M74HC595
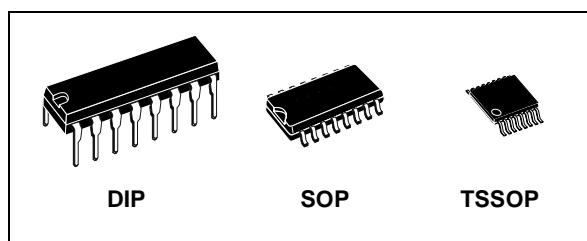
8 BIT SHIFT REGISTER
WITH OUTPUT LATCHES (3 STATE)

- **HIGH SPEED:**
  f_{MAX} = 59MHz (TYP.) at V_{CC} = 6V
- **LOW POWER DISSIPATION:**
  I_{CC} = 4μA(MAX.) at T_A=25°C
- **HIGH NOISE IMMUNITY:**
  V_{NIH} = V_{NIL} = 28% V_{CC} (MIN.)
- **SYMMETRICAL OUTPUT IMPEDANCE:**
  $|I_{OH}|$ = I_{OL} = 6mA (MIN.) FOR QA to QH
  $|I_{OH}|$ = I_{OL} = 4mA (MIN.) FOR QH'
- **BALANCED PROPAGATION DELAYS:**
  $t_{PLH} \cong t_{PHL}$
- **WIDE OPERATING VOLTAGE RANGE:**
  V_{CC} (OPR) = 2V to 6V
- **PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 595**

DIP   SOP   TSSOP

ORDER CODES

| PACKAGE	TUBE	T & R
DIP	M74HC595B1R	
SOP	M74HC595M1R	M74HC595RM13TR
TSSOP		M74HC595TTR

DESCRIPTION

The M74HC595 is an high speed CMOS 8-BIT SHIFT REGISTERS/OUTPUT LATCHES (3-STATE) fabricated with silicon gate C^2MOS technology.

This device contains an 8-bit serial-in, parallel-out shift register that feeds an 8-bit D-type storage register. The storage register has 8 3-STATE outputs. Separate clocks are provided for both the shift register and the storage register.

The shift register has a direct-overriding clear, serial input, and serial output (standard) pins for cascading. Both the shift register and storage register use positive-edge triggered clocks. If both clocks are connected together, the shift register state will always be one clock pulse ahead of the storage register.

All inputs are equipped with protection circuits against static discharge and transient excess voltage.

PIN CONNECTION AND IEC LOGIC SYMBOLS
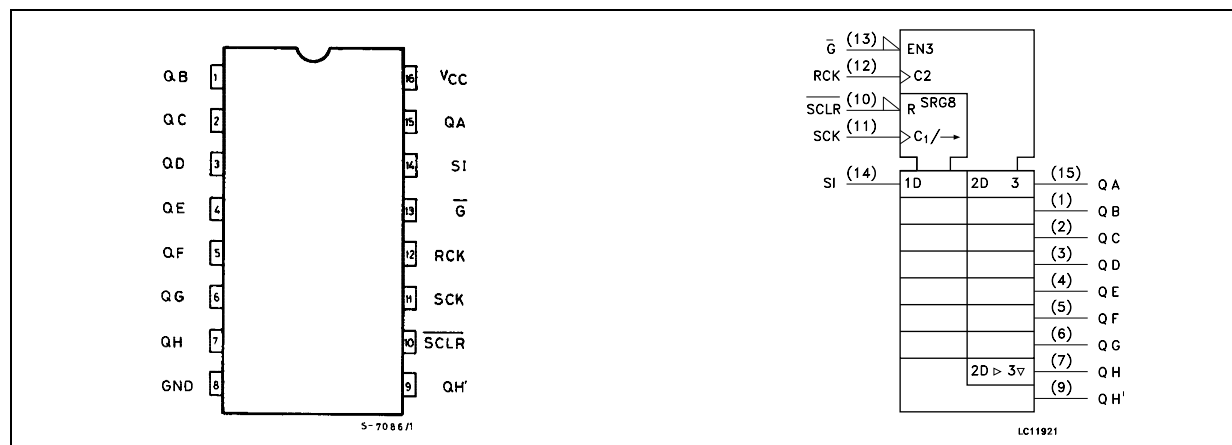
INPUT AND OUTPUT EQUIVALENT CIRCUIT

CS03580
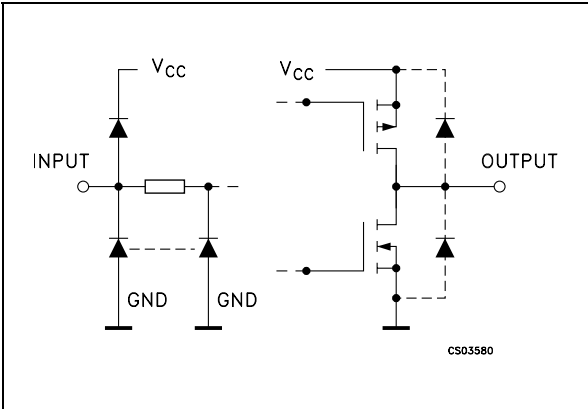
PIN DESCRIPTION

PIN N°	SYMBOL	NAME AND FUNCTION
1, 2, 3, 4, 5, 6, 7, 15	QA to QH	Data Outputs
9	QH'	Serial Data Outputs
10	$\overline{SCLR}$	Shift Register Clear Input
11	SCK	Shift Register Clock Input
13	$\overline{G}$	Output Enable Input
14	SI	Serial Data Input
12	RCK	Storage Register Clock Input
8	GND	Ground (0V)
16	V_{CC}	Positive Supply Voltage

TRUTH TABLE

| INPUTS					OUTPUTS
SI	SCK	$\overline{SCLR}$	RCK	$\overline{G}$	
X	X	X	X	H	QA THRU QH OUTPUTS DISABLE
X	X	X	X	L	QA THRU QH OUTPUTS ENABLE
X	X	L	X	X	SHIFT REGISTER IS CLEARED
L	⌐	H	X	X	FIRST STAGE OF S.R. BECOMES "L" OTHER STAGES STORE THE DATA OF PREVIOUS STAGE, RESPECTIVELY
H	⌐	H	X	X	FIRST STAGE OF S.R. BECOMES "H" OTHER STAGES STORE THE DATA OF PREVIOUS STAGE, RESPECTIVELY
X	⌐_	H	X	X	STATE OF S.R. IS NOT CHANGED
X	X	X	⌐	X	S.R. DATA IS STORED INTO STORAGE REGISTER
X	X	X	⌐_	X	STORAGE REGISTER STATE IS NOT CHANGED

