2 Megabit (256K x 8) SuperFlash MTP
SST27SF020

Preliminary Specifications

FEATURES:

- **5.0V Read Operation (4.5V to 5.5V)**
- **Superior Reliability**
  - Endurance: At least 1000 Cycles
  - Greater than 100 years Data Retention
- **Low Power Consumption**
  - Active Current: 20 mA (typical)
  - Standby Current: 10 µA (typical)
- **Fast Access Time**
  - 70 and 90 ns
- **Fast Programming Operation**
  - 20 µs per byte
  - 5.6 second for the entire chip
- **Features Electrical Erase**
  - Does Not Require UV Source
  - Chip Erase Time: 100 ms
- **TTL I/O Compatibility**
- **JEDEC Standard Byte-wide EPROM Pinouts**
- **12V Power Supply for Programming/Erase**
- **Packages Available**
  - 32-Pin PDIP
  - 32-Pin PLCC
  - 32-Pin TSOP (8mm x 14mm)

PRODUCT DESCRIPTION

The SST27SF020 is a 256K x 8 CMOS, many-time programmable (MTP) low cost flash, manufactured with SST's proprietary, high performance SuperFlash technology. The split-gate cell design and thick oxide tunneling injector attain better reliability and manufacturability compared with alternate approaches. The SST27SF020 can be electrically erased and programmed at least 1000 times using an external programmer with a 12 volt supply. The SST27SF020 has to be erased prior to programming. The SST27SF020 conforms to JEDEC standard pinouts for byte-wide memories.

Featuring high performance byte programming, the SST27SF020 provides a byte program time of 20 µs. The entire memory can be programmed byte-by-byte in 5.6 seconds. Designed, manufactured, and tested for a wide spectrum of applications, the SST27SF020 is offered with an endurance of at least 1000 cycles. Data retention is rated at greater than 100 years.

The SST27SF020 is suited for applications that require infrequent writes and low power nonvolatile storage. The SST27SF020 will improve flexibility, efficiency, and performance while matching the low cost in nonvolatile applications that currently use UV-EPROMs, OTPs, and mask ROMs.

To meet surface mount and conventional through hole requirements, the SST27SF020 is offered in 32-pin PLCC, 32-pin PDIP and 32-pin TSOP packages. See Figures 1 and 2 for pinouts.

Device Operation

The SST27SF020 is a low cost flash solution that can be used to replace existing UV-EPROM, OTP, and mask ROM sockets. This device is functionally (read and program) and pin compatible with industry standard EPROM products. In addition to EPROM functionality, the device also supports electrical erase operation via an external programmer. The SST27SF020 does not require a UV source to erase, and therefore the packages do not have a window.

Read

The Read operation of the SST27SF020 is controlled by CE# and OE#. Both CE# and OE# have to be low for the system to obtain data from the outputs. Once the address is stable, the address access time is equal to the delay from CE# to output (T_{CE}). Data is available at the output after a delay of T_{OE} from the falling edge of OE#, assuming that CE# pin has been low and the addresses have been stable for at least $T_{CE} - T_{OE}$. When the CE# pin is high, the chip is deselected and a typical standby current of 10 µA is consumed. OE# is the output control and is used to gate data from the output pins. The data bus is in high impedance state when either CE# or OE# is high.

Programming operation

The SST27SF020 is programmed by using an external programmer. The programming mode is activated by asserting 12V (±5%) on V_{PP} pin, Vcc = 5V±5%, V_{IL} on CE# pin, and V_{IH} on OE# pin. The device is programmed byte by byte with the desired data at the desired address using a single pulse (PGM# pin low) of 20 µs**.** Using the

MTP programming algorithm, the byte programming process continues byte by byte until the entire chip (256 KByte) has been programmed.

Chip Erase Operation

The only way to change a data from a "0" to "1" is by electrical erase that changes every bit in the device to "1". Unlike traditional EPROMs, which use UV light to do the chip erase, the SST27SF020 uses an electrical chip erase operation. This saves a significant amount of time (about 30 minutes for each erase operation). The entire chip can be erased in a single pulse of 100 ms (PGM# pin low). In order to activate the erase mode, the 12V (±5%) is applied to V_{PP} and A_9 pins, Vcc = 5V±5%, V_{IL} on CE# pin, and V_{IH} on OE# pin. All other address and data pins are "don't care". The falling edge of PGM# will start the Chip Erase operation. Once the chip has been erased, all bytes must be verified for FF. Refer to figure 8 for the flow chart.

