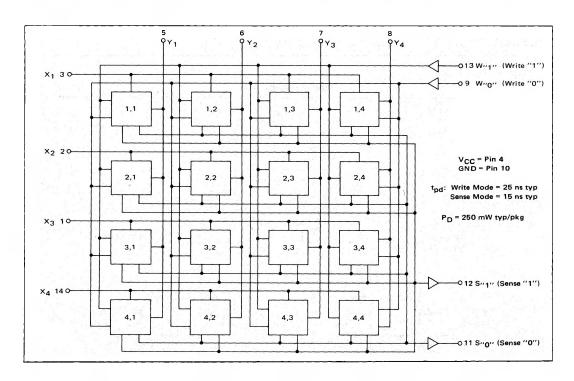
## MC4304F, L · MC4305F, L\* MC4004F, L, P · MC4005F, L, P\*

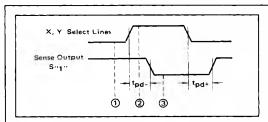
This 16-Bit memory cell serves as the basic building block for scratch pad memory systems having cycle times of less than 100 ns. The basic cell provides 16 words of one-bit memory operating in the non-destructive readout (NDRO) mode.

The memory contains 16 flip-flops arranged in a fourby-four matrix. A single bit of the matrix is selected by driving one of four X select lines and one of four Y select lines above the select threshold. Two sense amplifiers are shared by all 16 bits and provide a double rail output from the selected bit. The sense output of many devices can be "wired ORed" together since the output stage does not have a pullup resistor or network. Two write amplifiers allow a "1" or a "0" to be written into a selected bit.



#### - OPERATING SEQUENCE -

#### FIGURE 1 - READ MODE TIMING DIAGRAM



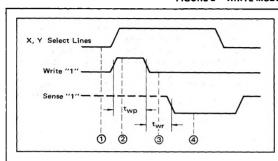
- (1) All X and Y selection lines and both write inputs are low (less than +0.8 V).
- 2 Desired bit selected by driving the appropriate X and Y select lines more positive than +2.1 V.
- After the turn-on delay time(tpd\_), the S"1" output will be low (less than +0.45 V) and the S"0" output will be high (more than +2.5 V), providing that a "1" is stored in the selected bit.

<sup>\*</sup>F suffix = TO-86 ceramic flat package (Case 607).

L suffix = TO-116 ceramic dual in-line package (Case 632).

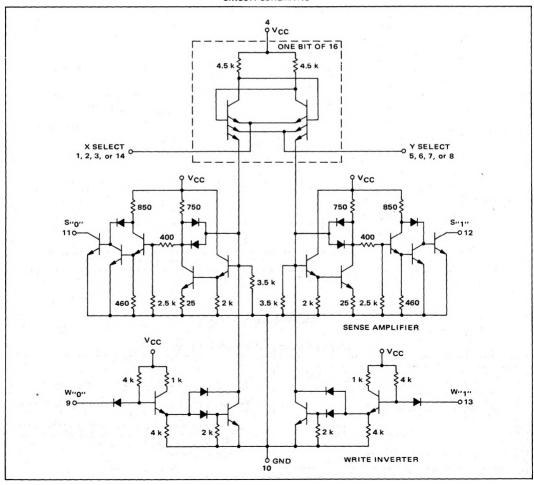
P suffix = TO-116 plastic dual in-line package (Case 605).





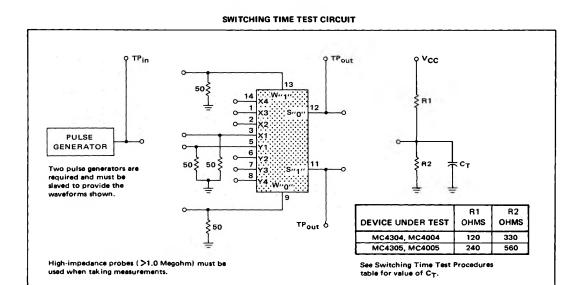
- (1) All X and Y selection lines and both write inputs are low (less than +0.8 V).
- ② Bit location selected by driving the appropriate X and Y select lines more positive than +2.1 V. To write a "1", drive the write "1" input more positive than +2.1 V for a minimum time of 25 ns (t<sub>Wp</sub>).
- (3) Write "1" line returned to low state.
- The stored bit can be read after the write recovery time (t<sub>wr</sub>) of 40 ns. (The sense output is in an indeterminate state between steps 2 and 4.)