X: Don't Care
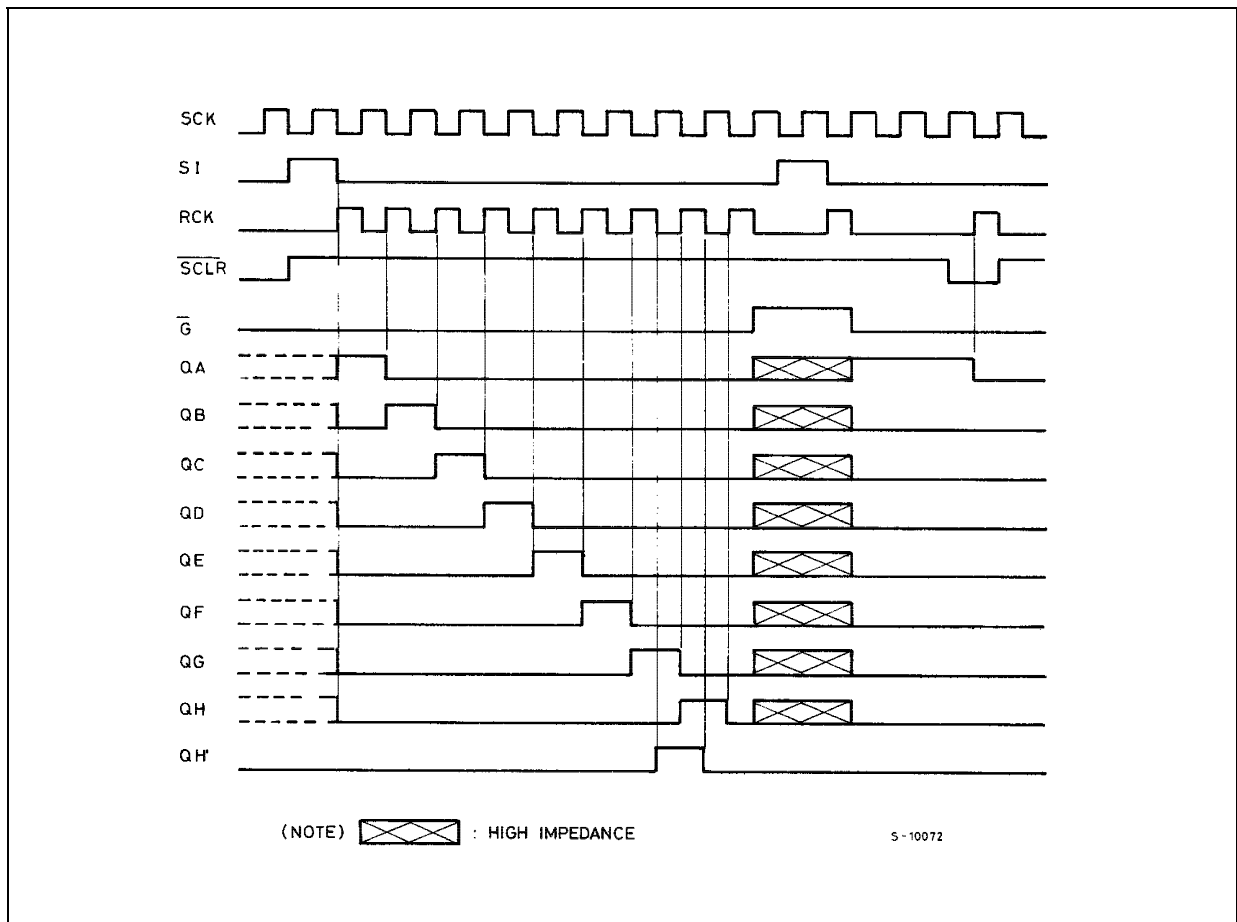
LOGIC DIAGRAM

S-10070
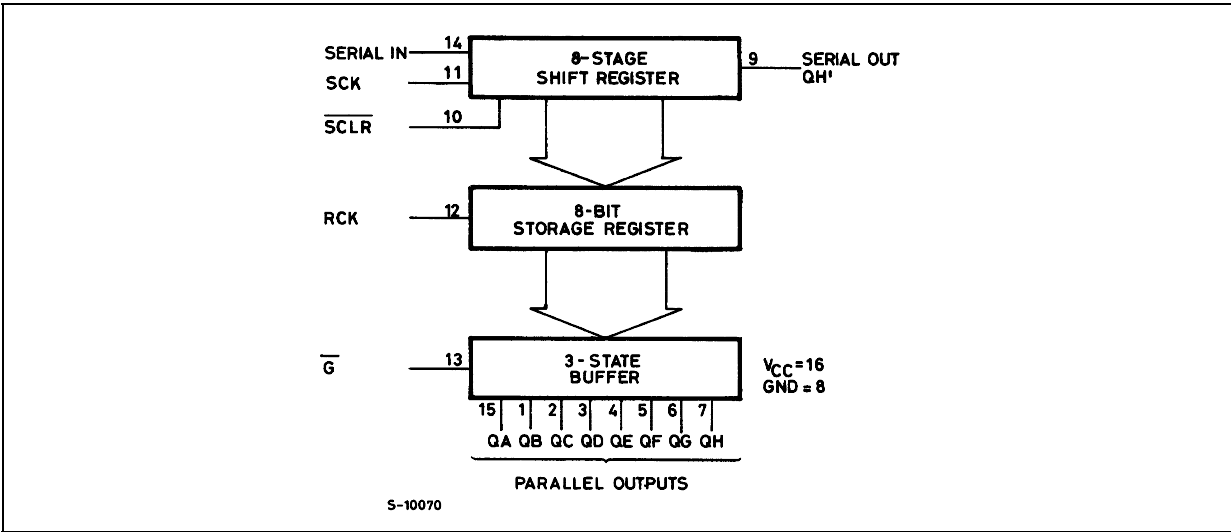
This logic diagram has not be used to estimate propagation delays