Product Identification Mode

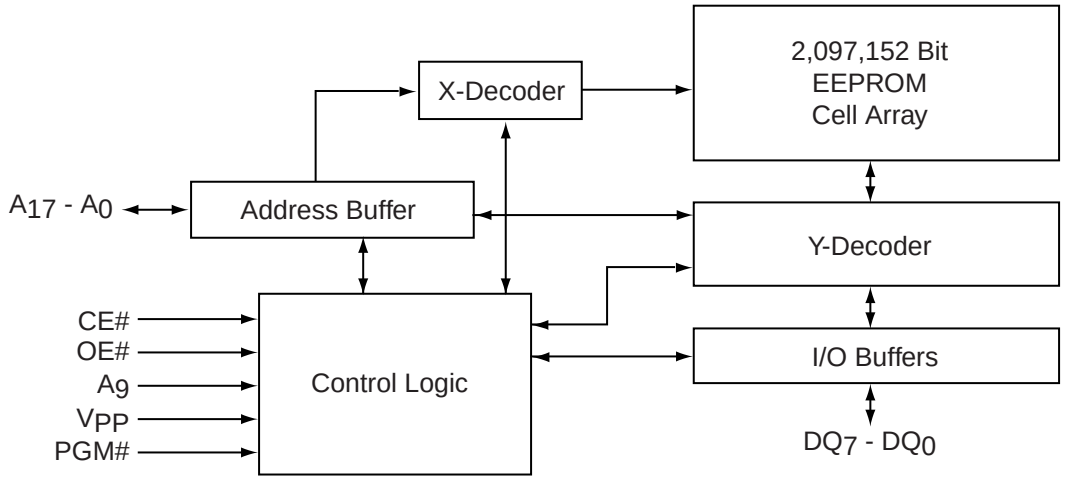
The product identification mode identifies the device as the SST27SF020 and manufacturer as SST. This mode may be accessed by the hardware method. To activate this mode, the programming equipment must force V_H (12V±5%) on address A_9 with V_{PP} pin at V_{CC} (5V±10%) or V_{SS}. Two identifier bytes may then be sequenced from the device outputs by toggling address line A_0. For details, see Table 3 for hardware operation.

