# 4-DIGIT COUNTERS WITH MULTIPLEXED 7-SEGMENT OUTPUT DRIVERS

## GENERAL DESCRIPTION

Theese CMOS counters consist of a 4-counter, an internal output latch, NPN output sourcing drivers for a 7-segment display and an internal multiplexing circuitry with four multiplexing outputs. The multiplexing circuit has its own free-running oscillator and requires no external clock. The counters advance on negative edge of clock. A high signal on the Reset input will reset the counter to zero and reset the carry-out low. A low signal on the Latch Enable input will latch the number in the counters into the internal output latches. A high signal on Display Select input will select the number in the counter to be displayed; a low level signal on the Display Select will select the number in the output latch to be displayed.
The MMC 22925 is a 4-decade counter and has Latch Enable, Clock and Reset inputs (16 pins package).
The MMC 22926 is like the MMC 22925 except that it has a Display Select and a Carry-Out used for cascading counters.
The Carry-Out signal goes high at 6000 and goes back low at 0000.
The MMC 22927 is like the MMC 22926 except that the secound most significant digit divides by 6 rather than 10. Thus, if the clock input frequency is 10 Hz, the display would read tenths of seconds and minutes (i.e., 9:59:9).
The MMC 22928 is like the MMC 22926 except that the most significant digit divides by 2 rather than 10 and the Carry Out is an overflow indicator which goes high at 2000, and goes back low only when the counter is reset. Thus, this is a 3 1/2-digit counter.

## FEATURES

- Supply voltage range 3 V to 6 V
- Internal multiplexing circuitry
- High segment sourcing current: 40 mA at $V_{OUT} = V_{DD} - 1.6$ V, $V_{DD} = 5$ V
- Guaranteed noise margin 1 V

## ABSOLUTE MAXIMUM RATINGS

| | | | | | |
|---|---|---|---|---|---|
| $V_{DD}$* | Supply voltage | −0.3 | to | 6.5 | V |
| $V_I$ | Input voltage | −0.3 | to | $V_{DD}$+0.3 | V |
| $I_I$ | DC input current (any one input) | | | ±10 | mA |
| $P_{tot}$ | Total power dissipation | Refer to $P_{D(MAX)}$ | | vs $T_A$ | Graph |
| $T_A$ | Operating temperature | 0 | to | 70 | C |
| Tstg | Storae temperature | −40 | to | 125 | C |

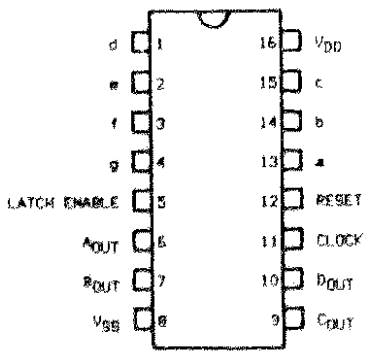
## RECOMMENDED OPERATING CONDITIONS

| | | | | | |
|---|---|---|---|---|---|
| $V_{DD}$* | Supply voltage | 3 | to | 6 | V |
| $V_I$ | Input voltage | 0 | to | $V_{DD}$ | V |
| $T_A$ | Operating temperature | 0 | to | 70 | C |

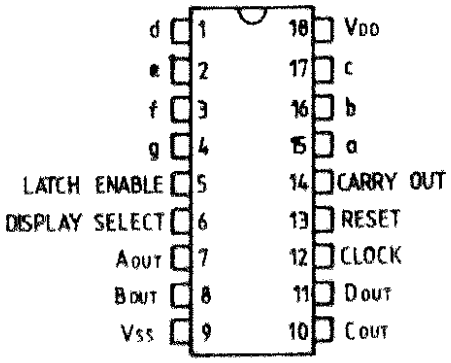
* All voltage volues are referred to $V_{SS}$ pin voltage