LOGIC DIAGRAM
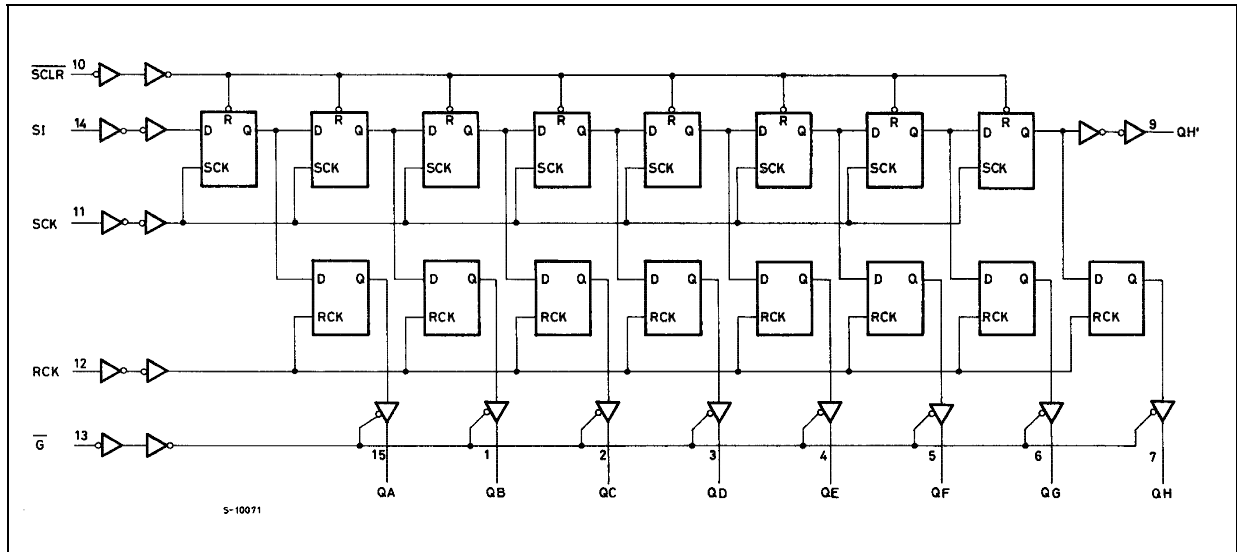
This logic diagram has not be used to estimate propagation delays

TIMING CHART

(NOTE) [✗✗✗] : HIGH IMPEDANCE

S-10072

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 Current		± 35	mA
I_{CC} or I_{GND}	DC V_{CC} or Ground Current		± 70	mA
P_D	Power Dissipation	DIP	750(*)	mW
		SOP	500(*)	mW
		TSSOP	450(*)	mW
T_{stg}	Storage Temperature		-65 to +150	°C
T_L	Lead Temperature (10 sec)		300	°C

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied
(*) Power dissipation at 65°C. Derating from 65°C to 125°C: DIP Package -10mW/°C; SO Package -7mW/°C; TSSOP Package -6.1mW/°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)		$T_A = 25°C$			-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 (for QH' outputs)	2.0	I_O=-20 μA	1.9	2.0		1.9		1.9		V
		4.5	I_O=-20 μA	4.4	4.5		4.4		4.4		
		6.0	I_O=-20 μA	5.9	6.0		5.9		5.9		
		4.5	I_O=-4.0 mA	4.18	4.31		4.13		4.10		
		6.0	I_O=-7.8 mA	5.68	5.8		5.63		5.60		
V_{OH}	High Level Output Voltage (for QA to QH outputs)	2.0	I_O=-20 μA	1.9	2.0		1.9		1.9		V
		4.5	I_O=-20 μA	4.4	4.5		4.4		4.4		
		6.0	I_O=-20 μA	5.9	6.0		5.9		5.9		
		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		
V_{OL}	Low Level Output Voltage (for QH' outputs)	2.0	I_O=20 μA		0.0	0.1		0.1		0.1	V
		4.5	I_O=20 μA		0.0	0.1		0.1		0.1	
		6.0	I_O=20 μA		0.0	0.1		0.1		0.1	
		4.5	I_O=4.0 mA		0.17	0.26		0.33		0.40	
		6.0	I_O=7.8 mA		0.18	0.26		0.33		0.40	
V_{OL}	Low Level Output Voltage (for QA to QH outputs)	2.0	I_O=20 μA		0.0	0.1		0.1		0.1	V
		4.5	I_O=20 μA		0.0	0.1		0.1		0.1	
		6.0	I_O=20 μA		0.0	0.1		0.1		0.1	
		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	
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)	C_L (pF)		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 (Qn)	2.0				25	60		75		90	
		4.5	50			7	12		15		18	ns
		6.0				6	10		13		15	
t_{TLH} t_{THL}	Output Transition Time (QH')	2.0				30	75		95		115	
		4.5	50			8	15		19		23	ns
		6.0				7	13		16		20	
t_{PLH} t_{PHL}	Propagation Delay Time (SCK - QH')	2.0				45	125		155		190	
		4.5	50			15	25		31		38	ns
		6.0				13	21		26		32	
t_{PLH} t_{PHL}	Propagation Delay Time (SCLR - QH')	2.0				60	175		220		265	
		4.5	50			18	35		44		53	ns
		6.0				15	30		37		45	
t_{PLH} t_{PHL}	Propagation Delay Time (RCK - Qn)	2.0				60	150		190		225	
		4.5	50			20	30		38		45	ns
		6.0				17	26		32		38	
		2.0				75	190		240		285	
		4.5	150			25	38		48		57	ns
		6.0				22	32		41		48	
t_{PZL} t_{PZH}	High Impedance Output Enable Time	2.0				45	135		170		205	
		4.5	50	R_L = 1 KΩ		15	27		34		41	ns
		6.0				13	23		29		35	
		2.0				60	175		220		265	
		4.5	150	R_L = 1 KΩ		20	35		44		53	ns
		6.0				17	30		37		45	
t_{PLZ} t_{PHZ}	High Impedance Output Disable Time	2.0				30	150		190		225	
		4.5	50	R_L = 1 KΩ		15	30		38		45	ns
		6.0				14	26		32		38	
f_{MAX}	Maximum Clock Frequency	2.0			6.0	17		4.8		4		
		4.5	50		30	50		24		20		MHz
		6.0			35	59		28		24		
		2.0			5.2	14		4.2		3.4		
		4.5	150		26	40		21		17		MHz
		6.0			31	45		25		20		
$t_{W(H)}$	Minimum Pulse Width (SCK, RCK)	2.0				17	75		95		110	
		4.5	50			6	15		19		22	ns
		6.0				6	13		16		19	
$t_{W(L)}$	Minimum Pulse Width (SCLR)	2.0				20	75		95		110	
		4.5	50			6	15		19		22	ns
		6.0				6	13		16		19	
t_s	Minimum Set-up Time (SI - CCK)	2.0				25	50		65		75	
		4.5	50			5	10		13		15	ns
		6.0				4	9		11		13	
t_s	Minimum Set-up Time (SCK - RCK)	2.0				35	75		95		110	
		4.5	50			8	15		19		22	ns
		6.0				6	13		16		19	

Symbol	Parameter	Test Condition			$T_A = 25°C$			-40 to 85°C		-55 to 125°C		Unit
		V_{CC} (V)	C_L (pF)		Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t_s	Minimum Set-up Time (SCRL - RCK)	2.0	50			40	100		125		145	ns
		4.5				10	20		25		29	
		6.0				7	17		21		25	
t_h	Minimum Hold Time	2.0	50				0		0		0	ns
		4.5					0		0		0	
		6.0					0		0		0	
t_{REM}	Minimum Clear Removal Time	2.0	50			15	50		65		75	ns
		4.5				3	10		13		15	
		6.0				3	9		11		13	