TABLE 1: PRODUCT IDENTIFICATION TABLE

	Byte	Data
Manufacturer's Code	0000 H	BF H
Device Code	0001 H	A6 H

319 PGM T1.0

FUNCTIONAL BLOCK DIAGRAM OF THE SST27SF020



319 ILL B1.0

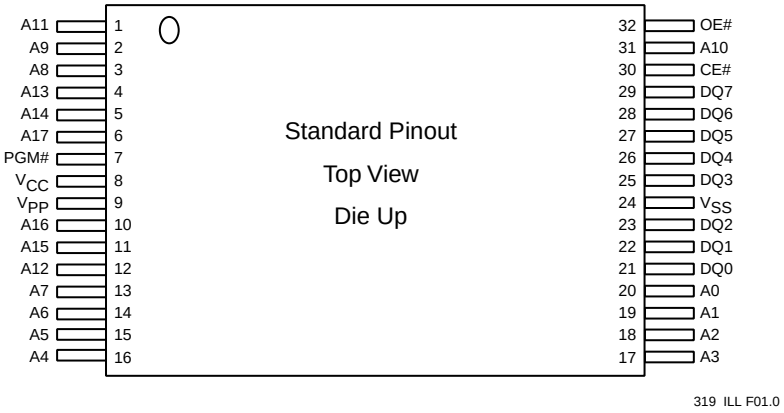


FIGURE 1: PIN ASSIGNMENTS FOR 32-PIN TSOP PACKAGES

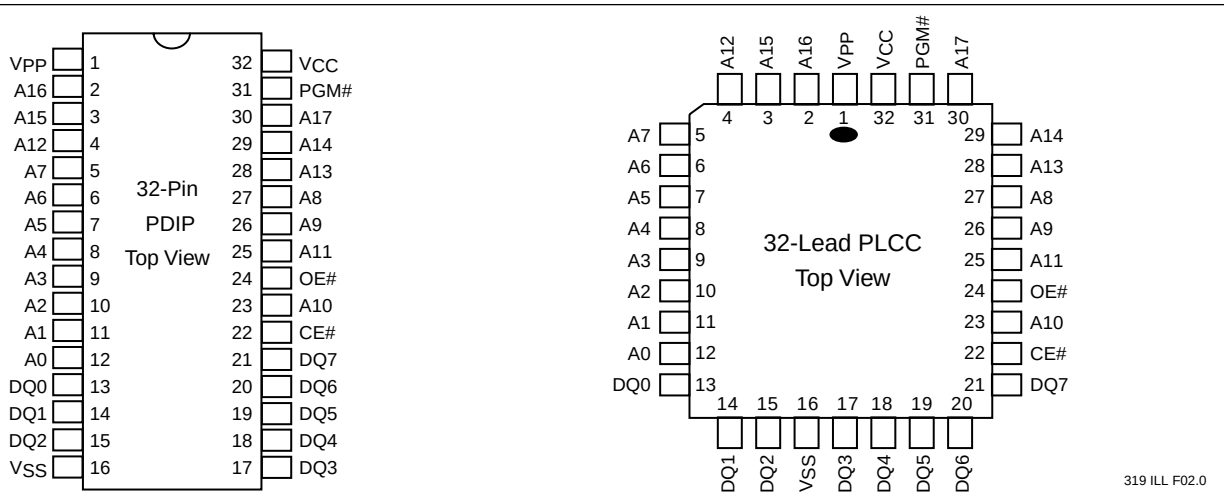


FIGURE 2: PIN ASSIGNMENTS FOR 32-PIN PLASTIC DIPS AND 32-LEAD PLCCS

TABLE 2: PIN DESCRIPTION

Symbol	Pin Name	Functions
A_{17}-A_0	Address Inputs	To provide memory addresses
DQ_7-DQ_0	Data Input/Output	To output data during read cycles and receive input data during program cycle, the outputs are in tri-state when OE# or CE# is high
CE#	Chip Enable	To activate the device when CE# is low
OE#	Output Enable	To gate the data output buffers during read operation
PGM#	Program/Erase Pin	Used for program or erase (PGM# = V_{IL} pulse during program or erase)
V_{PP}	Power Supply for Program or Erase	High voltage pin during chip erase and programming operation 12-volt (±5%)
V_{CC}	Power Supply	To provide 5-volt supply (±10%)
V_{SS}	Ground	

319 PGM T2.1

TABLE 3: OPERATION MODES SELECTION

Mode	CE#	OE#	PGM#	A_9	V_{PP}	DQ	Address
Read	V_{IL}	V_{IL}	X	A_{IN}	V_{CC} or V_{SS}	D_{OUT}	A_{IN}
Output Disable	V_{IL}	V_{IH}	X	X	V_{CC} or V_{SS}	High Z	A_{IN}
Program	V_{IL}	V_{IH}	V_{IL}	A_{IN}	V_{PPH}	D_{IN}	A_{IN}
Standby	V_{IH}	X	X	X	V_{CC} or V_{SS}	High Z	X
Chip Erase	V_{IL}	V_{IH}	V_{IL}	V_H	V_{PPH}	High Z	X
Program/Erase Inhibit	V_{IH}	X	X	X	V_{PPH}	High Z	X
Product Identification	V_{IL}	V_{IL}	X	V_H	V_{CC} or V_{SS}	Manufacturer Code (BF) Device Code (A6)	A_{17}-A_1 = V_{IL}, A_0 = V_{IL} A_{17}-A_1 = V_{IL}, A_0 = V_{IH}

319 PGM T3.1

Note: X = V_{IL} or V_{IH}
V_{PPH} = 12V±5%, V_H = 12V±5%

Absolute Maximum Stress Ratings (Applied conditions greater than those listed under "Absolute Maximum Stress Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions or conditions greater than those defined in the operational sections of this data sheet is not implied. Exposure to absolute maximum stress rating conditions may affect device reliability.)

Temperature Under Bias ..... -55°C to +125°C
Storage Temperature ..... -65°C to +150°C
D. C. Voltage on Any Pin to Ground Potential ..... -0.5V to V_{CC}+ 0.5V
Transient Voltage (<20 ns) on Any Pin to Ground Potential ..... -1.0V to V_{CC}+ 1.0V
Voltage on A_9 and V_{PP} Pin to Ground Potential ..... -0.5V to 14.0V
Package Power Dissipation Capability (T_A = 25°C) 1.0W
Through Hole Lead Soldering Temperature (10 Seconds) ..... 300°C
Surface Mount Lead Soldering Temperature (3 Seconds) ..... 240°C
Output Short Circuit Current[1] ..... 100 mA

Note: [1] Outputs shorted for no more than one second. No more than one output shorted at a time.

OPERATING RANGE

Range	Ambient Temp	V_{CC}	V_{PP}
Commercial	0°C to +70°C	5V±10%	12V±5%
Industrial	-40°C to +85°C	5V±10%	12V±5%

AC CONDITIONS OF TEST

Input Rise/Fall Time ..... 10 ns
Output Load ..... C_L = 100 pF for 90 ns
Output Load ..... C_L = 30 pF for 70 ns
See Figures 6 and 7

TABLE 4: READ MODE DC OPERATING CHARACTERISTICS
V_{CC} = 5 V±10%, V_{PP} = V_{CC} or V_{SS}, T_A = 0°C to 70°C (Commercial) or -40°C to +85°C (Industrial)

