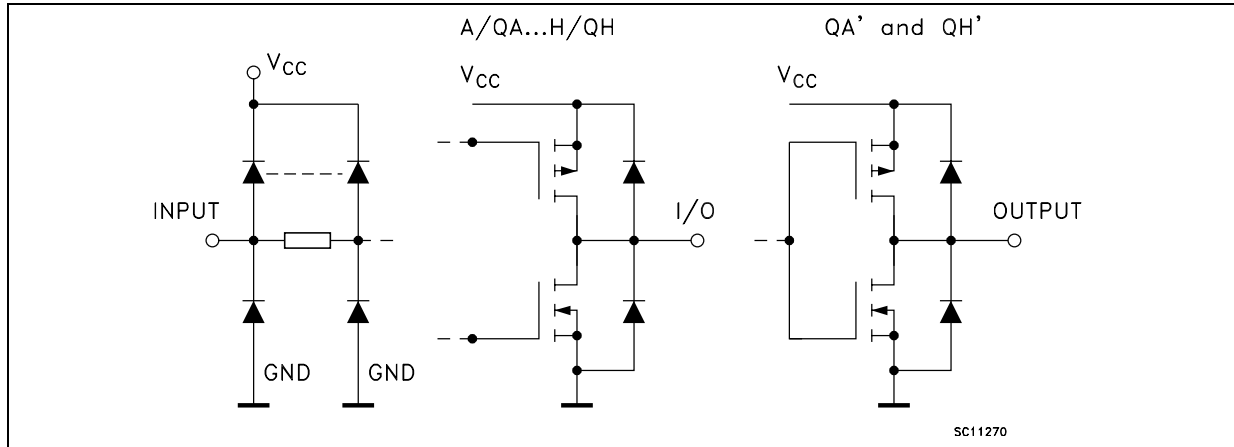


IINPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

| PIN No | SYMBOL | NAME AND FUNCTION |
|----------------------------|-----------------|---|
| 1, 19 | S0, S1 | Mode Select Inputs |
| 2, 3 | G1, G2 | 3-State Output Enable Inputs (Active LOW) |
| 7, 13, 6, 14, 5, 15, 4, 16 | A/QA to H/QH | Parallel Data Inputs or 3-State Parallel Outputs (Bus Driver) |
| 8, 17 | QA' to QH' | Serial Outputs (Standard Output) |
| 9 | CLEAR | Asynchronous Master Reset Input (Active LOW) |
| 11 | SR | Serial Data Shift Right Input |
| 12 | CLOCK | Clock Input (LOW to HIGH, Edge-triggered) |
| 18 | SL | Serial Data Shift Left Input |
| 10 | GND | Ground (0V) |
| 20 | V _{CC} | Positive Supply Voltage |

TRUTH TABLE

| MODE | INPUTS | | | | | CLOCK | INPUTS/OUTPUTS | | | OUTPUTS | | |
|-------------|--------|-------------------|----|----------------|-----|-------|----------------|----|------|---------|-----|-----|
| | CLEAR | FUNCTION SELECTED | | OUTPUT CONTROL | | | SERIAL | | A/QA | H/QH | QA' | QH' |
| | | S1 | S0 | G1* | G2* | | SL | SR | | | | |
| Z | L | H | H | X | X | X | X | X | Z | Z | L | L |
| CLEAR | L | L | X | L | L | X | X | X | L | L | L | L |
| | L | X | L | L | L | X | X | X | L | L | L | L |
| HOLD | H | L | L | L | L | X | X | X | QA0 | QH0 | QA0 | QH0 |
| SHIFT RIGHT | H | L | H | L | L | ┌ | X | H | H | QGn | H | QGn |
| | H | L | H | L | L | ┌ | X | L | L | QGn | L | QGn |
| SHIFT LEFT | H | H | L | L | L | ┌ | H | X | QBn | H | QBn | H |
| | H | H | L | L | L | ┌ | L | X | QBn | L | QBn | L |
| LOAD | H | H | H | X | X | ┌ | X | X | a | h | a | h |

* When one or both output controls are high, the eight input/output terminals are in the high impedance state: however sequential operation or clearing of the register is not affected.