CAPACITIVE CHARACTERISTICS

Symbol	Parameter	Test Condition		$T_A = 25°C$			-40 to 85°C		-55 to 125°C		Unit
		V_{CC} (V)		Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
C_{IN}	Input Capacitance				5	10		10		10	pF
C_{PD}	Power Dissipation Capacitance (note 1)				184						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. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

TEST CIRCUIT

SC11700
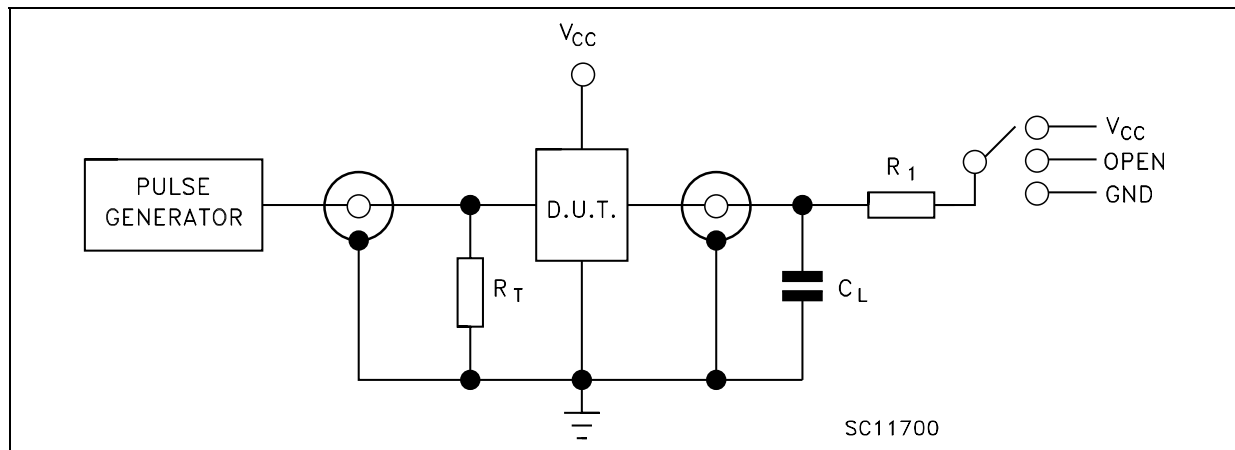
TEST	SWITCH
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	V_{CC}
t_{PZH}, t_{PHZ}	GND

C_L = 50pF/150pF or equivalent (includes jig and probe capacitance)
R_1 = 1KΩ or equivalent
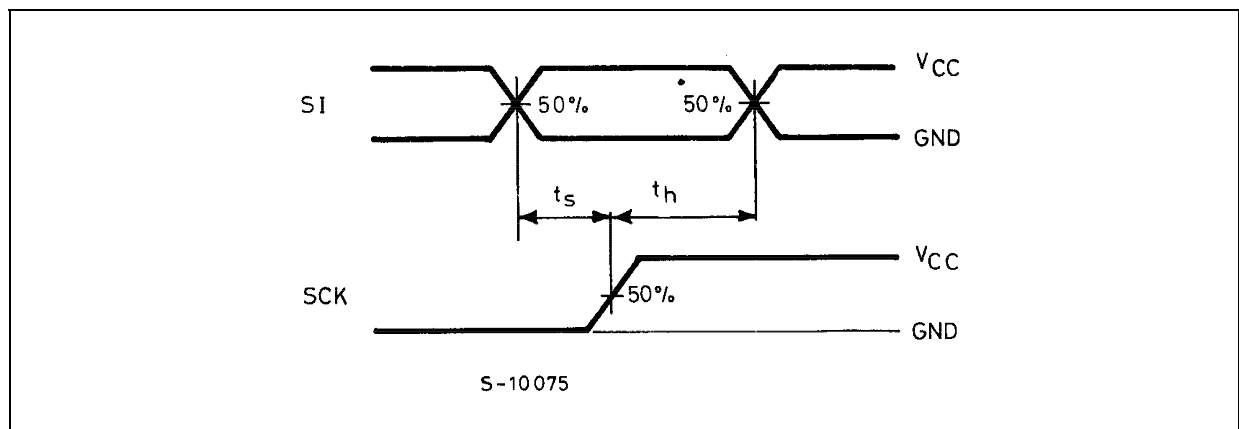R_T = Z_{OUT} of pulse generator (typically 50Ω)

