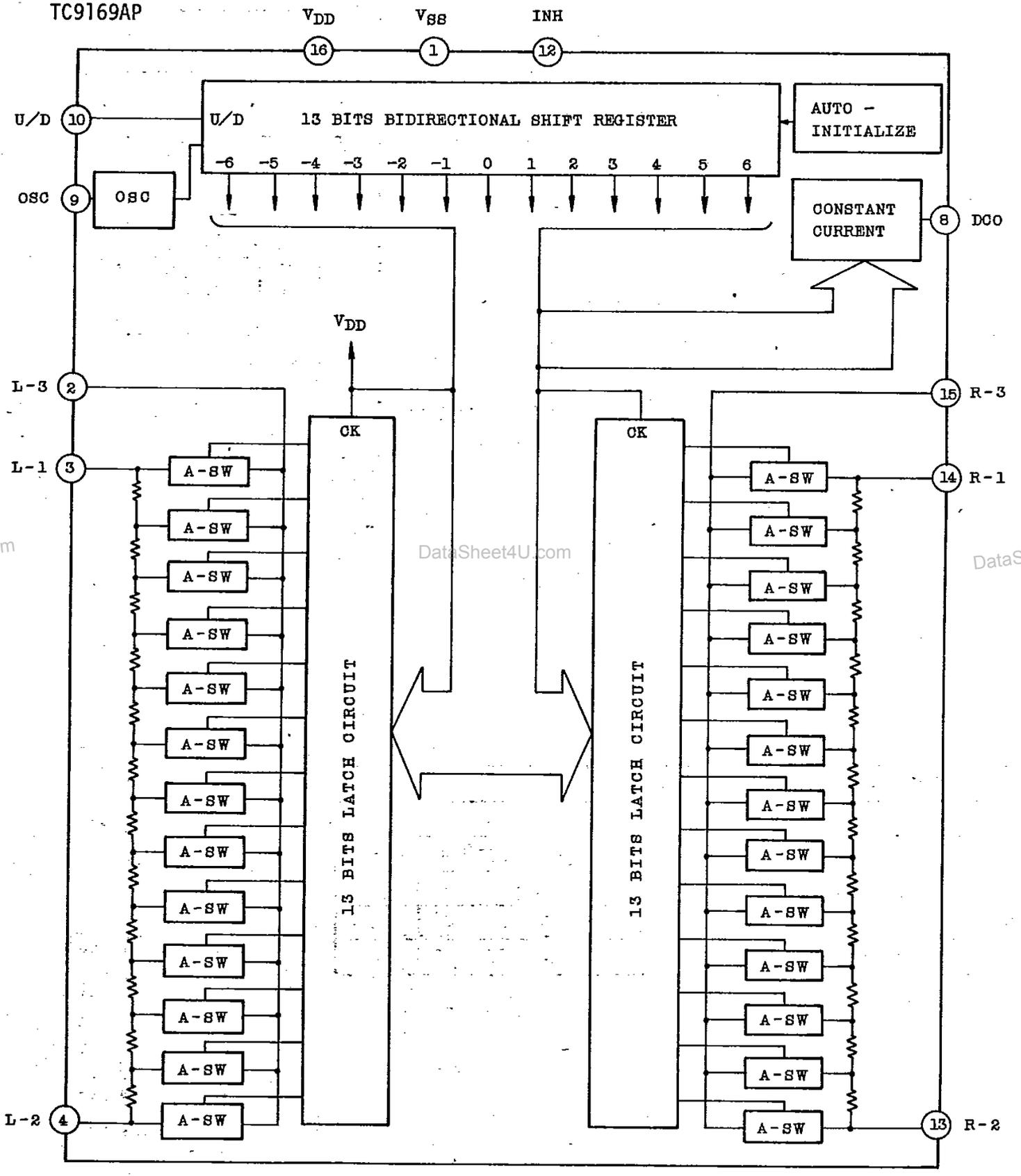
TC9169AP, TC9170AP
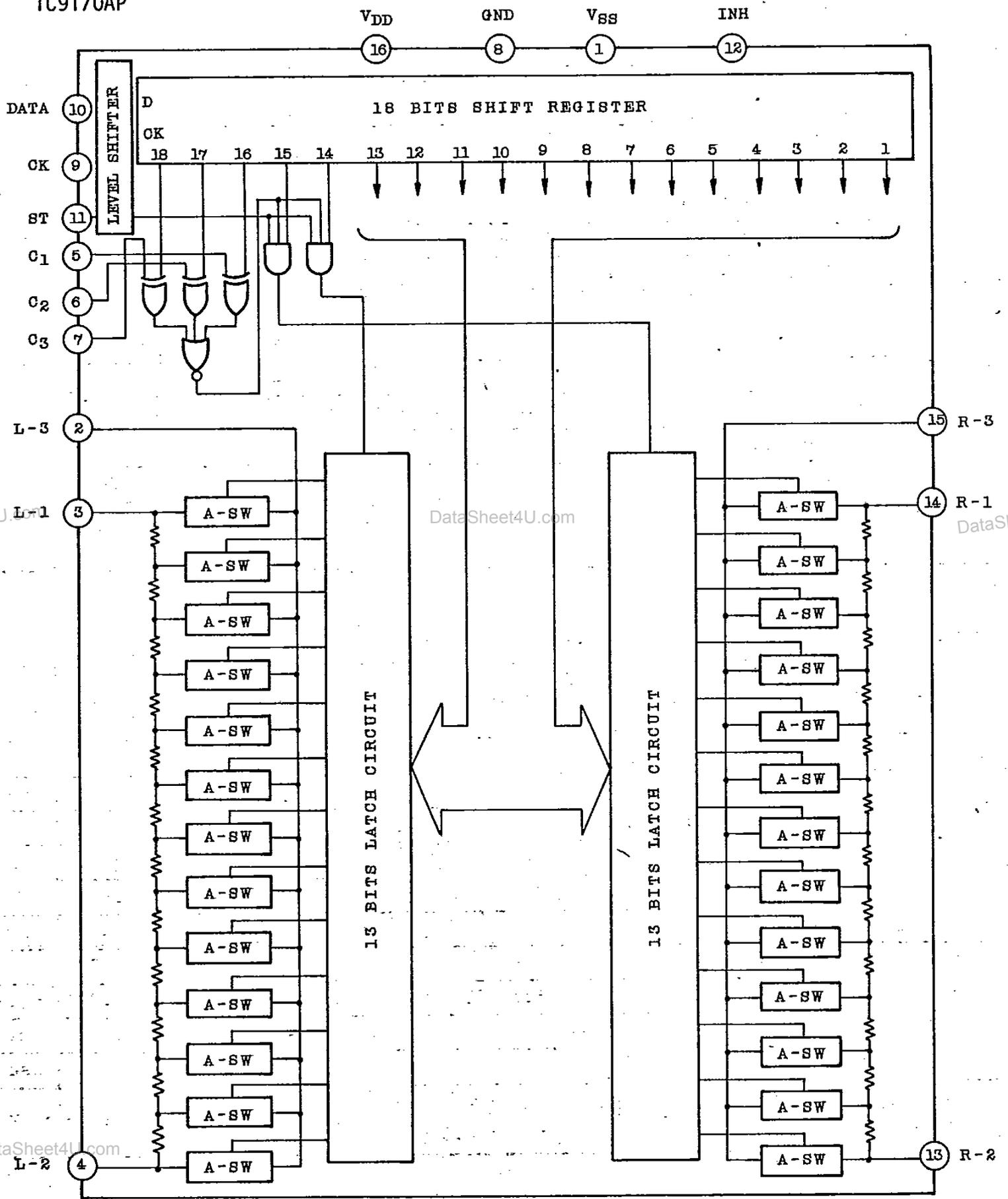
TC9170AP