#### CIRCUIT SCHEMATIC

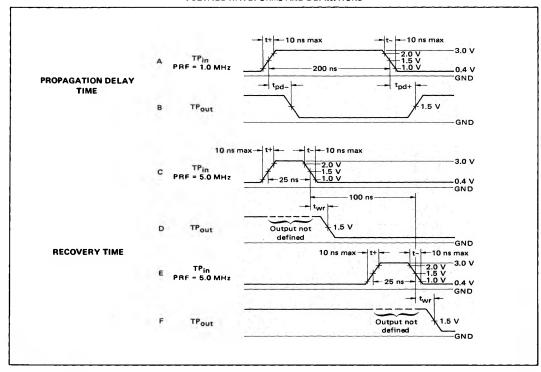


| Test procedures are shown for only one bit.          |                |               |        |                     |         |         |               |       |                            |                 |          |                       |       |      |      |                  |  |                   |                   |           |             |             |     |     |                   |                          |
|--|----------------|---------------|--------|---------------------|---------|---------|---------------|-------|----------------------------|-----------------|----------|-----------------------|-------|------|------|------------------|--|-------------------|-------------------|-----------|-------------|-------------|-----|-----|-------------------|--------------------------|
|  | wn for on      | ly one        | bit.   |                     |         |         |               |       |                            |                 |          |                       |       | -    | mA   |                  |  |                   |                   |           | Volts       | 5           |     |     |                   |                          |
| or bits are tested in t                              | he same r      | nannei        |        |                     |         |         |               |       |                            |                 | e le     | @ Test<br>Temperature | 4     | lso. | _}   | _k               | > =  | \<br>n,           | > 2               | >"        | >*          | >*          | >   | >8  | BV <sub>ck</sub>  | -                        |
|  |                |               |        |                     |         |         |               |       |                            |                 | ,        | -55°C                 | L     | 20   | 1.0  | 3.0              | 0.75   | 0.85              | 1                 | 0         | 4.5         | -           | 5.5 | +   |                   |                          |
|  |                |               |        |                     |         |         |               |       | MC430                      | MC4304*, MC4305 | -        | +25°C                 | 40    | 20   | 1.0  | 3.0              | 0.75   | 0.85              | 6.0               | 0         | 4.5         | +           | 5.5 | 5.0 | 7.0               |                          |
|  |                |               |        |                     |         |         |               |       |                            |                 | _        | +125°C                | 40    | 20   | 1.0  | 3.0              | 0.75   | 0.85              | 6.0               | 0         | 4.5         | 2.2         | 5.5 | 5.0 |                   |                          |
|  |                |               |        |                     |         |         |               |       |                            |                 | •        | ე <sub>0</sub> 0      | 40    | 20   | 1.0  | 3.0              | 0.8  | 1.0               | 1.0               | 0         | 4.5         | 2.1         | 5.5 | 5.0 |                   |                          |
|  |                |               |        |                     |         |         |               |       | MC400                      | MC4004", MC4005 | 4002     | +25°C                 | 40    | 20   | 1.0  | 3.0              | 9.0  | 1:0               | 1,0               | 0         | 4.5         | 2.1         | 5.5 | 5.0 | 7.0               |                          |
|  |                |               |        |                     |         |         |               |       |                            |                 | _        | +75°C                 |       | 20   | 1.0  | 3.0              | 9.0  | 1.0               | 1.0               | 0         | 4.5         | +           | 5.5 | 5.0 |                   |                          |
|  |                | -             | MC430  | MC4304, MC4305 Test | 05 Test | Limits  | -             | MC40  | MC4004, MC4005 Test Limits | 4005            | est Limi | ts t                  |       |      |      |                  | TEST CLIPPENT / VOLTAGE APPLIED TO BINS LISTED BELOW | AT ION THE        | II Iddy 35        | ED TO DIA | IC LICTED 5 | ELOW.       |     |     |                   |                          |
| tan'   |                |               | J. 20  | JOSET               | 00.     | J.361T  | L             | J.00  | TOEST                      |                 | JOJET.   |                       |       |      |      |                  | IESI CUKK  | ENI/ VOLI)        | AUE ALLE          | ווו ווו   | to civien   | SELUW:      |     |     |                   |                          |
| Characteristic                                       | Symbol         | Under<br>Test | Win Ma | _                   | Max     | Min Max | $\rightarrow$ | ×     | Min M                      | -               | n Max    | Unit                  |       | 180  | *    | l <sub>x</sub> , | V in 1   | V <sub>in 2</sub> | V <sub>in 3</sub> | ٧,        | >           | <b>&gt;</b> | Vou | Vcc | BV <sub>ckt</sub> | Gnd                      |