WAVEFORM 1: SCK TO QH' PROPAGATION DELAY TIMES, SCK MINIMUM PULSE WIDTH
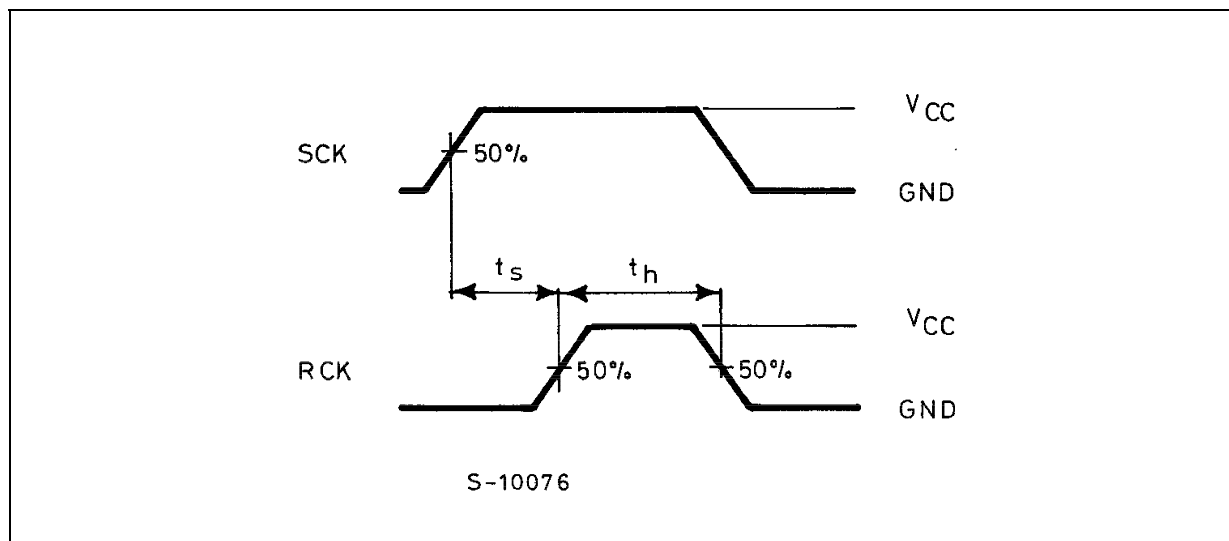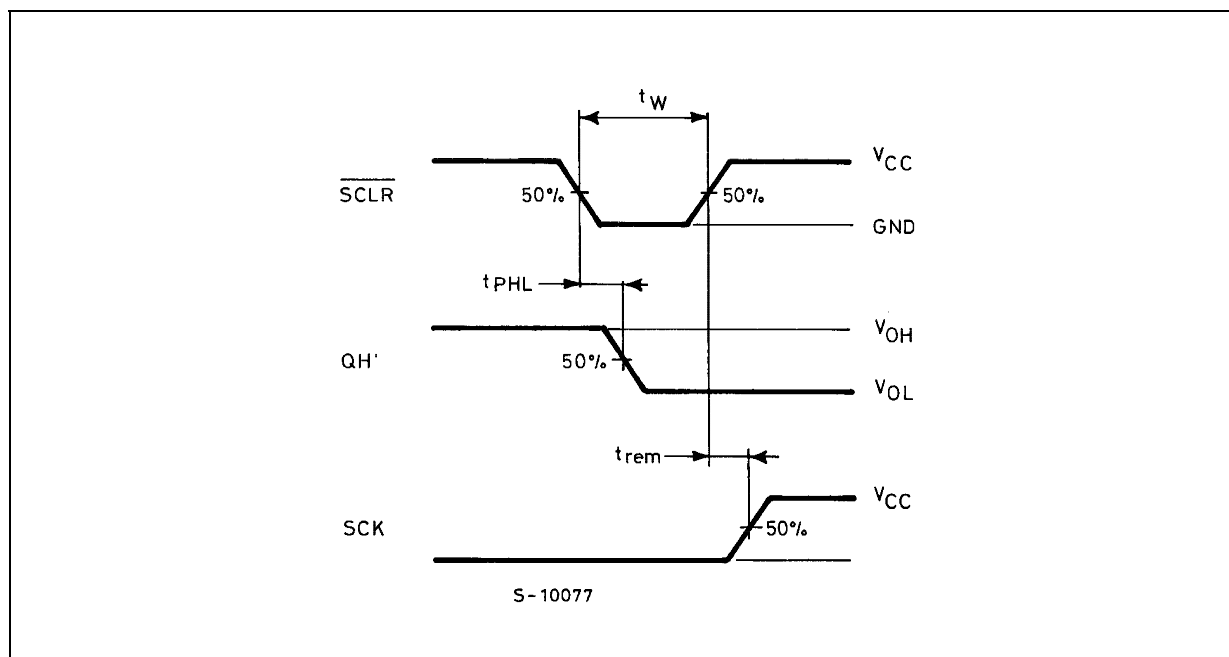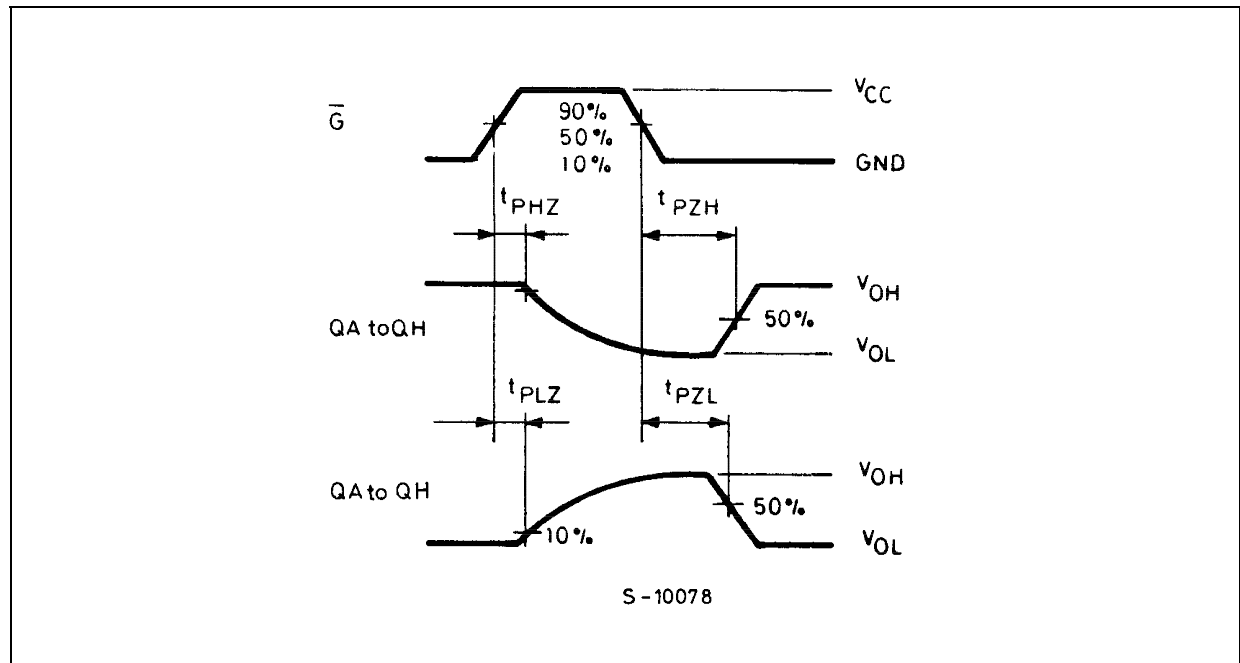(f=1MHz; 50% duty cycle)