TC9169AP, TC9170AP

ELECTRICAL CHARACTERISTICS

TC9169AP   (Unless otherwise specified, $V_{DD}=12V$, $V_{SS}=0V$, Ta=25°C)

| CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage		V_{DD}	–		6	~	12	V
Operating Supply Current		I_{DD}	–		–	1	3	mA
Backup Current		I_B	–	$V_{DD}=4V$, INH="L"	–	1	10	μA
Input Voltage	"H" Level	V_{IH}	–	INH, U/D Terminal	$0.8 \times V_{DD}$	~	$V_{DD}+0.3$	V
	"L" Level	V_{IL}	–		$V_{SS}-0.3$	~	$0.2 \times V_{DD}$	
Total Resistor		R_T	–		50	100	140	kΩ
Resistance Ratio Error		–	–		–5	~	+5	%
Max. Input Voltage		V_{in}	–	Bias $V_{DD}/2=6V$	–	–	4.0	Vrms
Operating OSC Frequency		f_{OSC}	–		5	~	10k	Hz
DCO Output Current		I_{DCO}	–	1 at/step	140	200	280	μA
Total Harmonic Distortion		THD	–	Step=+6, $f_{in}=1kHz$ $V_{in}=1.0Vp$-p	–	0.005	0.01	%

TC9170AP   (Unless otherwise specified, $V_{DD}=6V$, $V_{SS}=-6V$, GND=0V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage		$V_{DD}-V_{SS}$	–		6	~	12	V
Operating Supply Current		I_{DD}	–		–	1	3	mA
Static Supply Current		$I_{DD(S)}$	–	$V_{DD}=4V$, INH=0V	–	1	10	μA
Input Voltage	"H" Level	V_{IH}	–	Data CK,ST	$0.8 \times V_{DD}$	~	$V_{DD}+0.3$	V
	"L" Level	V_{IL}	–		–0.3	~	$0.2 \times V_{DD}$	
Total Resistance		R_T	–		50	100	140	kΩ
Resistance Relative Error		–	–		–5	~	+5	%
Max. Input Voltage		V_{in}	–	Bias=0V	–	–	4.0	Vrms
Max. Clock Frequency		f_{ck}	–		–	–	100	kHz
Min. Clock Width		T_{ck}	–		5	–	–	μsec
Total Harmonic Distortion		THD	–	Step=+6, $f_{in}=1kHz$ $V_{in}=1.0Vp$-p	–	0.005	0.01	%

FUNCTIONAL DESCRIPTION OF EACH TERMINAL

| TERMINAL No.	SYMBOL	FUNCTION	REMARKS
2	L-3	Input/Output terminal for tone control resistor.	L and R Symmetrical
15	R-3		
3	L-1		
14	R-1		
4	L-2		
13	R-2		
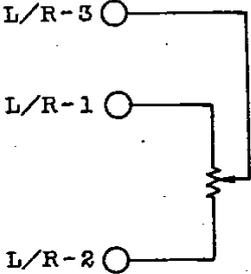
TC9169AP

7	INH	Inhibit pin. When this terminal is at "L" level, all input/output are cut off and the TC9169AP is placed in the inhibit state. When at "H" level, the TC9169AP operates normally.	
8	DCO	DC current output for displaying step -6~0~+6 is divided into 7 steps and approx. 200µA/step is transmitted.	Attenuation can be converted to DC voltage by attaching a resistor between the terminal and V_{SS}.
9	OSC	C, R connecting terminal for the oscillator. Up/down speed is decided by the up/down control oscillator for tone according to this time constant.	
10	U/D	Tone up/down control input terminal. When this terminal is at "H" level, high or low tone is increased synchronizing with rise of the oscillator. Conversely, when this terminal is at "L" level, high or low tone is decreased.	With pull-up resistance.
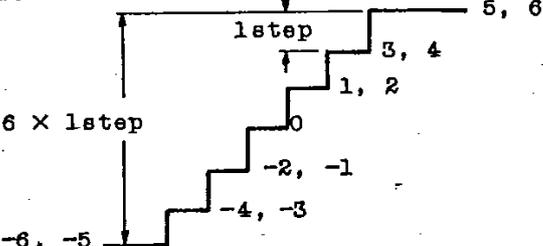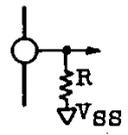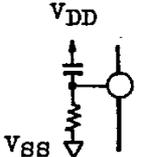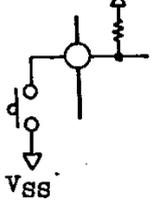
TC9170AP