Z : High Impedance

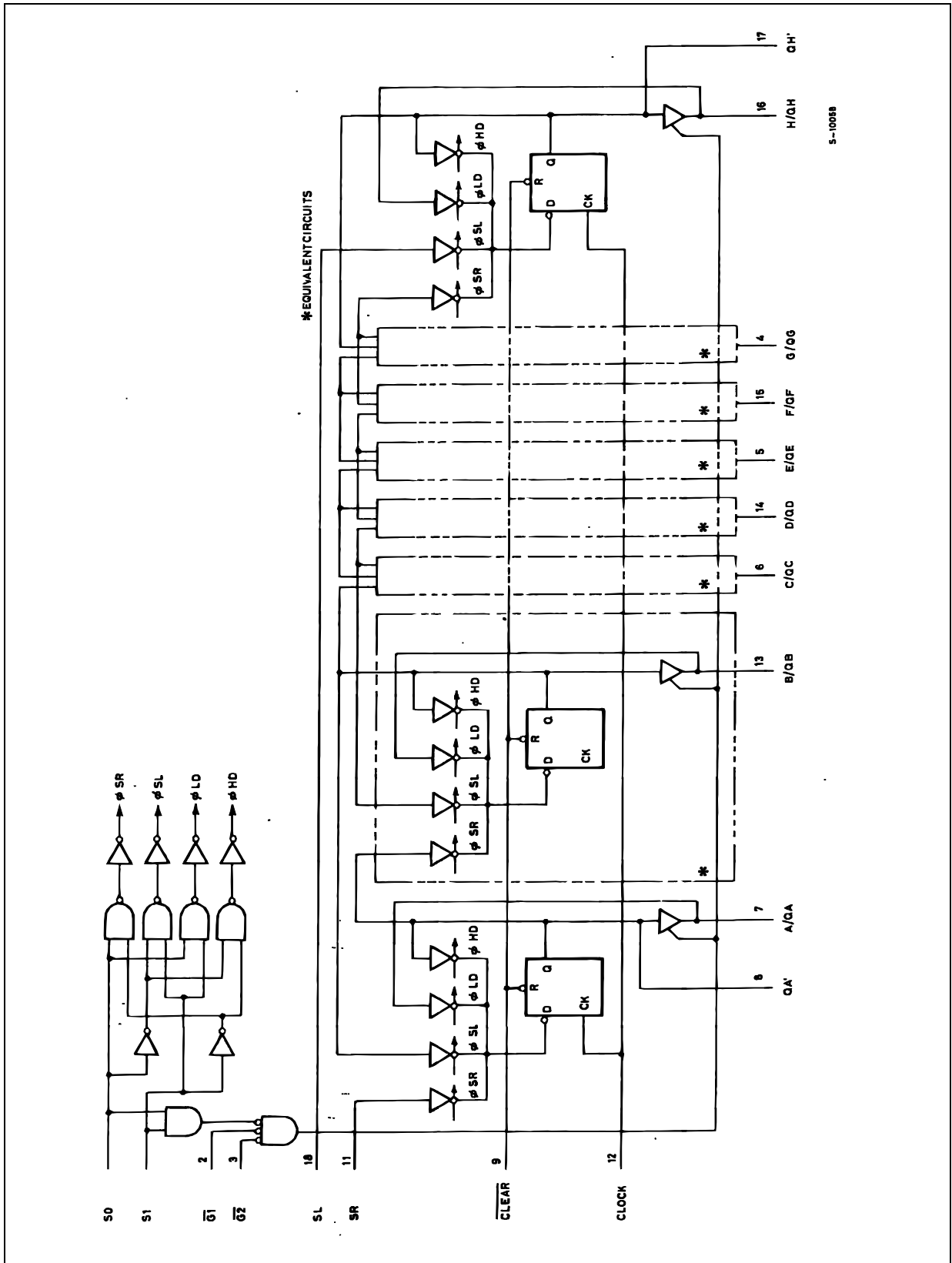
Qn0 : The level of An before the indicated steady state input conditions were established.

Qnn : The level of Qn before the most recent active transition indicated by \lrcorner OR \llcorner

a, h : The level of the steady state inputs A, H, respectively.

X : Don't Care

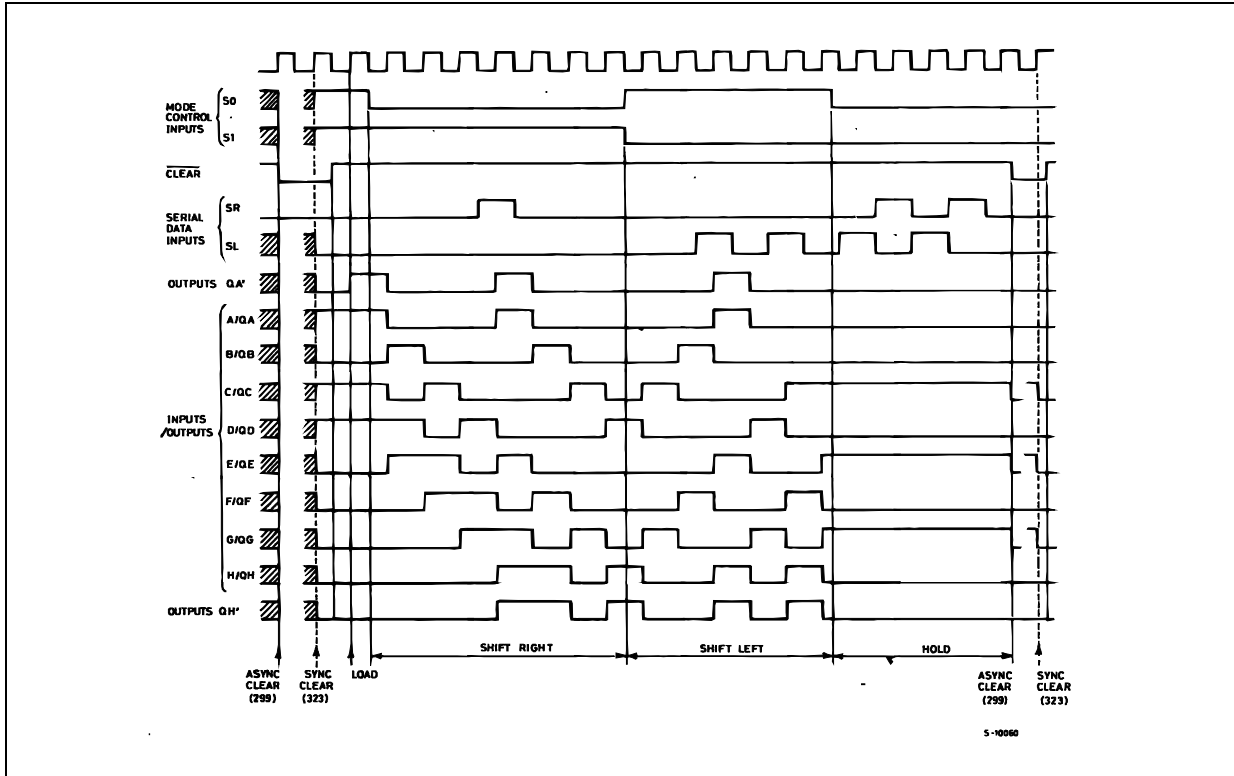
LOGIC DIAGRAM



5-10098



TIMING CHART



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|-----------------------|--|------------------------|-------------|
| V_{CC} | Supply Voltage | -0.5 to +7 | V |
| V_I | DC Input Voltage | -0.5 to $V_{CC} + 0.5$ | V |
| V_O | DC Output Voltage | -0.5 to $V_{CC} + 0.5$ | V |
| I_{IK} | DC Input Diode Current | ± 20 | mA |
| I_{OK} | DC Output Diode Current | ± 20 | mA |
| I_O | DC Output Source Sink Current Per Output Pin (QA-QH) | ± 35 | mA |
| I_O | DC Output Source Sink Current Per Output Pin (QA'-QH') | ± 235 | mA |
| I_{CC} or I_{GND} | DC V_{CC} or Ground Current | ± 70 | mA |
| P_D | Power Dissipation | 500(*) | mW |
| T_{stg} | Storage Temperature | -65 to +150 | $^{\circ}C$ |
| T_L | Lead Temperature (10 sec) | 300 | $^{\circ}C$ |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied

(*) 500mW at 65 $^{\circ}C$; derate to 300mW by 10mW/ $^{\circ}C$ from 65 $^{\circ}C$ to 85 $^{\circ}C$

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit | |
|------------|--------------------------|-----------------|-----------|----|
| V_{CC} | Supply Voltage | 2 to 6 | V | |
| V_I | Input Voltage | 0 to V_{CC} | V | |
| V_O | Output Voltage | 0 to V_{CC} | V | |
| T_{op} | Operating Temperature | -55 to 125 | °C | |
| t_r, t_f | Input Rise and Fall Time | $V_{CC} = 2.0V$ | 0 to 1000 | ns |
| | | $V_{CC} = 4.5V$ | 0 to 500 | ns |
| | | $V_{CC} = 6.0V$ | 0 to 400 | ns |

DC SPECIFICATIONS

| Symbol | Parameter | Test Condition | | Value | | | | | | Unit | |
|----------|---------------------------------------|-----------------|---|--------------------|------|-----------|-------------|---------|--------------|----------|---------|
| | | V_{CC} (V) | | $T_A = 25^\circ C$ | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. |
| V_{IH} | High Level Input Voltage | 2.0 | | 1.5 | | | 1.5 | | 1.5 | | V |
| | | 4.5 | | 3.15 | | | 3.15 | | 3.15 | | |
| | | 6.0 | | 4.2 | | | 4.2 | | 4.2 | | |
| V_{IL} | Low Level Input Voltage | 2.0 | | | | 0.5 | | 0.5 | | 0.5 | V |
| | | 4.5 | | | | 1.35 | | 1.35 | | 1.35 | |
| | | 6.0 | | | | 1.8 | | 1.8 | | 1.8 | |
| V_{OH} | High Level Output Voltage | 2.0 | $I_O = -20 \mu A$ | 1.9 | 2.0 | | 1.9 | | 1.9 | | V |
| | | 4.5 | $I_O = -20 \mu A$ | 4.4 | 4.5 | | 4.4 | | 4.4 | | |
| | | 6.0 | $I_O = -20 \mu A$ | 5.9 | 6.0 | | 5.9 | | 5.9 | | |
| | QA to QH | 4.5 | $I_O = -6.0 mA$ | 4.18 | 4.31 | | 4.13 | | 4.10 | | |
| | | 6.0 | $I_O = -7.8 mA$ | 5.68 | 5.8 | | 5.63 | | 5.60 | | |
| | QA' to QH' | 4.5 | $I_O = -4.0 mA$ | 4.18 | 4.31 | | 4.13 | | 4.10 | | |
| 6.0 | | $I_O = -5.2 mA$ | 5.68 | 5.8 | | 5.63 | | 5.60 | | | |
| V_{OL} | Low Level Output Voltage | 2.0 | $I_O = 20 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | 4.5 | $I_O = 20 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 6.0 | $I_O = 20 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | QA to QH | 4.5 | $I_O = 6.0 mA$ | | 0.17 | 0.26 | | 0.33 | | 0.40 | |
| | | 6.0 | $I_O = 7.8 mA$ | | 0.18 | 0.26 | | 0.33 | | 0.40 | |
| | QA' to QH' | 4.5 | $I_O = 4.0 mA$ | | 0.17 | 0.26 | | 0.33 | | 0.40 | |
| 6.0 | | $I_O = 5.2 mA$ | | 0.18 | 0.26 | | 0.33 | | 0.40 | | |
| I_I | Input Leakage Current | 6.0 | $V_I = V_{CC}$ or GND | | | ± 0.1 | | ± 1 | | ± 1 | μA |
| I_{OZ} | High Impedance Output Leakage Current | 6.0 | $V_I = V_{IH}$ or V_{IL} $V_O = V_{CC}$ or GND | | | ± 0.5 | | ± 5 | | ± 10 | μA |
| I_{CC} | Quiescent Supply Current | 6.0 | $V_I = V_{CC}$ or GND | | | 4 | | 40 | | 80 | μA |

AC ELECTRICAL CHARACTERISTICS (C_L = 50 pF, Input t_r = t_f = 6ns)