Symbol	Parameter	Limits			Test Conditions
		Min	Max	Units	
I_{CC}	V_{CC} Read Current		30	mA	CE# = OE# = V_{IL} all I/Os open, Address Input = V_{IL}/V_{IH} at f = $1/T_{RC}$ Min, V_{CC} = V_{CC} Max
I_{PPR}	V_{PP} Read Current		100	µA	CE# = OE# = V_{IL}, all I/Os open, Address Input = V_{IL}/V_{IH} at f = $1/T_{RC}$ Min, V_{CC} = V_{CC} Max, V_{PP} = Vcc
I_{SB1}	Standby V_{CC} Current (TTL input)		3	mA	CE# = V_{IH}, V_{CC} = V_{CC} Max
I_{SB2}	Standby V_{CC} Current (CMOS input)		50	µA	CE#=V_{CC} -0.3V V_{CC} = V_{CC} Max.
I_{LI}	Input Leakage Current		1	µA	V_{IN} = GND to V_{CC}, V_{CC} = V_{CC} Max
I_{LO}	Output Leakage Current		1	µA	V_{OUT} = GND to V_{CC}, V_{CC} = V_{CC} Max
V_{IL}	Input Low Voltage		0.8	V	V_{CC} = V_{CC} Min
V_{IH}	Input High Voltage	2.0	Vcc+0.5	V	V_{CC} = V_{CC} Max
V_{OL}	Output Low Voltage		0.4	V	I_{OL} = 2.1 mA, V_{CC} = V_{CC} Min
V_{OH}	Output High Voltage	2.4		V	I_{OH} = -400µA, V_{CC} = V_{CC} Min
I_H	Supervoltage Current for A_9		100	µA	CE# = OE# = V_{IL}, A_9 = V_H Max.

319 PGM T4.4

TABLE 5: PROGRAM/ERASE DC OPERATING CHARACTERISTICS
V_{CC} = 5 V±10%, V_{PP} = V_{PPH},T_A = 25°C±5°C

Symbol	Parameter	Limits			Test Conditions
		Min	Max	Units	
I_{CP}	V_{CC} Erase or Program Current		30	mA	CE# = PGM# = V_{IL}, OE# = V_{IH}, V_{PP} = 12V±5%, V_{CC} = V_{CC} Max
I_{PP}	V_{PP} Erase or Program Current		1	mA	CE# = PGM# = V_{IL}, OE# = V_{IH}, V_{PP} = 12V±5%, V_{CC} = V_{CC} Max
I_{LI}	Input Leakage Current		1	µA	V_{IN} = GND to V_{CC}, V_{CC} = V_{CC} Max
I_{LO}	Output Leakage Current		1	µA	V_{OUT} = GND to V_{CC}, V_{CC} = V_{CC} Max
V_H	Supervoltage for A_9	11.4	12.6	V	CE# = OE# = V_{IL}
I_H	Supervoltage Current for A_9		100	µA	CE# = OE# = V_{IL}, A_9 = V_H Max
V_{PPH}	High Voltage for V_{PP} Pin	11.4	12.6	V	

319 PGM T5.2

TABLE 6: RECOMMENDED SYSTEM POWER-UP TIMINGS

Symbol	Parameter	Minimum	Units
$T_{PU-READ}$	Power-up to Read Operation	100	µs
$T_{PU-WRITE}$	Power-up to Write Operation	100	µs

319 PGM T6.2

TABLE 7: CAPACITANCE (T_A = 25 °C, f=1 MHz, other pins open)

Parameter	Description	Test Condition	Maximum
$C_{I/O}$(1)	I/O Pin Capacitance	$V_{I/O}$ = 0V	12 pF
C_{IN}(1)	Input Capacitance	V_{IN} = 0V	6 pF

319 PGM T7.0

Note: (1)This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.

TABLE 8: RELIABILITY CHARACTERISTICS

Symbol	Parameter	Minimum Specification	Units	Test Method
N_{END}	Endurance	1000	Cycles	JEDEC Standard A117
T_{DR}(1)	Data Retention	100	Years	JEDEC Standard A103
V_{ZAP_HBM}(1)	ESD Susceptibility Human Body Model	1000	Volts	JEDEC Standard A114
V_{ZAP_MM}(1)	ESD Susceptibility Machine Model	200	Volts	JEDEC Standard A115
I_{LTH}(1)	Latch Up	100	mA	JEDEC Standard 78

319 PGM T8.3

Note: (1) This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.

AC CHARACTERISTICS

TABLE 9: READ CYCLE TIMING PARAMETERS

Symbol	Parameter	SST27SF020-70		SST27SF020-90		Units
		Min	Max	Min	Max	
T_{RC}	Read Cycle Time	70		90		ns
T_{CE}	Chip Enable Access Time		70		90	ns
T_{AA}	Address Access Time		70		90	ns
T_{OE}	Output Enable Access Time		35		45	ns
T_{CLZ}	CE# Low to Active Output	0		0		ns
T_{OLZ}	OE# Low to Active Output	0		0		ns
T_{CHZ}	CE# High to High-Z Output		25		30	ns
T_{OHZ}	OE# High to High-Z Output		25		30	ns
T_{OH}	Output Hold from Address Change	0		0		ns