| Input<br>Forward Current<br>Address Lines            | I.             | eo 11         | 75     |                     | 7.7     | 77      | 1             | -13.5 |                            | -13.5           | -13.5    | mAdc                  |       |      |      |                  | .,   | a 1 1             |                   | . 8 4     | 5,6,7,8     | 8 4         |     |     |                   | 1,2,9,10,13,14           |
| Write Inputs   |                | +-            | -      | 10                  | 1 m m   | -       |               | -1.66 | 1.1                        |                 |          |                       |       |      | 1    | 1:1              |  | 50                |                   | 9 61      | 100         | -           | , , | 4 4 | 1.1               | 1,2,3,5,6,7,8,10,13,14   |
| Leakage Current<br>Address Lines                     | <sup>1</sup> E | <b>6</b> 10   | 4.4    | 1.1                 | 4.4     | 4.4     | 44            | 4.0   | 00                         | 4.0             | 4.0      | mAdc                  |       |      |      | 4.1              |  | - 31-31           | 1.7               |           | 6 0         |             | 11  | 4.4 |                   | 1,2,5,6,7,8,9,10,13,14   |
| Write Inputs   |                | 9 21          | 0.0    |                     | 0.1     | 0.1     |               | 0.1   | 0.0                        | 0.1             | 0.1      | mAdc                  |       | -11  | 11   | 11               |  | . ;               | 1.1.              |           | 13          |             |     | 4 4 |                   | 1,2,3,5,6,7,8,10,13,14   |
| Breakdown Voltage<br>Address Lines                   | BVin           | w 10          | 5.5    | 5.5                 | 11      | 5.5     | 5.5           | ģ.ii  | 5.5                        | 6.6             |          | Vdc                   | 1,000 |      |      | m 10             |  |                   |                   |           |             | 1 !         |     | 44  | . ,               | 1,2,5,6,7,8,9,10,13,14   |
| Write Inputs   |                | 9 81          | 5.5    |                     |         | 5.5     | 5.5           |       |                            | 5.5             | 10.10    | Vdc                   |       |      | 9 13 |                  |  |                   |                   |           | 1           |             |     | 44  |                   | 1,2,3,5,6,7,8,10,13,14   |
| Output (Note 1) Output Voltage Write "1"             |                | ,             |        |                     |         |         |               |       | ,                          |                 |          | - 1                   |       |      | 1    |                  |  |                   | o                 |           |             | e.<br>e.    |     | 4   |                   | 10187961                 |
| le/  | Vout "0"       | 12            | - 0.45 |                     | 0.45    | - 0.45  | 12            | 0.45  | 0.                         | 0.45 -          | 0.45     | Vdc                   |       | 12   |      |                  |  |                   |                   |           | -           | 3,5         | ,   | 4   | '                 | 1,2,6,7,8,9,10,13,14     |
|  | :              | 1             | 1      | 1                   |         | 1       |               |       |                            |                 |          |                       |       |      |      |                  | 3,5  |                   | ,                 | 13        | 6           |             |     | 4   |                   | 1,2,6,7,8,10,14          |
|  | Vout "0"       | 12            | - 0.45 |                     | 0.45    | - 0.45  | 42            | 0.45  | - 0.                       | 0.45            | 0.45     | Vdc                   |       | 12   |      | •                | 1  |                   | i                 | ,         | - /         | 3,5         | ,   | 4   |                   | 1,2,6,7,8,9,10,13,14     |
| Write "0"  | :              |               | 1      |                     |         | 1       |               | •     |                            | -               |          | -                     | -     |      | •    | ,                |  | L                 | 13                | -         | 1           | 3,5,9       | -   | 4   | •                 | 1,2,6,7,8,10,14          |
|  | Vout "0"       | 11            | - 0.45 | 1                   | 0.45    | - 0.45  |               | 0.45  | 0.                         | 0.45 -          | 0.45     | Vdc                   |       |      | -    | •                | ř  |                   | •                 | '         | -           | 3, 5        |     | 4   | -                 | 1,2,6,7,8,9,10,13,14     |
| Write "1" Inhibit                                    | :              | -             | - t    | -                   | ,       | '       |               | ,     |                            | ,               | ٠,       |                       |       |      | . ,  | •                | 3,5  |                   |                   | 6         | 13          | '           | •   | 4   |                   | 1,2,6,7,8,10,14          |