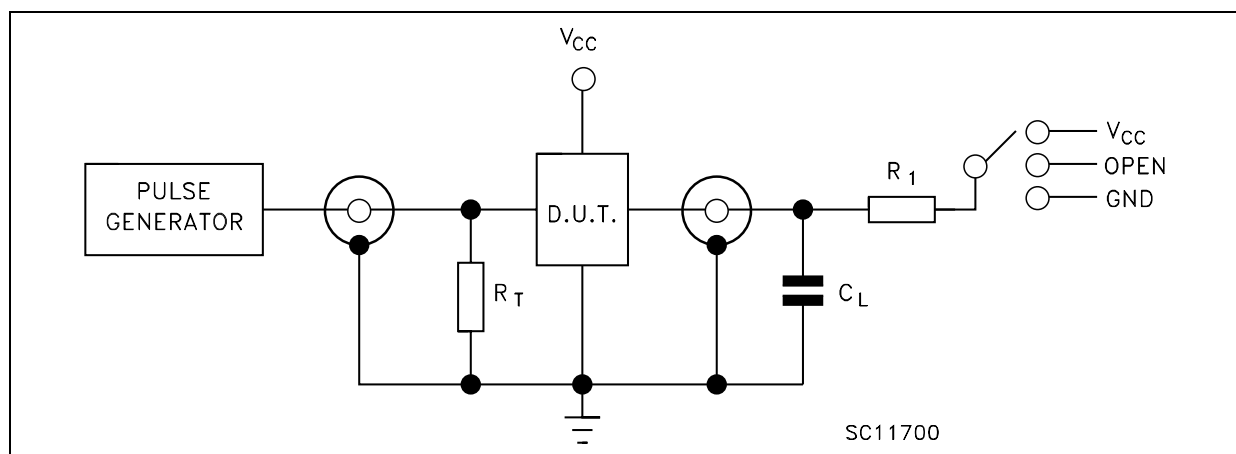
| Symbol | Parameter | Test Condition | | Value | | | | | | Unit | | |
|--|---|------------------------|-----|-----------------------|------|------|-------------|------|--------------|------|------|----|
| | | V _{CC} (V) | | T _A = 25°C | | | -40 to 85°C | | -55 to 125°C | | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. | |
| t _{TLH} t _{THL} | Output Transition Time (QA, QH) | 2.0 | 50 | | 25 | 60 | | 75 | | 90 | ns | |
| | | 4.5 | | | 7 | 12 | | 15 | | 18 | | |
| | | 6.0 | | | 6 | 10 | | 13 | | 15 | | |
| t _{TLH} t _{THL} | Output Transition Time (QA', QH') | 2.0 | 50 | | 30 | 75 | | 95 | | 110 | ns | |
| | | 4.5 | | | 8 | 15 | | 19 | | 22 | | |
| | | 6.0 | | | 7 | 13 | | 16 | | 19 | | |
| t _{PLH} t _{PHL} | Propagation Delay Time (CLOCK - QA', QH') | 2.0 | 50 | | 85 | 170 | | 215 | | 255 | ns | |
| | | 4.5 | | | 23 | 34 | | 43 | | 51 | | |
| | | 6.0 | | | 18 | 29 | | 37 | | 43 | | |
| t _{PHL} | Propagation Delay Time (CLEAR - QA', QH') | 2.0 | 50 | | 85 | 175 | | 220 | | 265 | ns | |
| | | 4.5 | | | 24 | 35 | | 44 | | 53 | | |
| | | 6.0 | | | 18 | 30 | | 37 | | 45 | | |
| t _{PLH} t _{PHL} | Propagation Delay Time (CLOCK - QA, QH) | 2.0 | 50 | | 80 | 160 | | 200 | | 240 | ns | |
| | | 4.5 | | | 21 | 32 | | 40 | | 48 | | |
| | | 6.0 | | | 17 | 27 | | 34 | | 41 | | |
| | | 2.0 | 150 | | 100 | 200 | | 250 | | 300 | ns | |
| | | 4.5 | | | 26 | 40 | | 50 | | 60 | | |
| | | 6.0 | | | 21 | 34 | | 43 | | 51 | | |
| t _{PZL} t _{PZH} | High Impedance Output Enable Time | 2.0 | 50 | R _L = 1 KΩ | | 60 | 130 | | 165 | | 195 | ns |
| | | 4.5 | | | | 17 | 26 | | 33 | | 39 | |
| | | 6.0 | | | | 13 | 22 | | 28 | | 33 | |
| | | 2.0 | 150 | R _L = 1 KΩ | | 78 | 170 | | 15 | | 255 | ns |
| | | 4.5 | | | | 23 | 34 | | 43 | | 51 | |
| | | 6.0 | | | | 17 | 29 | | 37 | | 43 | |
| t _{PZL} t _{PHZ} | High Impedance Output Disable Time | 2.0 | 50 | R _L = 1 KΩ | | 54 | 150 | | 190 | | 225 | ns |
| | | 4.5 | | | | 19 | 30 | | 38 | | 45 | |
| | | 6.0 | | | | 16 | 26 | | 32 | | 38 | |
| f _{MAX} | Maximum Clock Frequency | 2.0 | 50 | | 6 | 12 | | 4.8 | | 4 | MHz | |
| | | 4.5 | | | 30 | 58 | | 24 | | 20 | | |
| | | 6.0 | | | 35 | 80 | | 28 | | 24 | | |
| t _{W(L)} t _{W(H)} | Minimum Pulse Width (CLOCK) | 2.0 | 50 | | | 75 | | 95 | | 110 | ns | |
| | | 4.5 | | | | 15 | | 19 | | 22 | | |
| | | 6.0 | | | | 13 | | 16 | | 19 | | |
| t _{W(L)} | Minimum Pulse Width (CLEAR) | 2.0 | 50 | | | 75 | | 95 | | 110 | ns | |
| | | 4.5 | | | | 15 | | 19 | | 22 | | |
| | | 6.0 | | | | 13 | | 16 | | 19 | | |
| t _s | Minimum Set-up Time (S0, S1) (SL, SR, A, H) | 2.0 | 50 | | | 100 | | 125 | | 150 | ns | |
| | | 4.5 | | | | 20 | | 25 | | 30 | | |
| | | 6.0 | | | | 17 | | 21 | | 26 | | |
| t _h | Minimum Hold Time (S0, S1) (SL, SR, A, H) | 2.0 | 50 | | | 0 | | 0 | | 0 | ns | |
| | | 4.5 | | | | 0 | | 0 | | 0 | | |
| | | 6.0 | | | | 0 | | 0 | | 0 | | |
| t _{REM} | Minimum Removal Time (CLEAR) | 2.0 | 50 | | | 50 | | 65 | | 75 | ns | |
| | | 4.5 | | | | 10 | | 13 | | 15 | | |
| | | 6.0 | | | | 9 | | 11 | | 13 | | |

CAPACITIVE CHARACTERISTICS

| Symbol | Parameter | Test Condition | | Value | | | | | | Unit | |
|-----------------|--|------------------------|--|-----------------------|------|------|-------------|------|--------------|------|------|
| | | V _{CC} (V) | | T _A = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. |
| C _{IN} | Input Capacitance | 5.0 | | | 5 | 10 | | 10 | | 10 | pF |
| C _{PD} | Power Dissipation Capacitance (note 1) | 5.0 | | | 170 | | | | | | pF |

1) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(oper)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