TERMINAL No.	SYMBOL	FUNCTION	REMARKS
10	DATA	Equalizer channel selection data input terminal. Data consists of 18 bits and inputted by CK signal.	
9	CK	Clock input terminal. Clock input terminal for taking data from DATA terminal.	
11	ST	Strobe input terminal. Attenuation channel selection signals taken from DATA and CK terminals are latched when this terminal is placed at "H" level. When no "H" level signal is applied to this terminals, previous data is kept maintained.	C-MOS Input
5 6 7	C_1 C_2 C_3	Cord bit input terminals. Only when the states ("H" or "L") of those terminals are the same as those (C_1=16th bit, C_2=17th bit, C_3=18th bit) of the transmitted tone control data, the 16th to 18th bit, the TC9170AP operates. ("H"=V_{DD}, "L"=V_{SS})	C-MOS Input
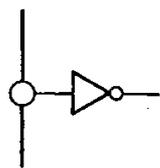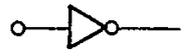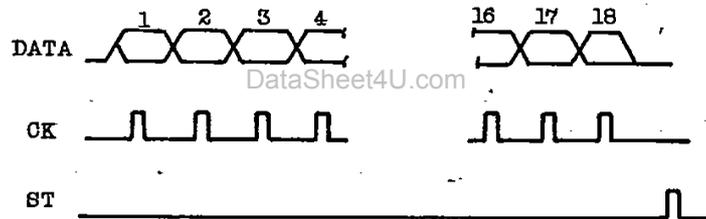
DESCRIPTION OF OPERATION

1. **SETTING OF TONE CONTROL POSITION**

    Setting of tone control position differs between the TC9169AP and TC9170AP.

    On the TC9169AP, position can be increased/decreased according to the state of U/D terminal ("H" or "L" level) by actuating the built-in oscillator.

    On the TC9170AP, position can be set at optional level by inputting specified data to the DATA, CK and ST terminal, respectively.

. In Case of TC9169AP

On the TC9169AP, control position is automatically set at the 0dB (center) position when power is applied.
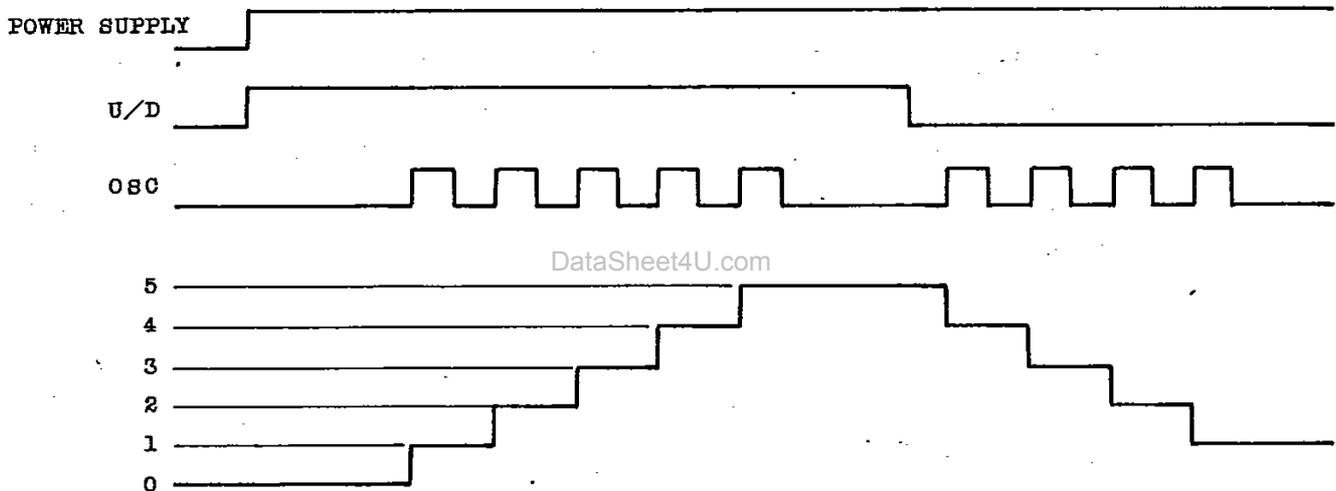
When the UP key is pressed after power ON, the U/D terminal is placed in the up state at "H" level, and the oscillator is actuated.

When the DOWN key is pressed, the U/D terminal is lept at "L" level as long as the DOWN key is pressed, and the oscillator is actuated in the down state and therefore, position is decreased. Oscillation frequency is decided by Cx and Rx.

$$f_{OSC} \doteqdot \frac{1}{0.7 C_x \cdot R_x} \text{ (Hz)} \quad (R_s \geqq 3R_x)$$

EXAMPLE

$R_x = 33 k\Omega$

$C_x = 4.7 \mu F$

$R_s = 100 k\Omega$
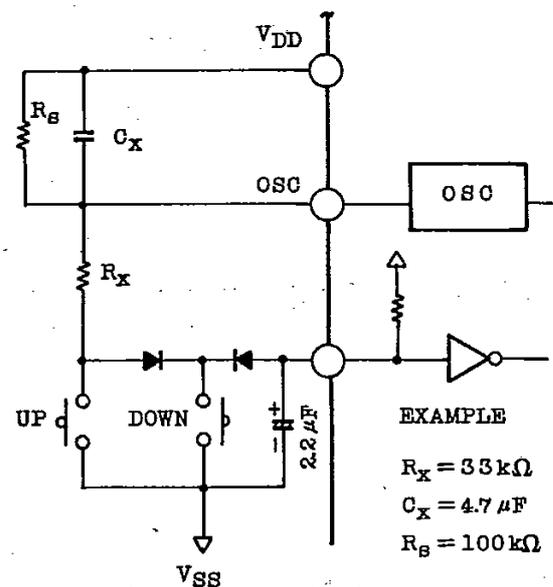
- In Case of TC9170AP

On the TC9170AP, optional position data is inputted throuth the DATA, CK and ST. Data consists of 18 bits as follows.