## CONNECTION DIAGRAM - MMC 22925

### MMC 22925




### MMC 22925/6/7/8

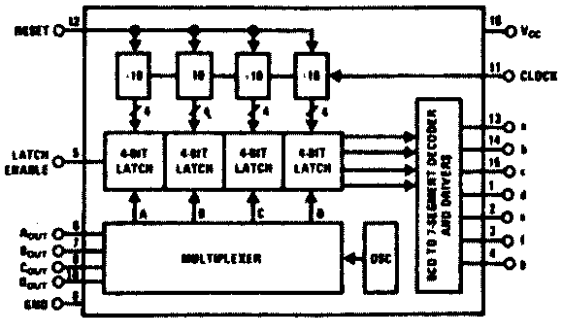


## FUNCTIONAL DESCRIPTION

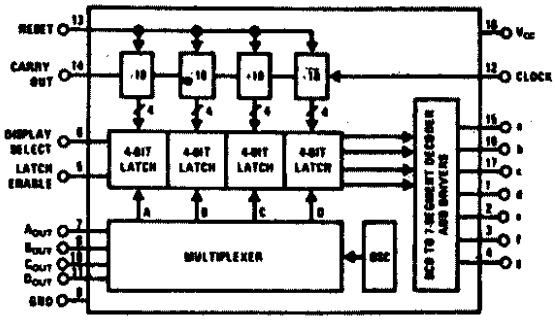
| | |
|---|---|
| Reset | — Asynchronous, active high |
| Display Select | — High, displays output of counter<br>— Low, displays output of latch |
| Latch Enable | — High, flow through condition<br>— Low, latch condition |
| Clock | — Negative edge sensitive |
| Digit Output | — Current sourcing with 1 mA $V_{OUT}$ = 1.75 V. Also sink capability = 2 LTTL loads |
| Carry-out | — 2 LTTL loads (see caryy-out waveforms) |
| Segment Output | — Current sourcing with 80 mA $V_{OUT} = V_{DD} - 1.6$ V typical ($T_j$ = = 25 C). Also sink capability = 2 LTTL loads. |

## BLOCK DIAGRAM

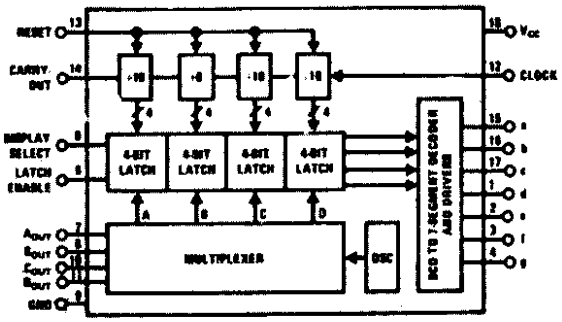
### MMC 22925



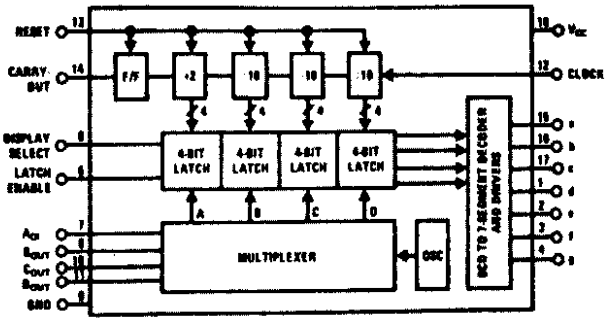

### MMC 22926




### MMC 22927




### MMC 22928




## STATIC ELECTRICAL CHARACTERISTICS

(over recommended operating conditions)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **CMOS TO CMOS INTERFACE** | | | | | | |
| $V_{IN}$ (1) | Logical "1" Input Voltage | $V_{CC}$ = 5.0V | 3.5 | | | V |
| $V_{IN}$ (0) | Logical "0" Input Voltage | $V_{CC}$ = 5.0V | | | 1.5 | V |
| $V_{OUT}$ (1) | Logical "1" Output Voltage (Carry-Out and Digit Output Only) | $V_{CC}$ = 5.0V, $I_O$ = −10μA | 4.5 | | | V |
| $V_{OUT}$ (0) | Logical "0" Output Voltage | $V_{CC}$ = 5.0V, $I_O$ = 10 μA | | | 0.5 | V |
| $I_{IN}$ (1) | Logical "1" Input Current | $V_{CC}$ = 5.0V, $V_{IN}$ = 5V | | 0.005 | 1.0 | μA |
| $I_{IN}$ (0) | Logical "0" Input Current | $V_{CC}$ = 5.0V, $V_{IN}$ = 0V | −1.0 | −0.005 | | μA |
| $I_{CC}$ | Supply Current | $V_{CC}$ = 5.0V, Outputs Open Circuit, $V_{IN}$ = 0V or 5 V | | 20 | 1000 | μA |

| | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **OUTPUT DRIVE** | | | | | | |
| $V_{OUT}$ | Output Voltage (Segment Sourcing Output) | $I_{OUT}$ = −65mA, $V_{CC}$ = 5V, $T_j$ = 25°C | | $V_{CC}$−1.3 | | V |
| | | $I_{OUT}$ = −40mA, $V_{CC}$ = 5V; $T_j$=100°C | | $V_{CC}$−1.6 | | V |
| | | $I_{OUT}$ = −40mA, $V_{CC}$ = 5V; $T_j$=150°C | | $V_{CC}$−2 | | V |
| $R_{ON}$ | Output Resistance (Segment Sourcing Output) | $I_{OUT}$ = −65mA, $V_{CC}$ = 5V, $T_j$ = 25°C | | 20 | | Ω |
| | | $I_{OUT}$ = −40mA, $V_{CC}$ = 5V; $T_j$=100°C | | 30 | 40 | Ω |
| | | $I_{OUT}$ = −40mA, $V_{CC}$ = 5V; $T_j$=150°C | | 35 | 50 | Ω |
| | Output Resistance (Segment Output) Temperature Coeficient | | | 0.6 | 0.8 | %/°C |
| $I_{SOURCE}$ | Output Source Current (Digit Output) | $V_{CC}$ = 4.75V, $V_{OUT}$ = 1.75V, $T_j$ = 150°C | −1 | −2 | | mA |
| $I_{SOURCE}$ | Output Source Current (Carry-out) | $V_{CC}$ = 5V, $V_{OUT}$ = 0V, $T_j$ = 25°C | −1.75 | −3.3 | | mA |
| $I_{SINK}$ | Output Sink Current (All Outputs) | $V_{CC}$ = 5V, $V_{OUT}$ = $V_{CC}$, $T_j$ = 25°C | 1.75 | 3.6 | | mA |
| $\phi_{JA}$※ | Thermal Resistance | MMC 22925 | | 75 | 100 | °C/W |
| | | MMC 22926/7/8 | | 70 | 90 | °C/W |

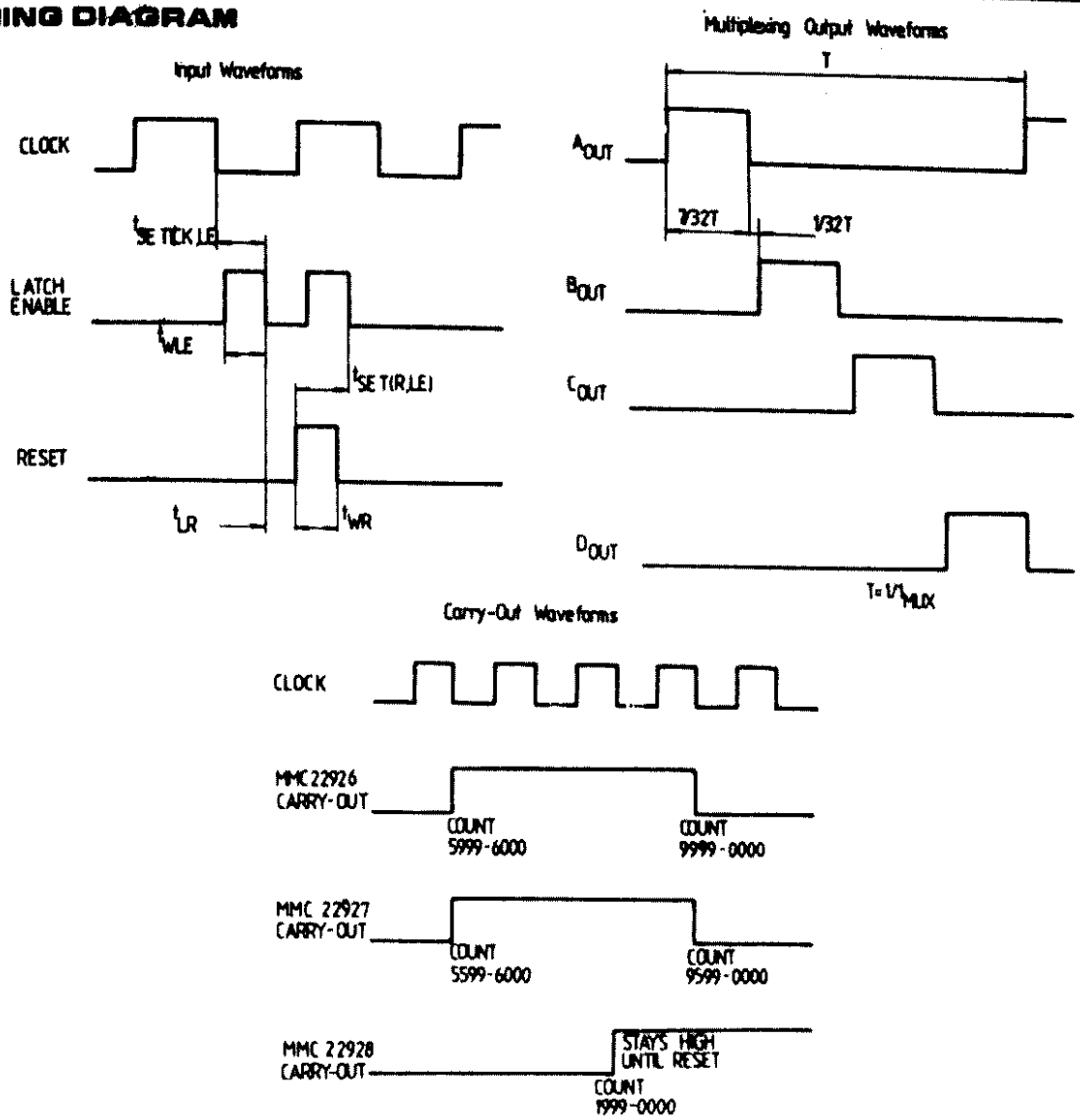
※ $\phi_{JA}$ measured in free-air with device soldered into printed circuit board