TEST CIRCUIT



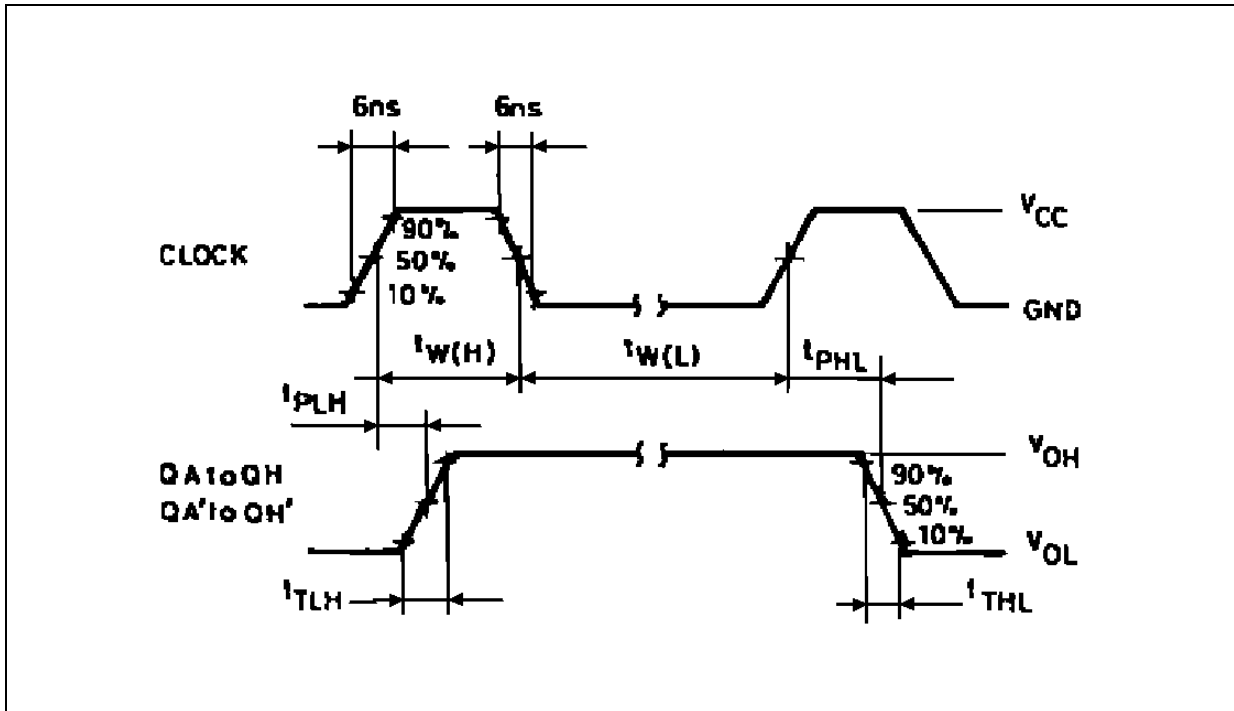
| TEST | SWITCH |
|-------------------------------------|-----------------|
| t _{PLH} , t _{PHL} | Open |
| t _{PZL} , t _{PLZ} | V _{CC} |
| t _{PZH} , t _{PHZ} | GND |

C_L = 50pF/150pF or equivalent (includes jig and probe capacitance)

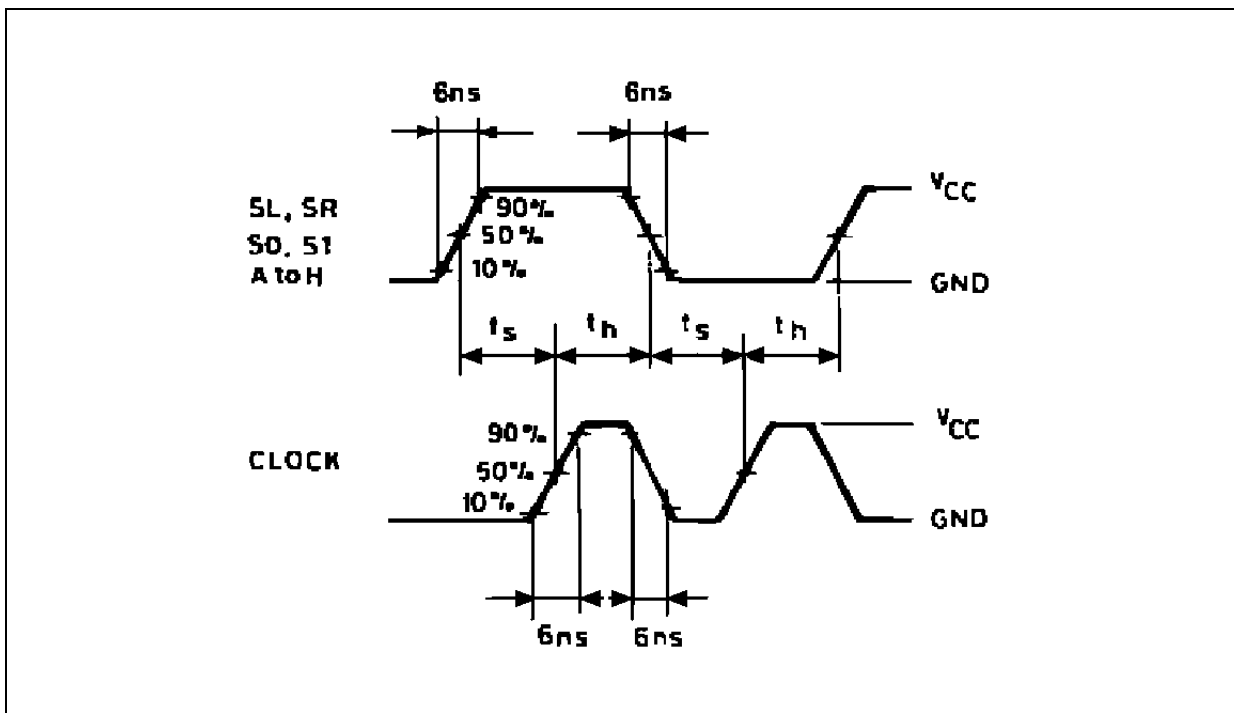
R₁ = 1KΩ or equivalent

R_T = Z_{OUT} of pulse generator (typically 50Ω)