| Logic "0" Level                                      | Vout "0"       | 11            | - 0.45 |                     | 0.45    | - 0.45  | - 12          | 0.45  | - 0                        | 0.45 -          | 0.45     | Vdc                   |       | 11   |      |                  | -  |                   | 1                 | ,         | 1           | 3,5         | •   | 4   | •                 | 1,2,6,7,8,9,10,13,14     |
| Write "1"  | :              |               | 1      |                     |         | - '     |               |       |                            | -               |          | _                     |       | -    | -    |                  | 1  | -                 | 6                 |           |             | 3,5,13      | -   | 4   |                   | 1,2,6,7,8,10,14          |
| _  | Vout "0"       | 12            | - 0.45 |                     | 0.42    | - 0.45  | 45 -          | 0.45  | 0 -                        | 0.45            | 0.45     | Vdc                   |       | 12   |      | -                |  |                   | -                 | 1         | -           | 3,5         | -   | 4   |                   | 1,2,6,7,8,9,10,13,14     |
| Leakage Current<br>Write "1"                         | 1              |               |        |                     |         | -       | 9 1           | -1    |                            |                 |          | . 1                   |       |      |      |                  |  |                   | 6                 |           | -           | 3,5,13      | _   | 4   |                   | 1,2,6,7,8,10,14          |
| Leakage Current                                      | POLK           | 12            | - 0.25 |                     | 0.25    | - 0.25  | - 52          | 0.25  | - 0                        | 0.25            | 0.25     | mAdc                  |       |      |      |                  |  | 3,5               |                   | •         | 4           |             | 12  | 4   |                   | 1,2,6,7,8,9,10,13,14     |
| Write "0"  | **             |               |        |                     |         | 7       | •             |       |                            |                 | . ,      |                       |       | ,    |      | '                |  | •                 | 13                | •         | -           | 3,5,9       | •   | 4   |                   | 1,2,6,7,8,10,14          |
| Leakage Current                                      | POLK           | 11            | - 0.25 | -                   | 0.25    | - 0.25  | - 52          | 0.25  | - 0.                       | 0.25 -          | 0.25     | mAdc                  |       |      |      | ,                |  | 3,5               |                   |           | •           |             | 11  | 4   |                   | 1,2,6,7,9,10,13,14       |
| Write "1"  | :              |               | '      | -                   |         |         |               |       | -                          | 1               |          | r                     |       | -    |      |                  | -  |                   |                   |           | 13          | 3,5,6,7,8   | - 8 | 4   |                   | 1,2,9,10,14              |
| Leakage Current                                      | LOLK           | 11            | - 0.25 | 1                   | 0.25    | - 0.25  | - 52          | 0.25  | - 0.                       | 0.25 -          | 0.25     | mAdc                  |       |      |      | 1                | •  | ,                 | 1                 | 1         |             | 3,5,6,7,8   | 111 | 4   | -                 | 1,2,9,10,13,14           |
| Write "0"  | :              |               |        | 1                   | -       |         |               | ,     | 1                          |                 |          |                       |       |      |      | '                |  |                   | '                 |           | 6           | 3,5,6,7,8   | ,   | 4   |                   | 1,2,10,13,14             |
| Leakage Current                                      | POLK           | 12            | - 0.25 |                     | 0.25    | - 0.25  | - 52          | 0.25  | - 0                        | 0.25            | 0.25     | mAdc                  |       |      |      |                  | ,  | •                 |                   |           |             | 3,5,6,7,8   | . 8 | 4   | -                 | 1,2,9,10,13,14           |
| Power Requirements (Total Device) Power Supply Drain | IPD            | 4             | - 65   |                     | 65      | - 65    | 9             | 72    |                            | 72              | 72       | mAdc                  |       |      |      |                  |  |                   | '                 |           |             |             | '   | 4   | '                 | 1,2,3,5,6,7,8,9,10,13,14 |
|  | 1              |               | 1      | -                   | -       | 1       | 1             | 1     | 1                          | 1               | 1        | 1                     | 1     | -    | -    |                  |  |                   |                   |           | -           | -           | -   | -   |                   |                          |