319 PGM T9.2

Note: C_L = 100 pF for 90 ns, 30 pF for 70 ns

TABLE 10: PROGRAMMING/ERASE CYCLE TIMING PARAMETERS

Symbol	Parameter	Min	Max	Units
T_{CES}	CE# Setup Time	1		µs
T_{CEH}	CE# Hold Time	1		µs
T_{AS}	Address Setup Time	1		µs
T_{AH}	Address Hold Time	1		µs
T_{PRT}	V_{PP} Pulse Rise Time	50		ns
T_{VPS}	V_{PP} Setup Time	1		µs
T_{VPH}	V_{PP} Hold Time	1		µs
T_{PW}	PGM# Program Pulse Width	20	30	µs
T_{EW}	PGM# Erase Pulse Width	100	500	ms
T_{DS}	Data Setup Time	1		µs
T_{DH}	Data Hold Time	1		µs
T_{VR}	A_9 Recovery Time for Erase	1		µs
T_{ART}	A_9 Rise Time to 12V during Erase	50		ns
T_{A9S}	A_9 Setup Time during Erase	1		µs
T_{A9H}	A_9 Hold Time during Erase	1		µs

319 PGM T10.1

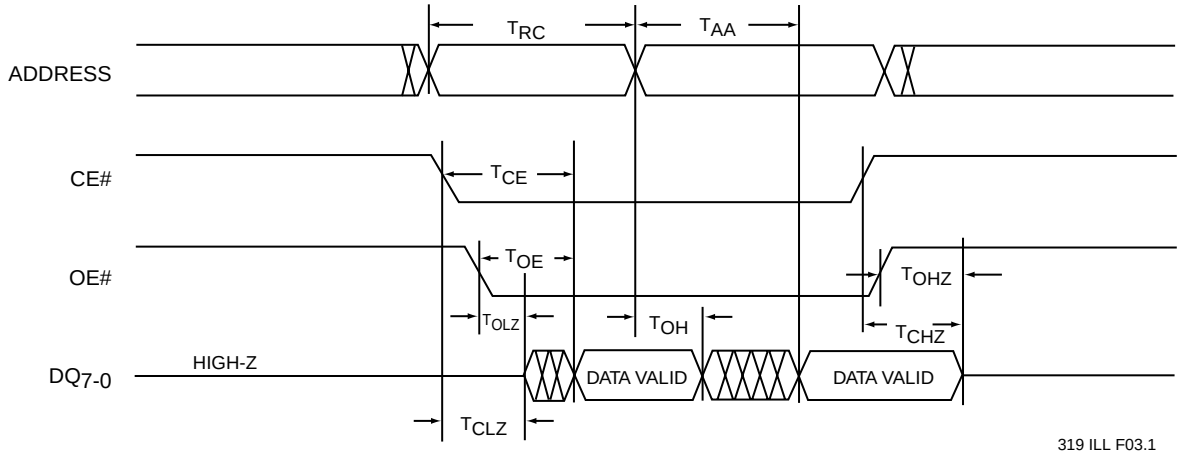


FIGURE 3: READ CYCLE TIMING DIAGRAM

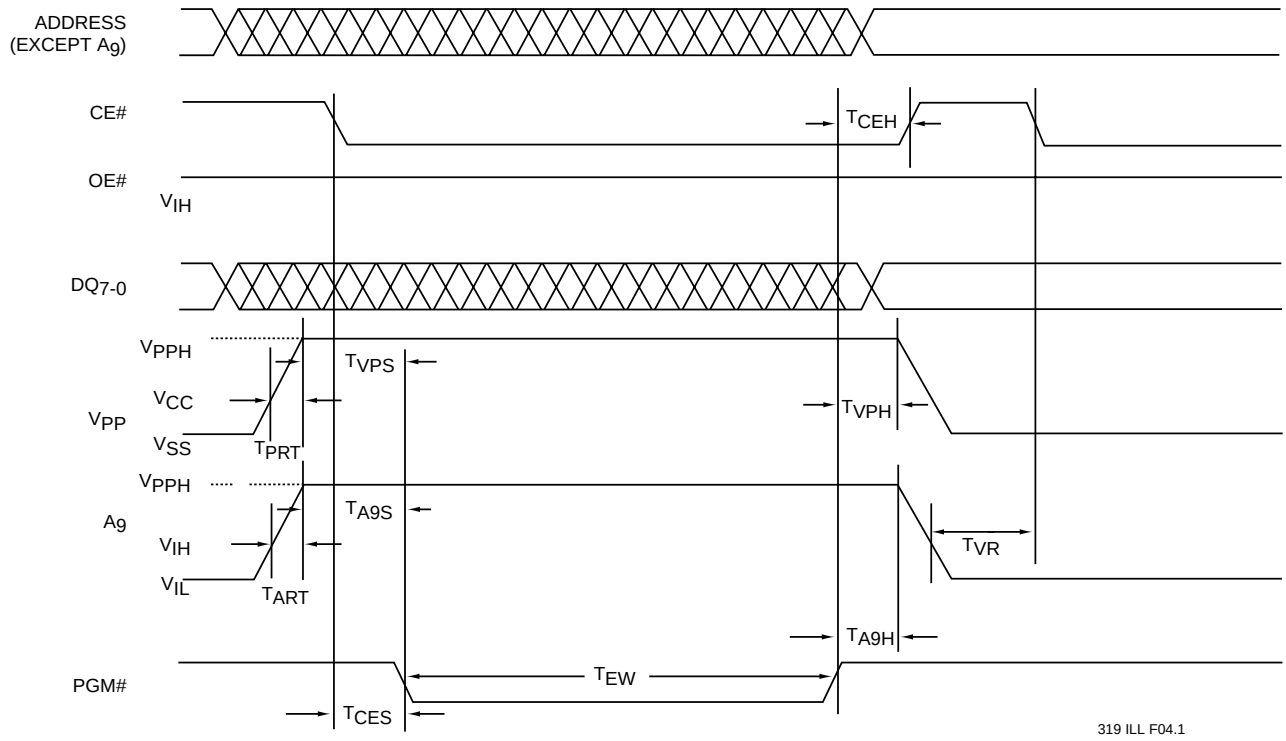


FIGURE 4: ERASE TIMING DIAGRAM

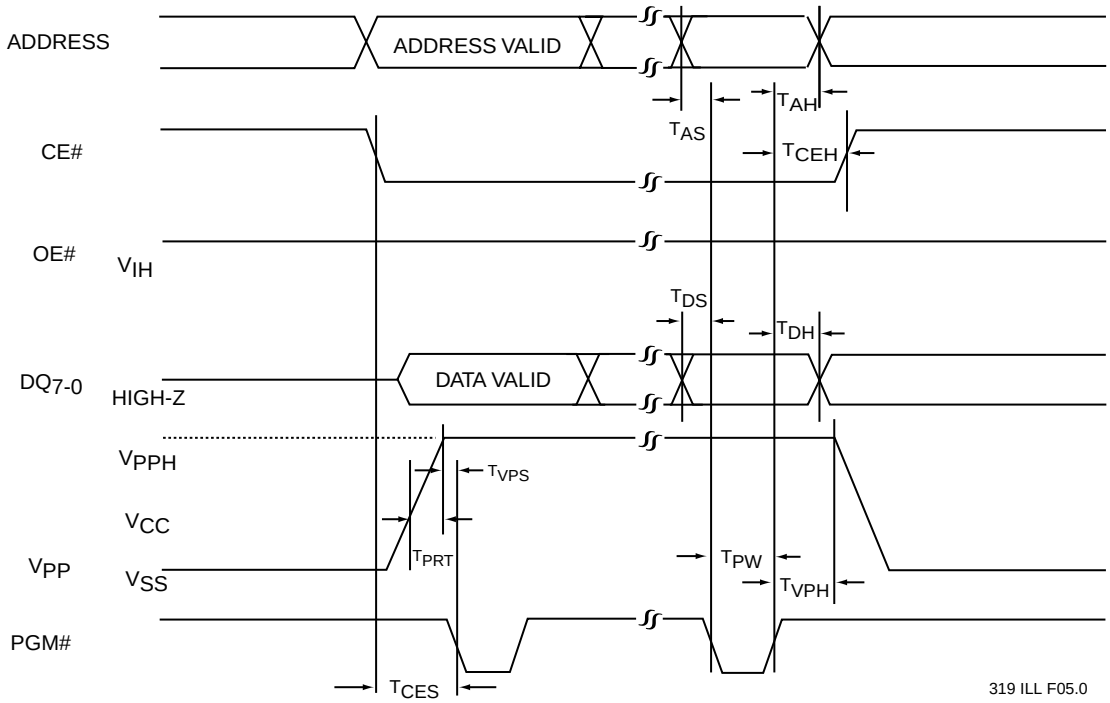
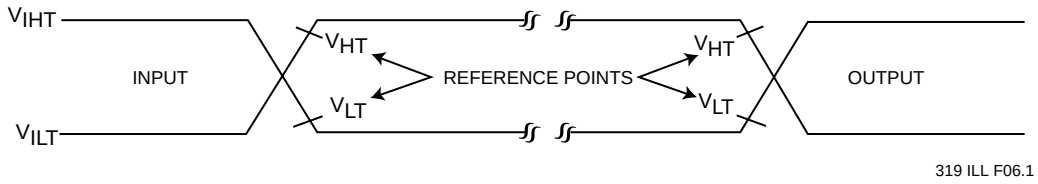


FIGURE 5: PROGRAM TIMING DIAGRAM



AC test inputs are driven at V_{IHT} (2.4 V) for a logic "1" and V_{ILT} (0.4 V) for a logic "0". Measurement reference points for inputs and outputs are V_{HT} (2.0 V) and V_{LT} (0.8 V). Inputs rise and fall times (10% ↔ 90%) are <10 ns.