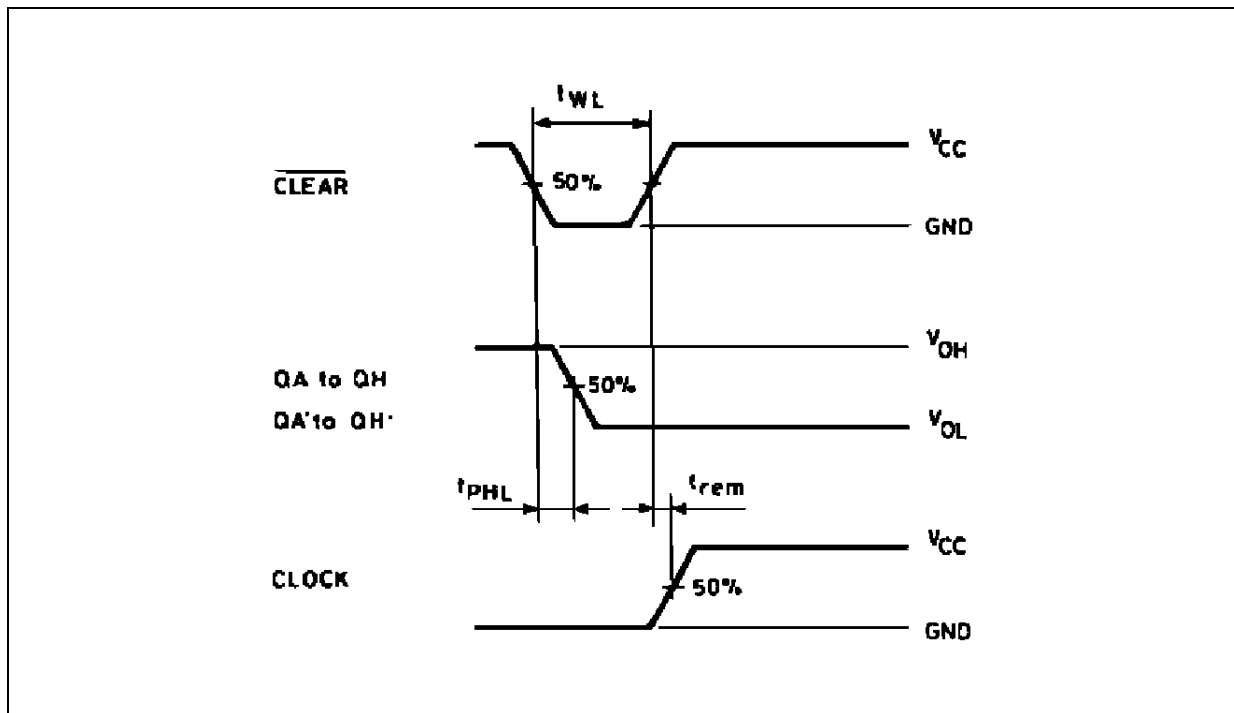
WAVEFORM 1: PROPAGATION DELAY TIMES, MINIMUM PULSE WIDTH ($f=1\text{MHz}$; 50% duty cycle)



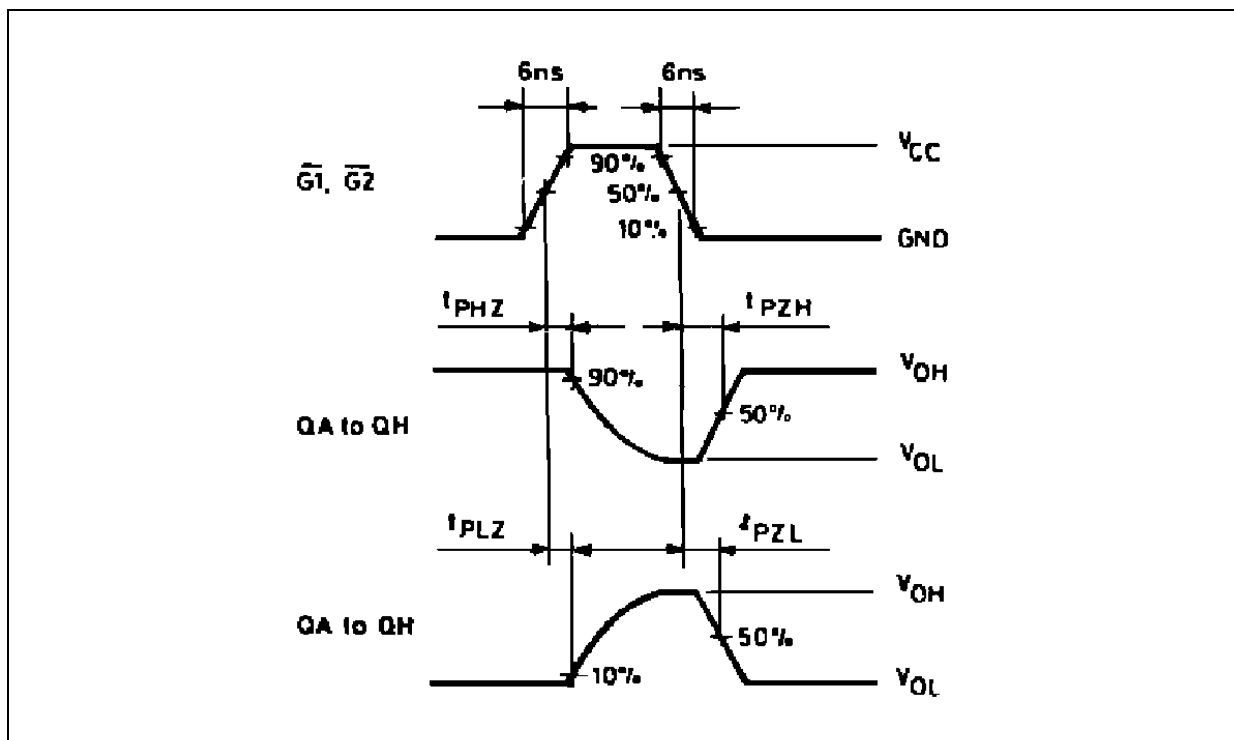
WAVEFORM 2 : SETUP AND HOLD TIMES ($f=1\text{MHz}$; 50% duty cycle)