| 6	5	4	3	2	1	0	-1	-2	-3	-4	-5	-6	L-ch	R-ch	C1	C2	C3

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
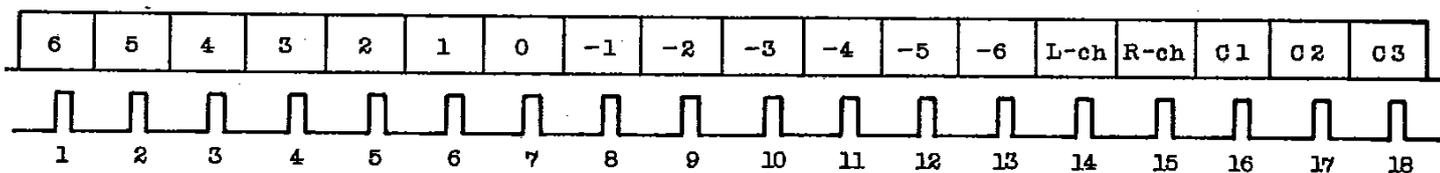
For instance, when data of (000100000000011000) is inputted through the DATA terminal, position is set at +3.

The 1st to 13th bit of the data are tone control data, allowing 13 steps of +6~0~-6 be set up.

The 14th and 15th bit are for selecting the left and right channels, and "1". "0"=Lch, "0", "1"=Rch, "1", "1"=L & Rch.

The 16th to 18th bit are code bits.

```
              1      ~      13 bit
   -2 (0000000010000)
   -3 (0000000001000)
   -4 (0000000000100)
   -5 (0000000000010)
   -6 (0000000000001)
```

DATA
CK
ST

-3
-4
-5
-6
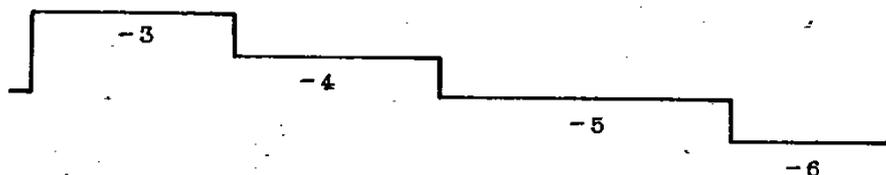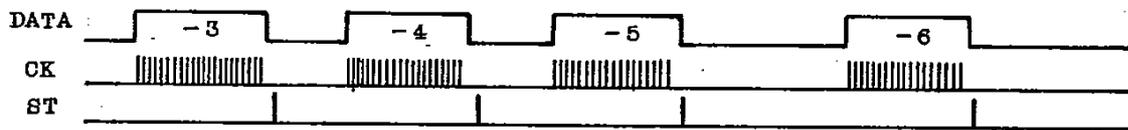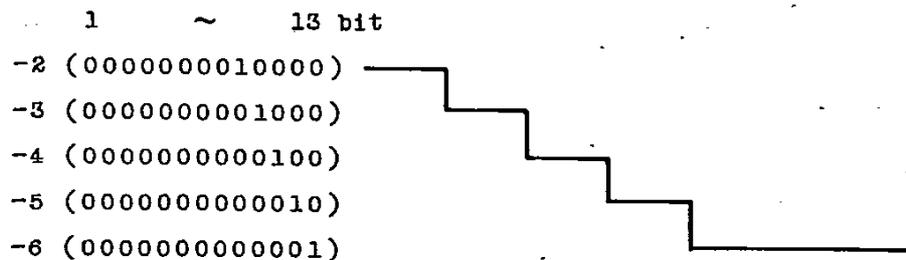
Changes to data that has been taken in are all synchronized with ST signal.

TC9169AP, TC9170AP

TIMING OF DATA, CK AND ST

DATA, CK and ST should be inputted under the conditions shown below.

$A > 5 \mu s$

$B > 10 \mu s$
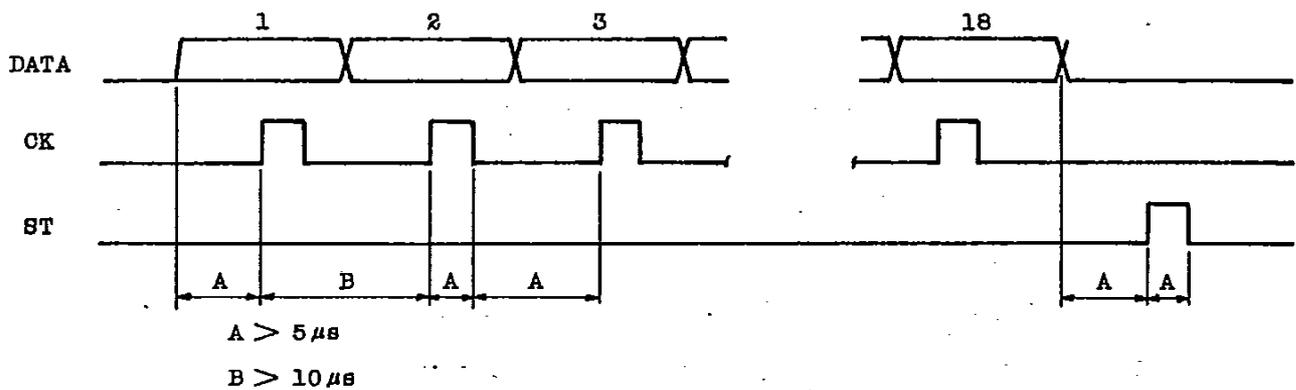
CODE BITS

Terminals 5, 6 and 7 are code bit terminals.