Pprime Fan-Cut.
Note 1. Output logic '00" voltage and leakage current measurements are made as part of a functional test of a memory.
Procedures identified by a double asterisk', year percondinouing procedures for the subsequent test. All power supply and note Voltages must be maintained between tests.



### **VOLTAGE WAVEFORMS AND DEFINITIONS**



### SWITCHING TIME TEST PROCEDURES

(Letters shown in test columns refer to waveforms)

|  |                   | Pin           |                     |                     |                     |                      | -                   | nput P              | in                  |                     |       |            | Out        | tput     |          | Li                 | mits               |
|--|-------------------|---------------|---------------------|---------------------|---------------------|----------------------|---------------------|---------------------|---------------------|---------------------|-------|------------|------------|----------|----------|--------------------|--------------------|
| Test   | Symbol            | Under<br>Test | 3<br>X <sub>1</sub> | 2<br>X <sub>2</sub> | 1<br>X <sub>3</sub> | 14<br>X <sub>4</sub> | 5<br>Y <sub>1</sub> | 6<br>Y <sub>2</sub> | 7<br>Y <sub>3</sub> | 8<br>Y <sub>4</sub> | M0    | 13<br>W"1" | 11<br>S"0" |          |          | MC4304-5<br>ns max | MC4004-5<br>ns max |
| Turn-Off Delay Time  |                   | _             | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V                | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V               | Gnd   | 3.0 V      | _          | _        | _        |                    | · · ·              |
| (Address Lines to  |                   | -             | 3.0 V               | Gnd                 | Gnd                 | Gnd                  | 3.0 V               | Gnd                 | Gnd                 | Gnd                 | 3.0 V | Gnd        | -          | -        | _        |                    |                    |
| Sense "0" Output)  | tpd+              | 11            | Α                   | Gnd                 | Gnd                 | Gnd                  | A                   | Gnd                 | Gnd                 | Gnd                 | Gnd   | Gnd        | В          | -        | 30       | 23                 | 23                 |
|  | tpd+              | 11            | A                   | Gnd                 | Gnd                 | Gnd                  | A                   | Gnd                 | Gnd                 | Gnd                 | Gnd   | Gnd        | В          | _        | 200      | 35                 | 35                 |
| Turn-Off Delay Time  |                   |               | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V                | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V | Gnd        | -          | -        | _        |                    | _                  |
| (Address Lines to  | •••               | -             | 3.0 ∨               | Gnd                 | Gnd                 | Gnd                  | 3.0 V               | Gnd                 | Gnd                 | Gnd                 | Gnd   | 3.0 V      | _          | <u> </u> | -        | -                  | _                  |
| Sense "1" Output)  | tpd+              | 12            | Α                   | Gnd                 | Gnd                 | Gnd                  | Α                   | Gnd                 | Gnd                 | Gnd                 | Gnd   | Gnd        | -          | В        | 30       | 23                 | 23                 |
|  | t <sub>pd+</sub>  | 12            | A                   | Gnd                 | Gnd                 | Gnd                  | Α                   | Gnd                 | Gnd                 | Gnd                 | Gnd   | Gnd        | -          | В        | 200      | 35                 | 35                 |
| Turn-On Delay Time   |                   | _             | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V                | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V               | Gnd   | 3.0 V      | _          | Ξ        | <u> </u> | 1                  | -                  |
| (Address Lines to  | •••               |               | 3.0 V               | Gnd                 | Gnd                 | Gnd                  | 3.0 V               | Gnd                 | Gnd                 | Gnd                 | 3.0 V | Gnd        | _          | ~        | _        | 1                  | -                  |
| Sense "0" Output)  | tpd-              | 11            | A                   | Gnd                 | Gnd                 | Gnd                  | Α                   | Gnd                 | Gnd                 | Gnd                 | Gnd   | Gnd        | В          | -        | 30       | 23                 | 23                 |