WAVEFORM 3 :PROPAGATION DELAY AND REMOVAL TIME, MINIMUM PULSE WIDTH
 (f=1MHz; 50% duty cycle)

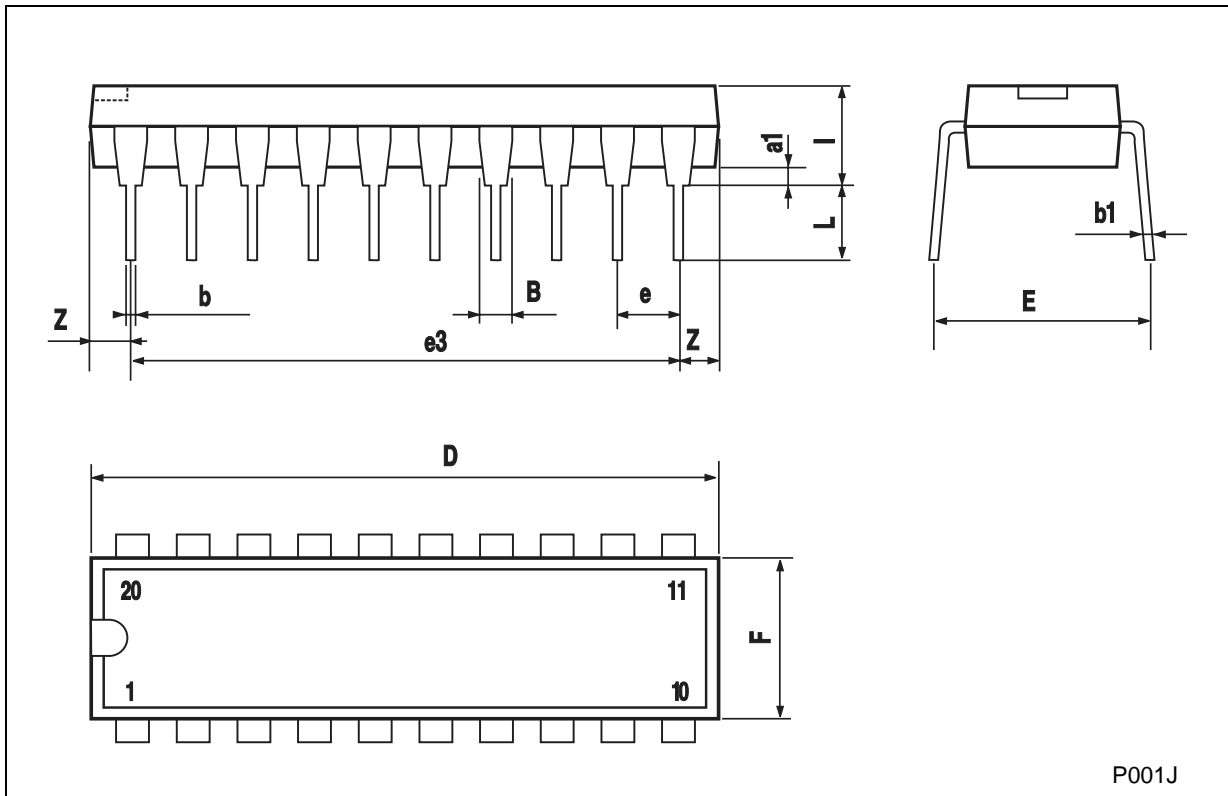


WAVEFORM 4: OUTPUT ENABLE AND DISABLE TIMES (f=1MHz; 50% duty cycle)



Plastic DIP-20 (0.25) MECHANICAL DATA

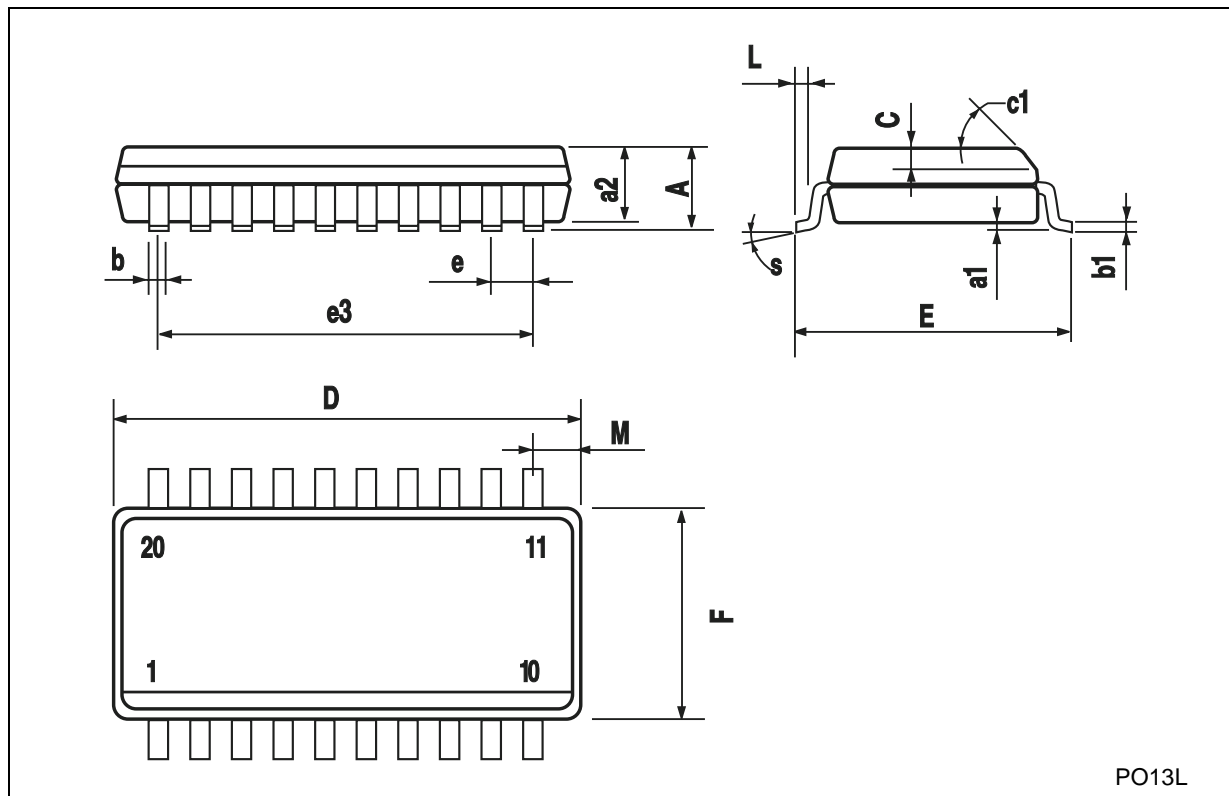
| DIM. | mm. | | | inch | | |
|------|-------|-------|------|-------|-------|-------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.254 | | | 0.010 | | |
| B | 1.39 | | 1.65 | 0.055 | | 0.065 |
| b | | 0.45 | | | 0.018 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 25.4 | | | 1.000 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 0.100 | |
| e3 | | 22.86 | | | 0.900 | |
| F | | | 7.1 | | | 0.280 |
| I | | | 3.93 | | | 0.155 |
| L | | 3.3 | | | 0.130 | |
| Z | | | 1.34 | | | 0.053 |