When the code bit data among transmitted data are compared with these terminals, if their codes are the same, the data are accepted. These code bit terminals are used for selecting two ICs or more.
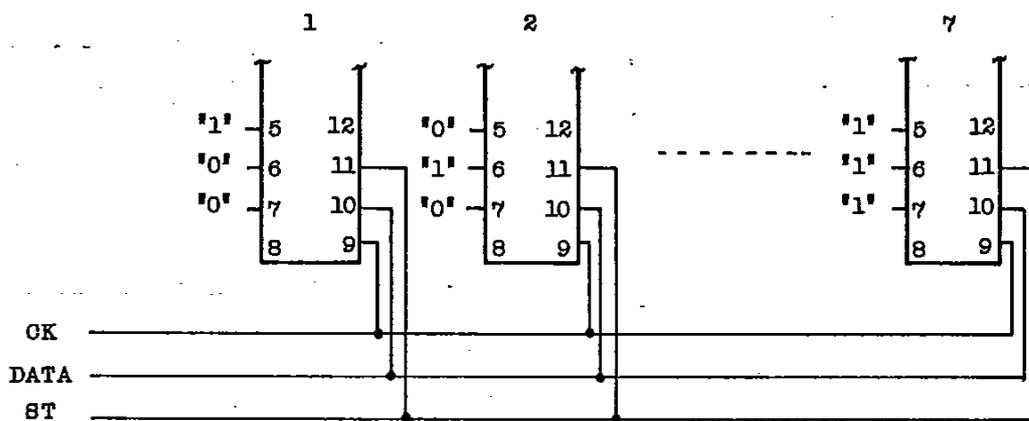

Code bits can be used up to the following seven codes.

C1	C2	C3
1	0	0
0	1	0
1	1	0
0	0	1
1	0	1
0	1	1
1	1	1

* The TC9169AP IC for electronic volume is internally set up to C1=C2=C3=0. Therefore, when the codes are used at the same time, note that the codes "0""0""0" of the TC9170AP should not be used.

STEP POSITION DISPLAY OUTPUT

The TC9169AP is provided with the DC current output terminal for +6~0~-6 steps.

STEP	DCO	POSITION
0	0	-6, -5
1	$200\mu A \pm 60\mu A$	-4, -3
2	$2 \times$ STEP 1	-2, -1
3	$3 \times$ STEP 1	0
4	$4 \times$ STEP 1	+1, +2
5	$5 \times$ STEP 1	+3, +4
6	$6 \times$ STEP 1	+5, +6
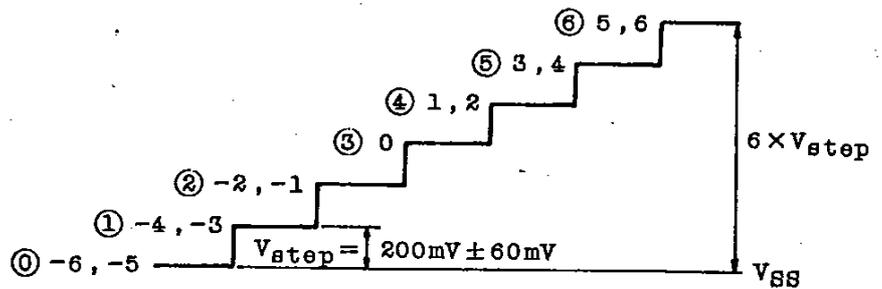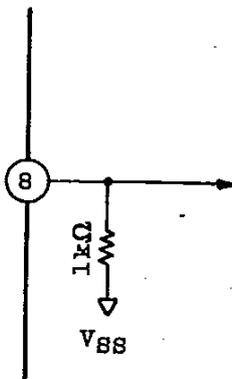
* Output current may fluctuate depending upon IC.

When high precision is required, use a variable resistor.

VARIABLE RESISTANCE

The variable resistance consist of diffused resistors and analog switches.
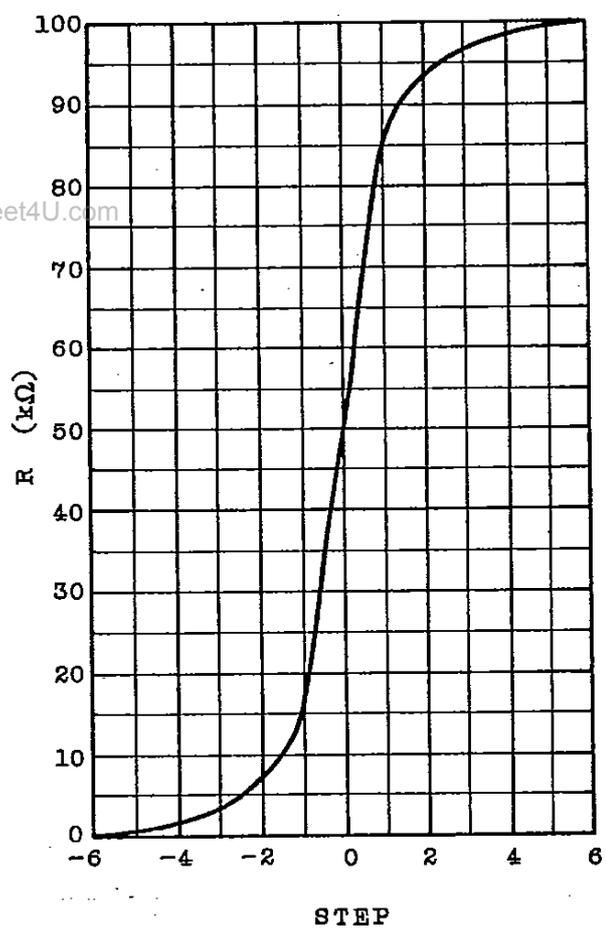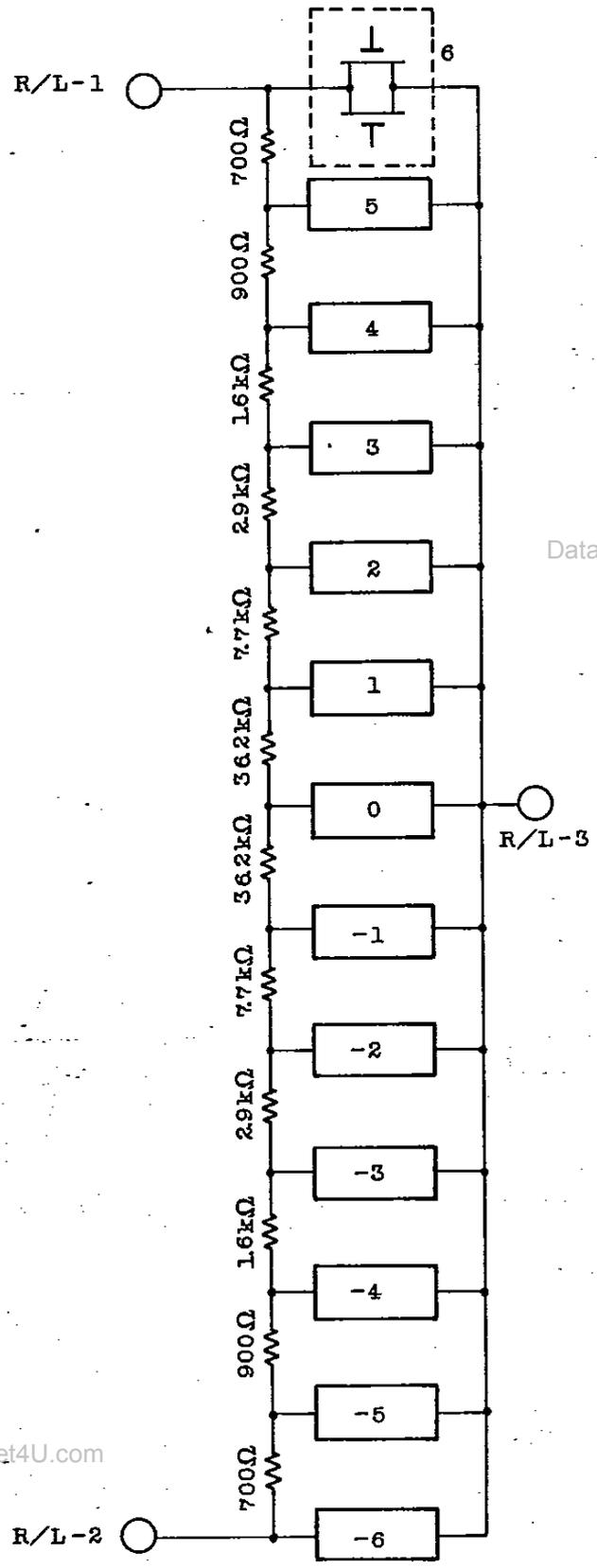
TC9169AP,
TC9170AP