## DYNAMIC ELECTRICAL CHARACTERISTICS

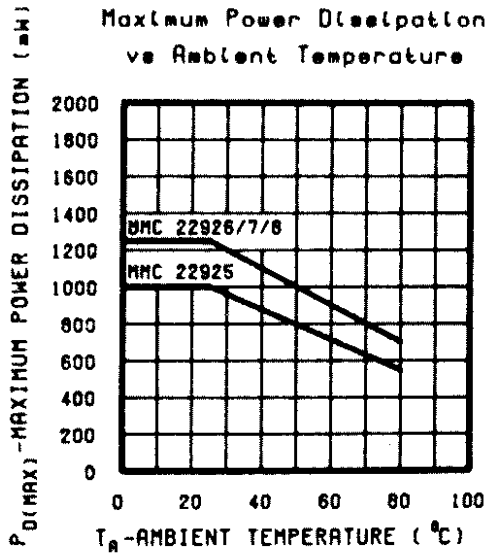
$T_j$ = 25°C, $C_L$ = 50 pF, unless otherwise specified

| | PARAMETER | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $f_{MAX}$ | Maximum Clock Frequency | $V_{CC}$ = 5.0V Square Wave Clock | $T_j$ = 25°C | 2 | 4 | | MHz |
| | | | $T_j$ = 100°C | 1.5 | 3 | | MHz |
| $t_r$, $t_f$ | Maximum Clock Rise or Fall Time | $V_{CC}$ = 5.0V | | | | 15 | µs |
| $t_{WR}$ | Reset Pulse Width | $V_{CC}$ = 5.0V | $T_j$ = 25°C | 250 | 10 | | ns |
| | | | $T_j$ = 100°C | 320 | 125 | | ns |
| $t_{WLE}$ | Latch Enable Pulse Width | $V_{CC}$ = 5.0V | $T_j$ = 25°C | 250 | 100 | | ns |
| | | | $T_j$ = 100°C | 320 | 125 | | ns |
| $t_{SETICK,LE}$ | Clock Latch Enable Set-Up Time | $V_{CC}$ = 5.0V | $T_j$ = 25°C | 2500 | 1250 | | ns |
| | | | $T_j$ = 100°C | 3200 | 1600 | | ns |
| $t_{LR}$ | Latch Enable to Reset Wait Time | $V_{CC}$ = 5.0V | $T_j$ = 25°C | 0 | −100 | | ns |
| | | | $T_j$ = 100°C | 0 | −100 | | ns |
| $t_{SETIR,LE}$ | Reset to Latch Enable Set-Up Time | $V_{CC}$ = 5.0V | $T_j$ = 25°C | 320 | 160 | | ns |
| | | | $T_j$ = 100°C | 400 | 200 | | ns |
| $f_{MUX}$ | Multiplexing Output Frequency | $V_{CC}$ = 5.0V | | | 1000 | | Hz |
| $C_{IN}$ | Input Capacitance | Any Input | | | 5 | | pF |

## TIMING DIAGRAM




## TYPICAL PERFORMANCE CHARACTERISTICS



## TYPICAL APPLICATION