P001J

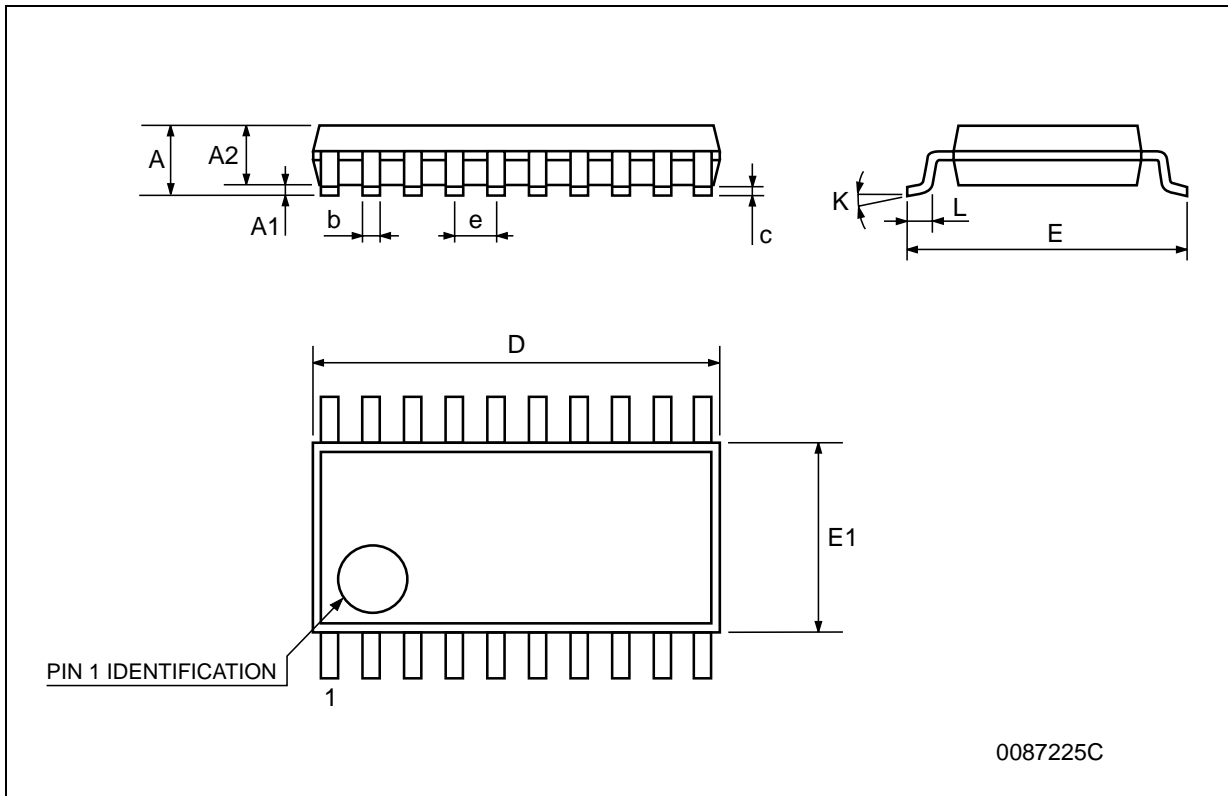
SO-20 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------------|-------|-------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 2.65 | | | 0.104 |
| a1 | 0.1 | | 0.2 | 0.004 | | 0.008 |
| a2 | | | 2.45 | | | 0.096 |
| b | 0.35 | | 0.49 | 0.014 | | 0.019 |
| b1 | 0.23 | | 0.32 | 0.009 | | 0.012 |
| C | | 0.5 | | | 0.020 | |
| c1 | 45° (typ.) | | | | | |
| D | 12.60 | | 13.00 | 0.496 | | 0.512 |
| E | 10.00 | | 10.65 | 0.393 | | 0.419 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 11.43 | | | 0.450 | |
| F | 7.40 | | 7.60 | 0.291 | | 0.300 |
| L | 0.50 | | 1.27 | 0.020 | | 0.050 |
| M | | | 0.75 | | | 0.029 |
| S | 8° (max.) | | | | | |



TSSOP20 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|----------|------|-------|------------|--------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0089 |
| D | 6.4 | 6.5 | 6.6 | 0.252 | 0.256 | 0.260 |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.48 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |



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