S - 10073
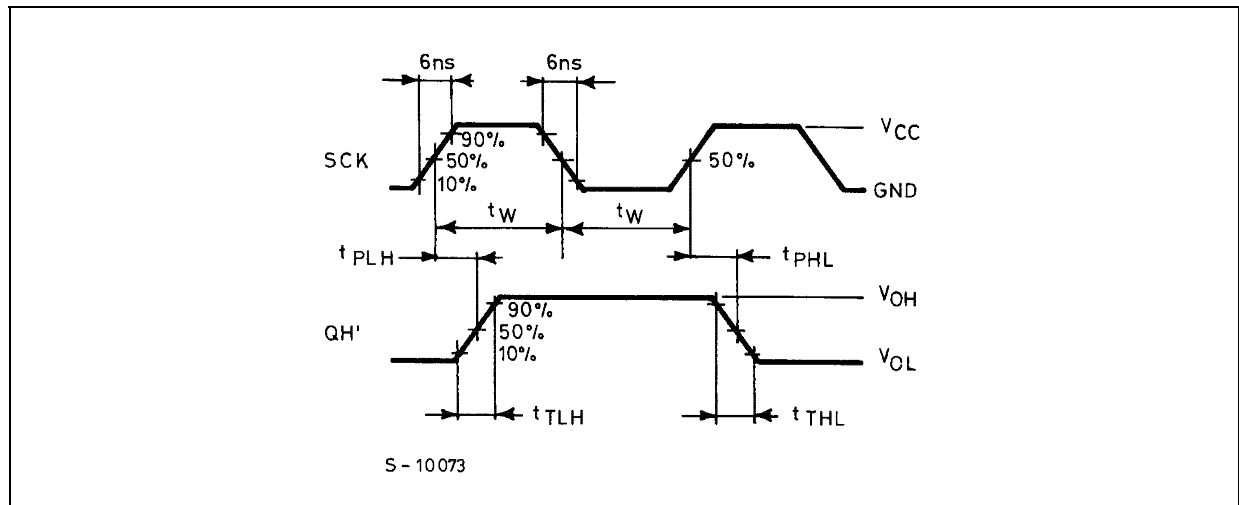
WAVEFORM 2: RCK TO Qn PROPAGATION DELAY TIMES (f=1MHz; 50% duty cycle)

S - 10074
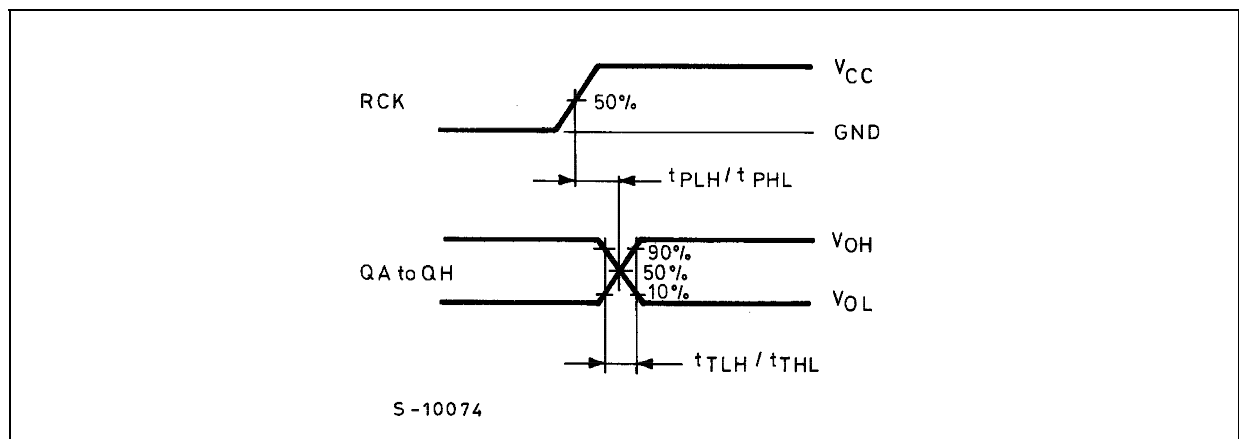
**WAVEFORM 3: SI TO SCK SETUP AND HOLD TIMES** (f=1MHz; 50% duty cycle)

S - 10075

WAVEFORM 4: SCK TO RCK SETUP AND HOLD TIMES (f=1MHz; 50% duty cycle)

S-10076

WAVEFORM 5: $\overline{SCLR}$ MINIMUM PULSE WIDTH, MINIMUM REMOVAL TIME
(f=1MHz; 50% duty cycle)

S-10077

WAVEFORM 6: OUTPUT ENABLE AND DISABLE TIMES (f=1MHz; 50% duty cycle)

S-10078

WAVEFORM 7: INPUT WAVEFORM (f=1MHz; 50% duty cycle)