POWER SUPPLY

TC9169AP

. IN CASE OF DUAL POWER SUPPLY
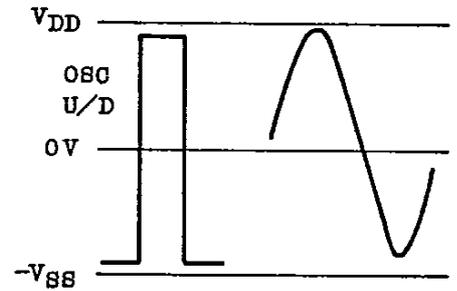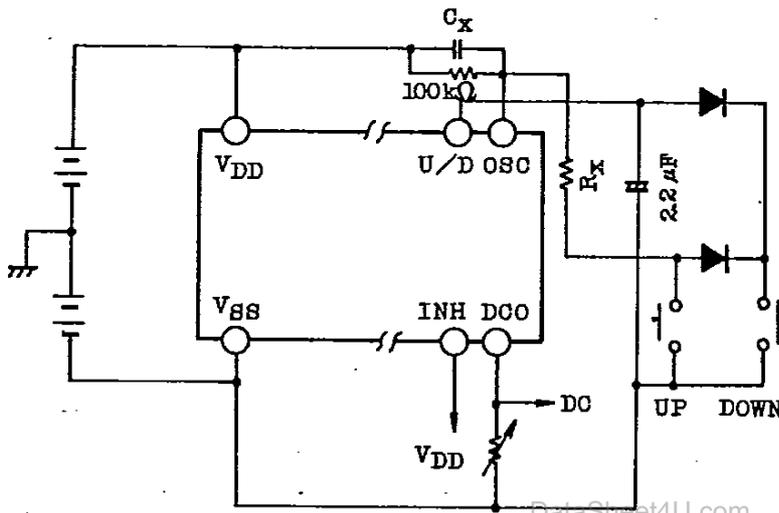
. IN CASE OF SINGLE POWER SUPPLY
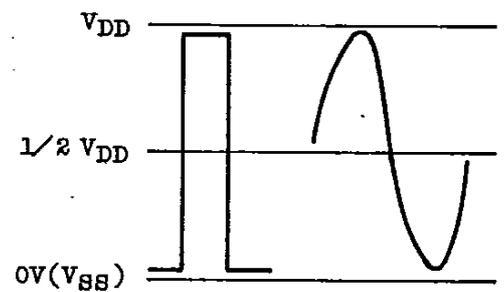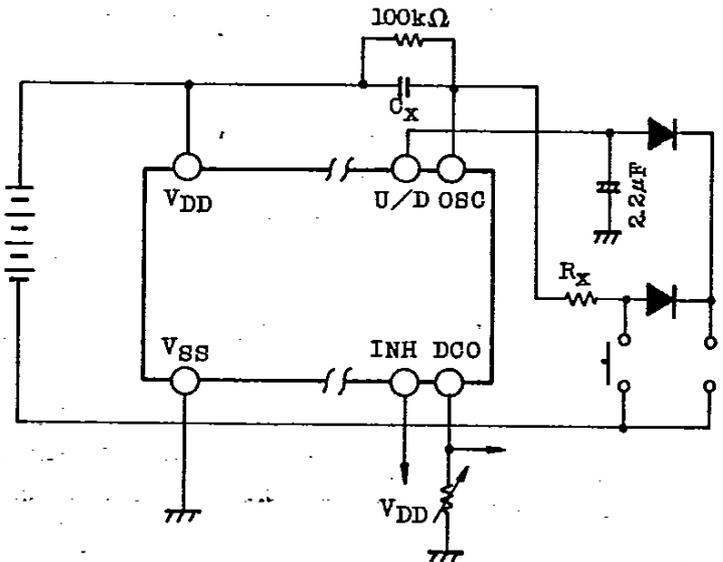
TC9170AP

As the TC9170AP has a built-in level shifter, DATA, CK and ST inputs can be operated by a single power supply (V$_{DD}$-GND) even when Dual power supplies are used. As a result, it has become easy to connect to a microcomputer, other controller.