|  | tpd-              | 11            | A                   | Gnd                 | Gnd                 | Gnd                  | Α                   | Gnd                 | Gnd                 | Gnd                 | Gnd   | Gnd        | В          | -        | 200      | 35                 | 35                 |
| Turn-On Delay Time   | ••                | -             | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V                | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V | Gnd        | _          | -        | _        | _                  |                    |
| (Address Lines to  | •••               | _             | 3.0 V               | Gnd                 | Gnd                 | Gnd                  | 3.0 V               | Gnd                 | Gnd                 | Gnd                 | Gnd   | 3.0 V      | _          | -        | _        |                    | _                  |
| Sense "1" Output)  | t <sub>pd</sub> - | 12            | A                   | Gnd                 | Gnd                 | Gnd                  | Α                   | Gnd                 | Gnd                 | Gnd                 | Gnd   | Gnd        | _          | В        | 30       | 23                 | 23                 |
|  | tpd-              | 12            | A                   | Gnd                 | Gnd                 | Gnd                  | A                   | Gnd                 | Gnd                 | Gnd                 | Gnd   | Gnd        | _          | В        | 200      | 35                 | 35                 |
| Turn-Off Delay Time  |                   | _=_           | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V                | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V               | Gnd   | 3.0 V      | _          | -        | <u> </u> |                    | _                  |
| (4 Bits) (Address Lines  | •••               |               | 3.0 V               | Gnd                 | Gnd                 | Gnd                  | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V | Gnd        | _          | <b>-</b> |          |                    | _                  |
| to Sense "O" Output)   | t <sub>pd+</sub>  | 11            | A                   | Gnd                 | Gnd                 | Gnd                  | A                   | Α                   | Α                   | Α                   | Gnd   | Gnd        | В          | _        | 30       | 35                 | 35                 |
| Turn-Off Delay Time<br>(4 Bits) (Address Lines<br>to Sense "1" Output) | •••               | -             | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V                | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V | Gnd        | _          | _        | -        |                    |                    |
|  | •••               |               | 3.0 V               | Gnd                 | Gnd                 | Gnd                  | 3.0 V               | 3.0 V               | 3.0 V               | 3.0 V               | Gnd   | 3.0 V      | -          | -        | -        | -                  | 1                  |
|  | t <sub>pd+</sub>  | 12            | A                   | Gnd                 | Gnd                 | Gnd                  | A                   | A                   | Α                   | A                   | Gnd   | Gnd        | -          | В        | 30       | 35                 | 35                 |
| Write Recovery Time  | twr.              | 12            | 3.0 V               | Gnd                 | Gnd                 | Gnd                  | 3.0 V               | Gnd                 | Gnd                 | Gnd                 | E     | c          | -          | Б        | 30       | 40                 | 40                 |
|  | "                 | 11            | 3.0 V               | Gnd                 | Gnd                 | Gnd                  | 3.0 V               | Gnd                 | Gnd                 | Gnd                 | E     | С          | F          | -        | 30       | 40                 | 40                 |
|  |                   |               |                     |                     |                     |                      |                     |                     |                     |                     |       | _          |            |          |          | ns min             | ns min             |
| Write Pulse Width  | twp               | -             |                     |                     |                     |                      | Tes                 | ted du              | ring t <sub>v</sub> | vr test:            | i.    |            |            |          |          | 25                 | 25                 |

<sup>\*</sup>Capacitance value for load of the Switching Time Test Circuit

<sup>\*\*</sup>Preconditioning procedures for subsequent test.