S-10080
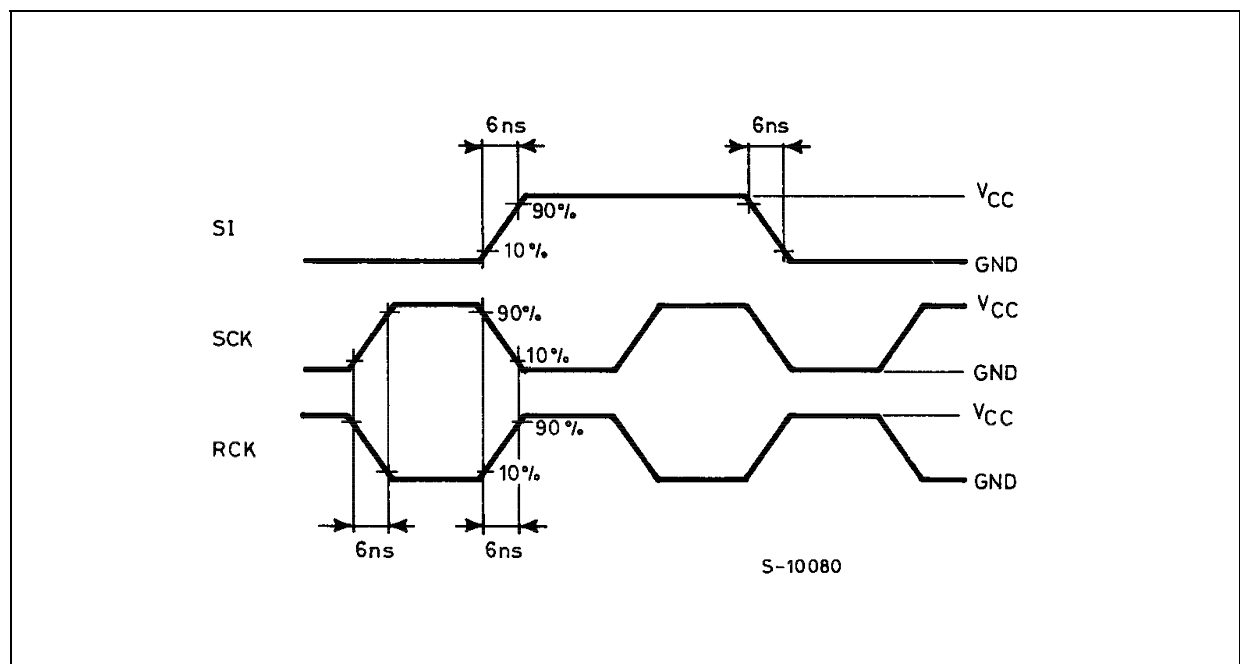
Plastic DIP-16 (0.25) MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050
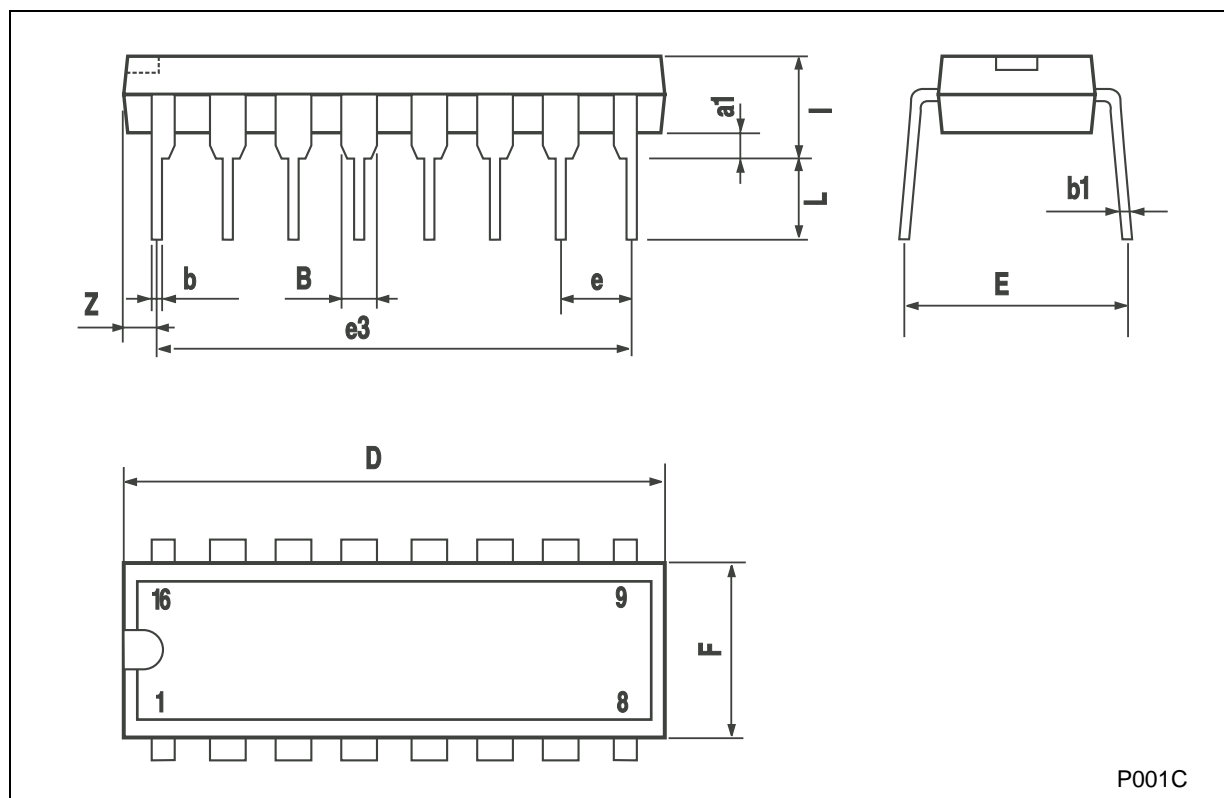
P001C

SO-16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.004		0.008
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1			45° (typ.)			
D	9.8		10	0.385		0.393
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.62			0.024
S		8	° (max.)			

PO13H
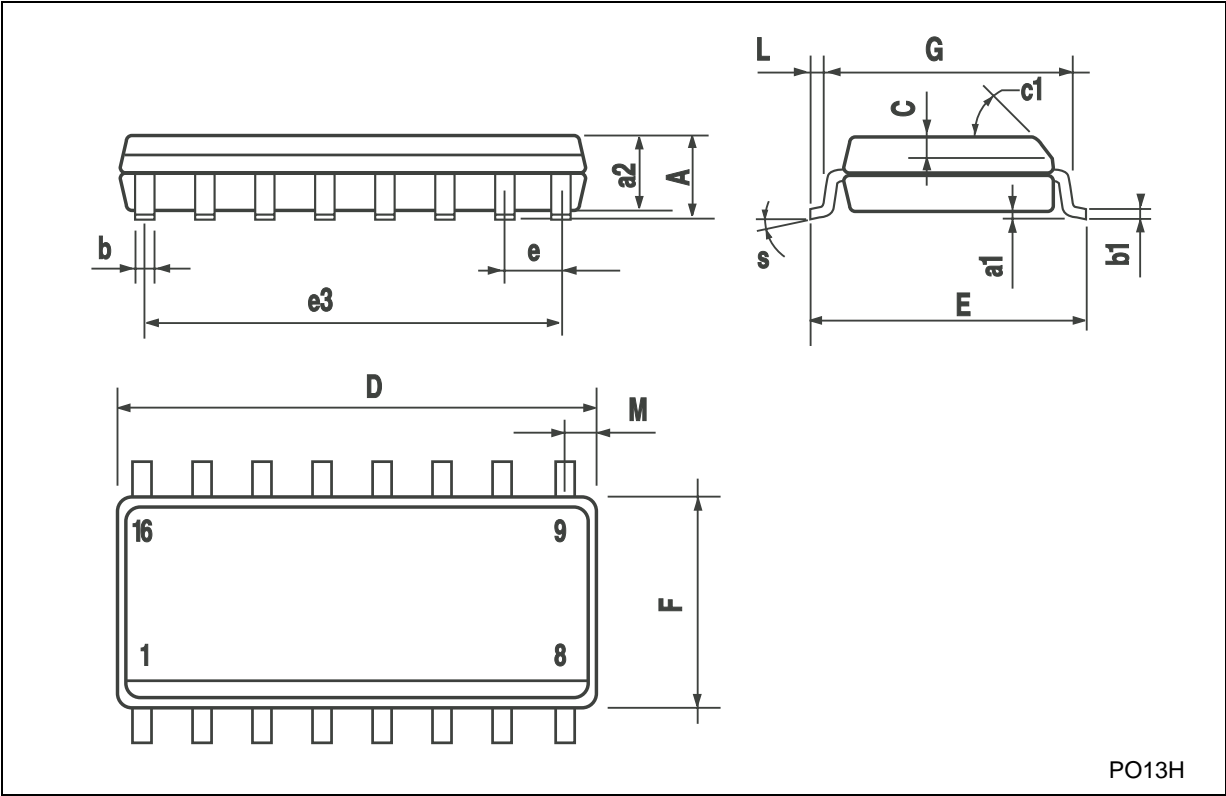
TSSOP16 MECHANICAL DATA

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		0.0079
D	4.9	5	5.1	0.193	0.197	0.201
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