. IN CASE OF DUAL POWER SUPPLY
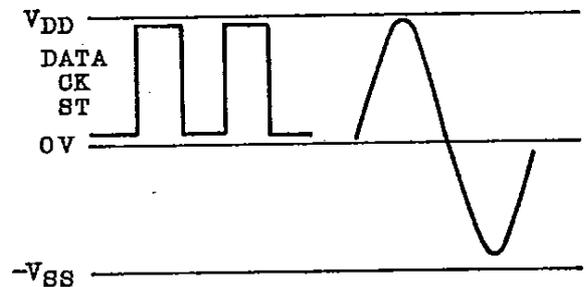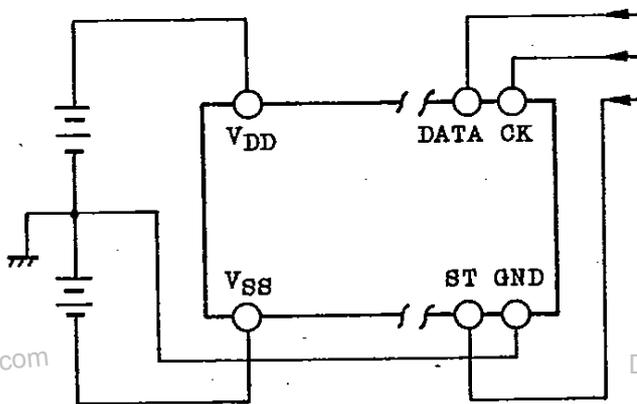
. IN CASE OF DUAL POWER SUPPLY
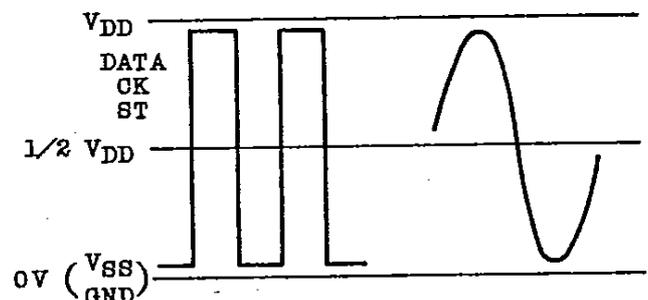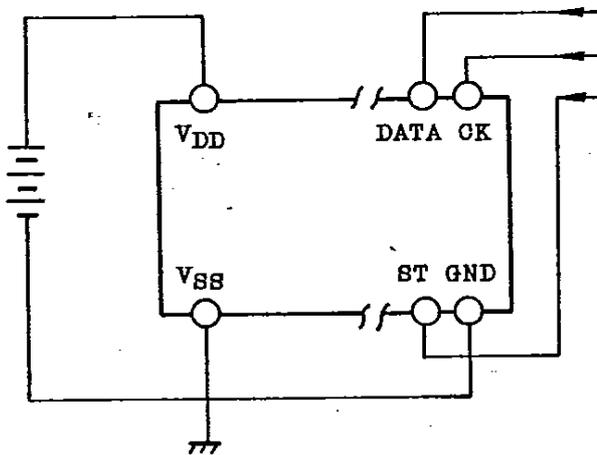
BACKUP WHEN POWER OFF

On the TC9169AP, when the INH terminal is set at "L" ($-V_{SS}$) level, all input/output terminals are shut off and current consumption is reduced to the minimum.

The backup by means of a capacitor becomes possible in this condition.

An example of application when a backup capacitor is used is shown below.
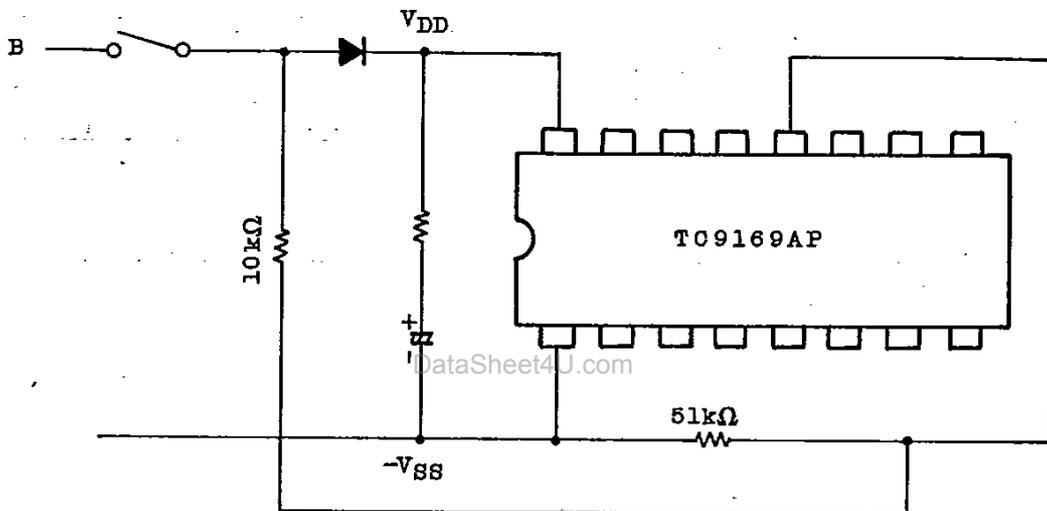
* If $V_{DD}-V_{SS}$ drops below 4.0V, the backup becomes impossible.

The TC9170AP is of such type that position data is supplied externally and therefore, is not suited for the backup. It is recommended to perform the backup at the controller side and to input holding data when power is ON.

INITIALIZATION WHEN POWER ON

The TC9169AP has the auto-initializing function built-in for initialization at time of power ON.

As the initializing system through detection of supply voltage level is adopted, if rise of power supply is too fast, the initialization may not be fully effected. (No external initialization is necessary.) In additions for effective initialization it is necessary that the INH terminal is raised simultaneously with supply vloatge. Further, the initializing level is "0" position.

It is recommended to rise supply voltage and the INH terminal as illustrated below.

$V_{DD} - V_{SS}$
AND INH PIN VOLTAGE

$* V_{DD} - V_{SS} = 4.0V$

T $T \geqq$ 1ms
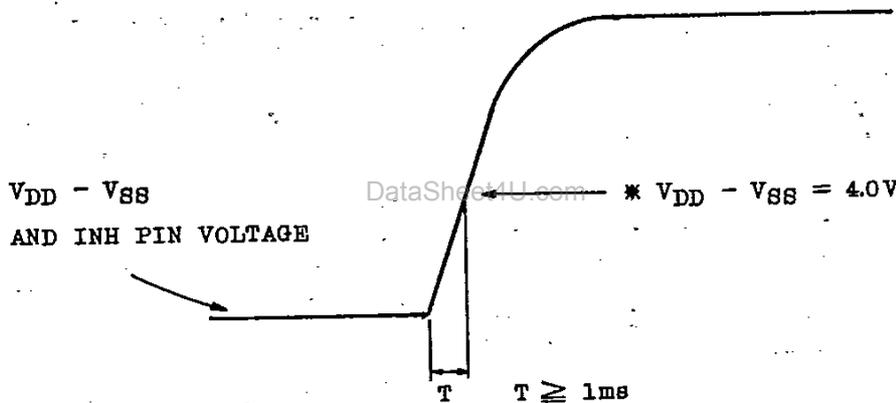
* On the TC9169AP, if $V_{DD}-V_{SS}$ drops below 4.0V, the auto-initializing function is actuated.

The TC9170AP is of such type that position data is supplied externally, it has no built-in auto-initializing function. It is recommended to send data after power to the TC9170AP is raised.

TC9169AP APPLICATION CIRCUIT

(5 BANDS GRAPHIC EQUALIZER)

* Op Amp TA75902P

SAME AS Rch

TC9170AP APPLICATION CIRCUIT
(5 BNADS GRAPHIC EQUALIZER)

ST
DATA
CK
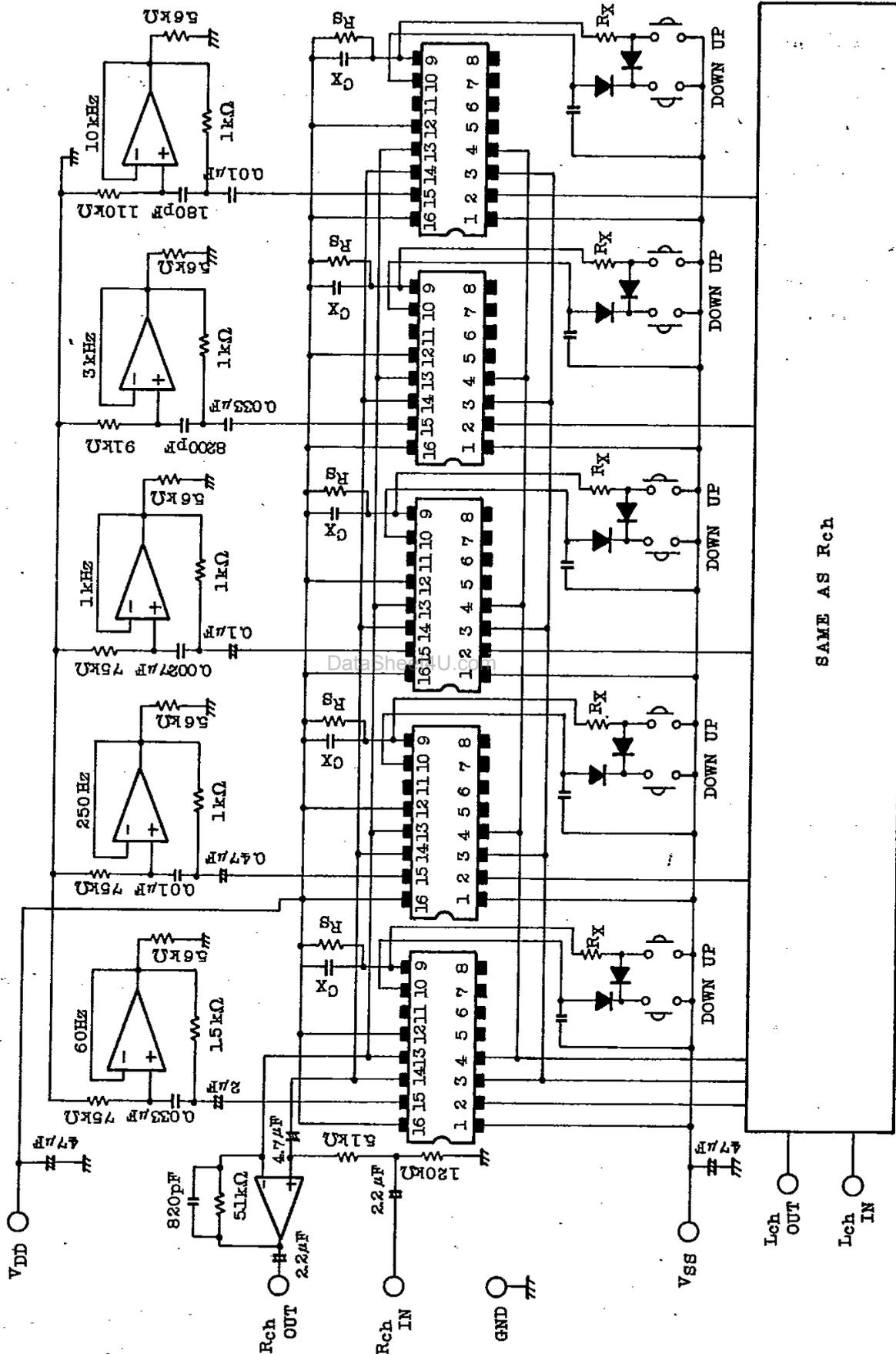
SAME AS Rch

* Op Amp TA75902P

10kHz   56kΩ   1kΩ   0.01μF 180pF 110kΩ
3kHz   56kΩ   1kΩ   0.0033μF 8200pF 91kΩ
1kHz   56kΩ   1kΩ   0.1μF 0.0027μF 75kΩ
250Hz   56kΩ   1kΩ   0.47μF 0.01μF 75kΩ
60Hz   56kΩ   1.5kΩ 2μF 0.0033μF 75kΩ

820pF 5.1KΩ 4.7μF 5.1KΩ 130kΩ

VDD   47μF
Rch OUT 2.2μF
Rch IN 2.2μF
GND
VSS 47μF

Lch OUT
Lch IN