PIN 1 IDENTIFICATION
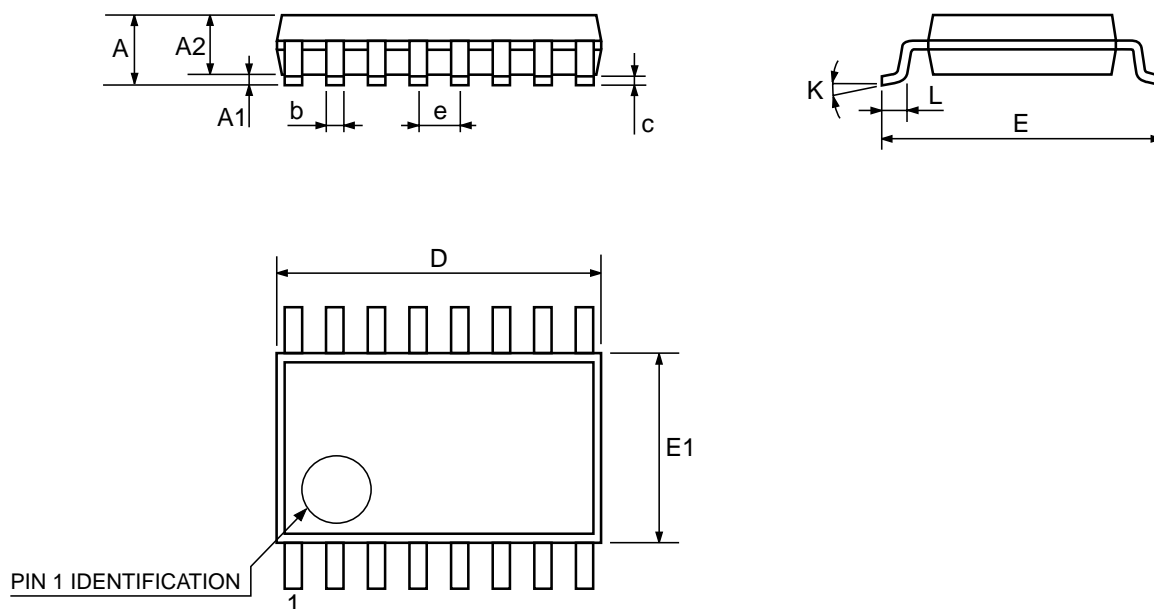
0080338D

Tape & Reel SO-16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	**TYP**	**MAX.**	**MIN.**	**TYP.**	**MAX.**
A			330			12.992
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.45		6.65	0.254		0.262
Bo	10.3		10.5	0.406		0.414
Ko	2.1		2.3	0.082		0.090
Po	3.9		4.1	0.153		0.161
P	7.9		8.1	0.311		0.319

Note: Drawing not in scale
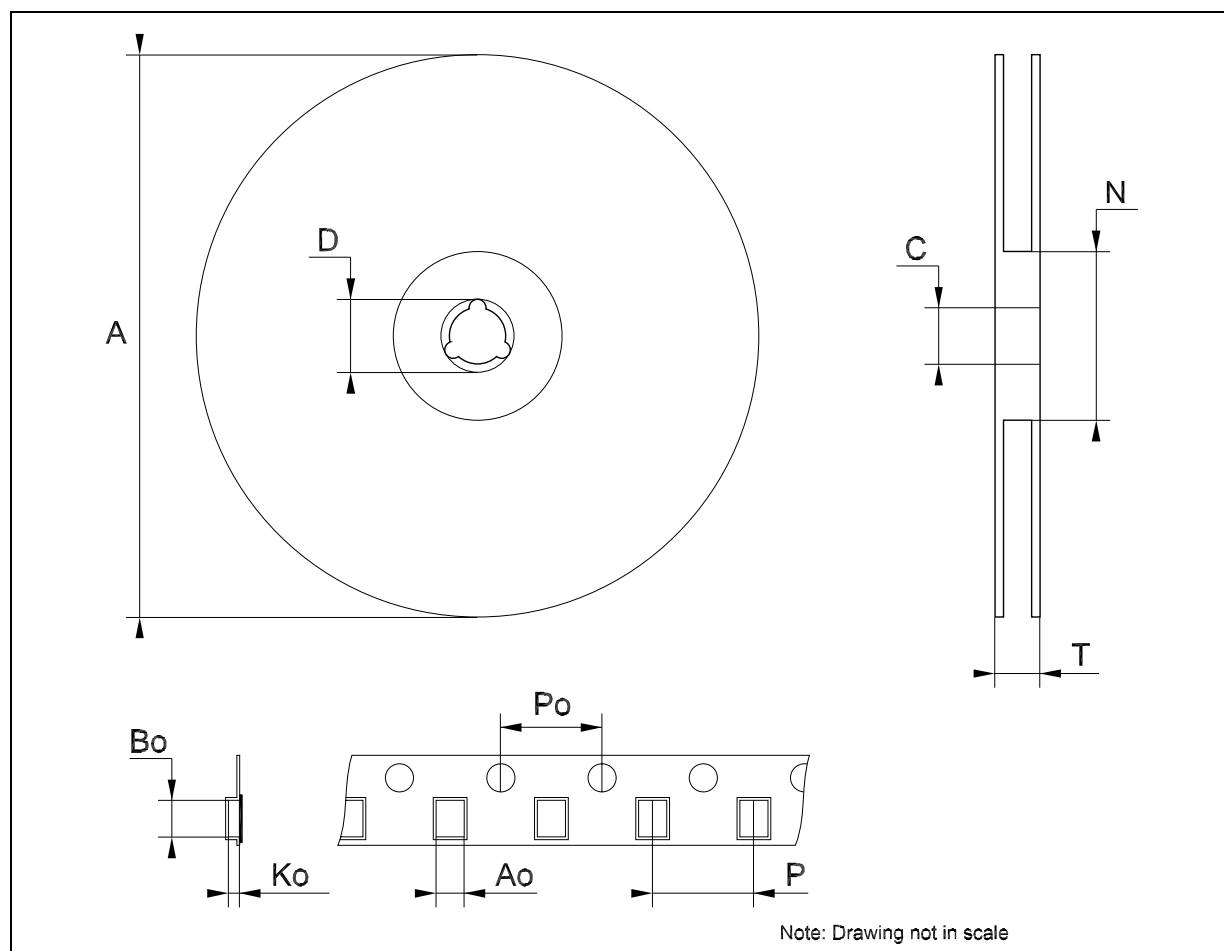
Tape & Reel TSSOP16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	**TYP**	**MAX.**	**MIN.**	**TYP.**	**MAX.**
A			330			12.992
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.7		6.9	0.264		0.272
Bo	5.3		5.5	0.209		0.217
Ko	1.6		1.8	0.063		0.071
Po	3.9		4.1	0.153		0.161
P	7.9		8.1	0.311		0.319

Note: Drawing not in scale