Note: V_{HT}–V_{HIGH} Test
V_{LT}–V_{LOW} Test
V_{IHT}–V_{INPUT} HIGH Test
V_{ILT}–V_{INPUT} LOW Test

FIGURE 6: AC INPUT/OUTPUT REFERENCE WAVEFORMS

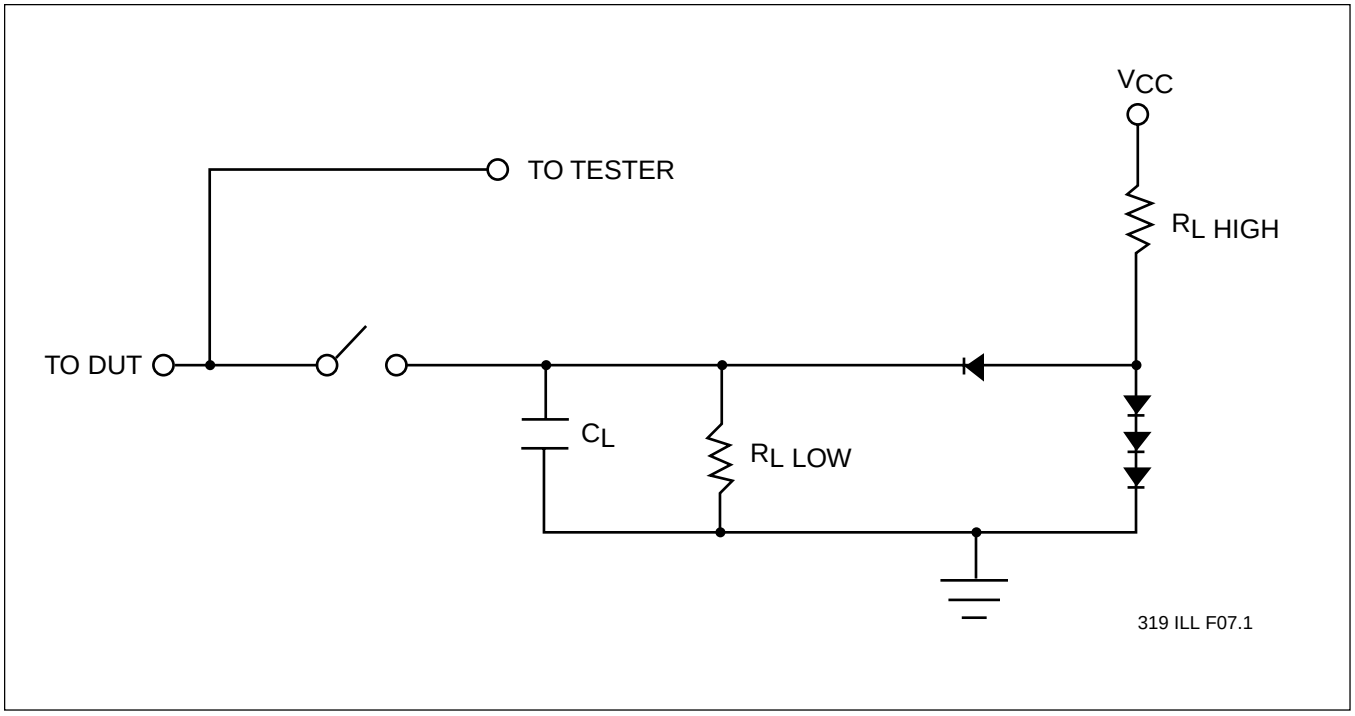


FIGURE 7: A TEST LOAD EXAMPLE

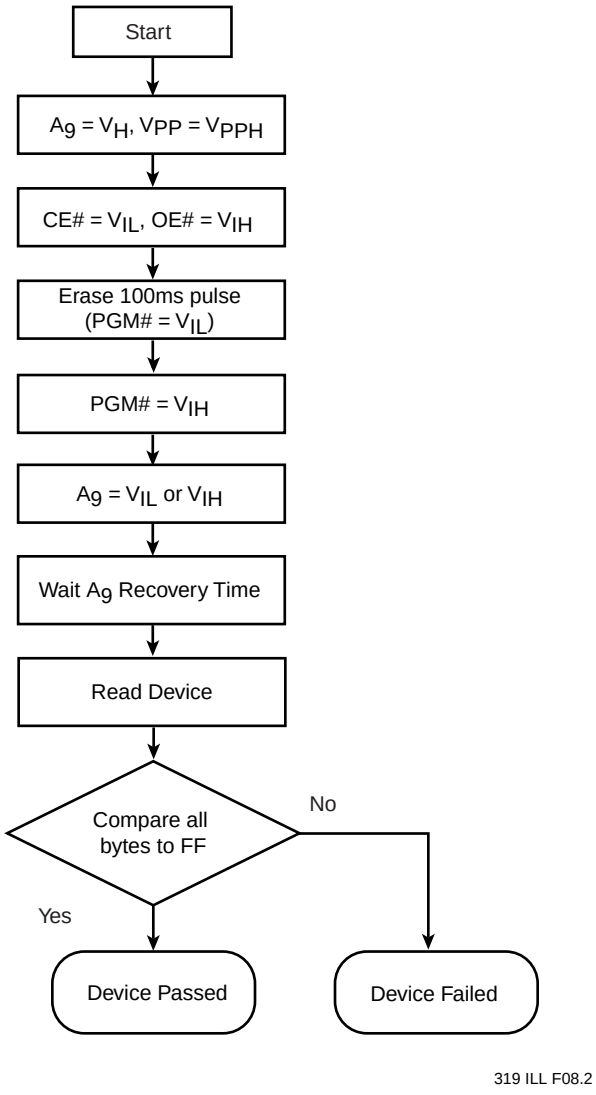


FIGURE 8: ERASE ALGORITHM

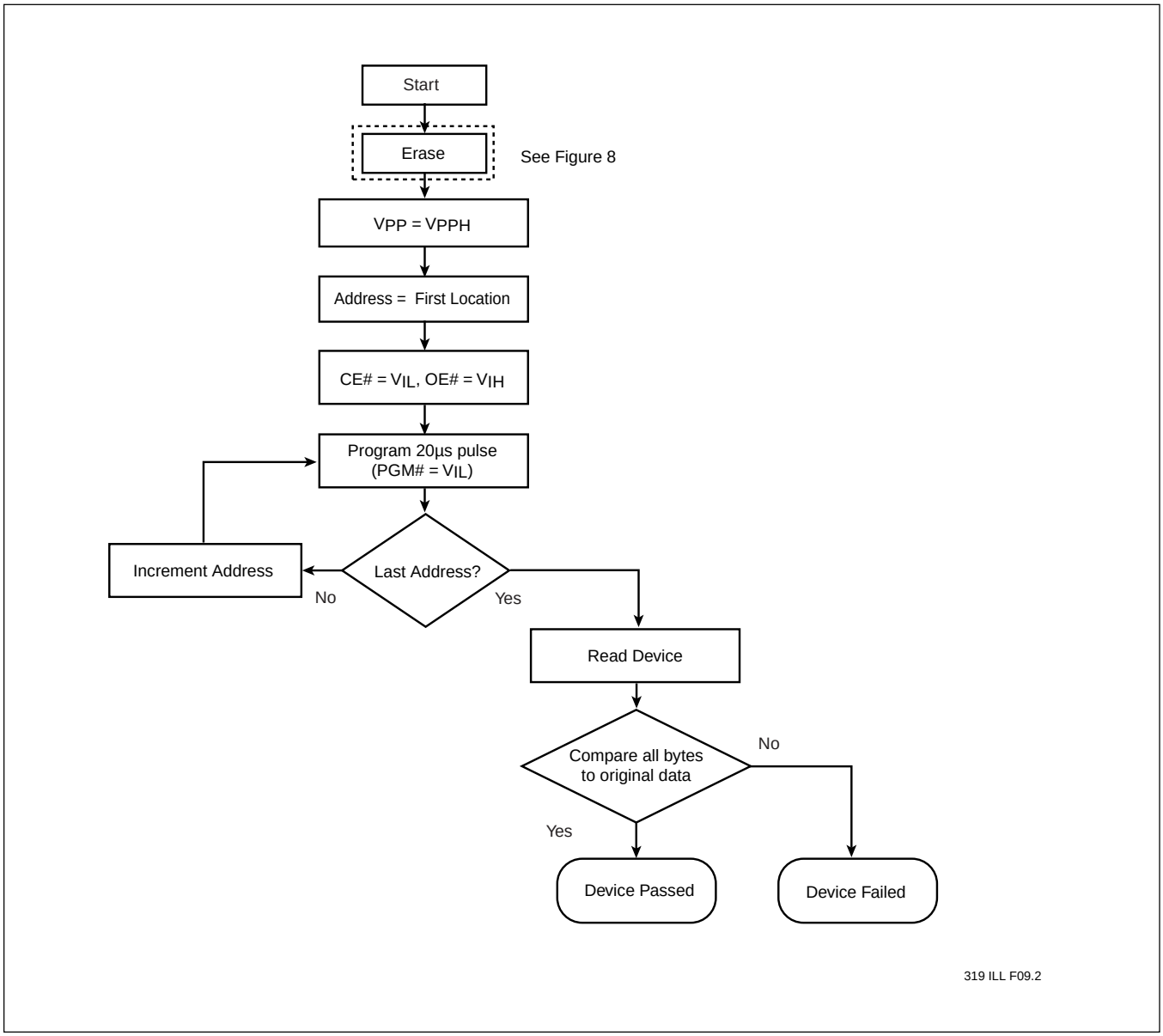


FIGURE 9: PROGRAMMING ALGORITHM

PRODUCT ORDERING INFORMATION

Device **Speed** **Suffix1** **Suffix2**

SST27SF020 - XXX - XX - XX

Package Modifier
H = 32 leads
Numeric = Die modifier

Package Type
P = PDIP
N = PLCC
W = TSOP (die up) (8mm x 14mm)
U = Unencapsulated die

Operating Temperature
C = Commercial = 0° to 70°C
I = Industrial = -40° to 85°C

Minimum Endurance
3 = 1000 cycles

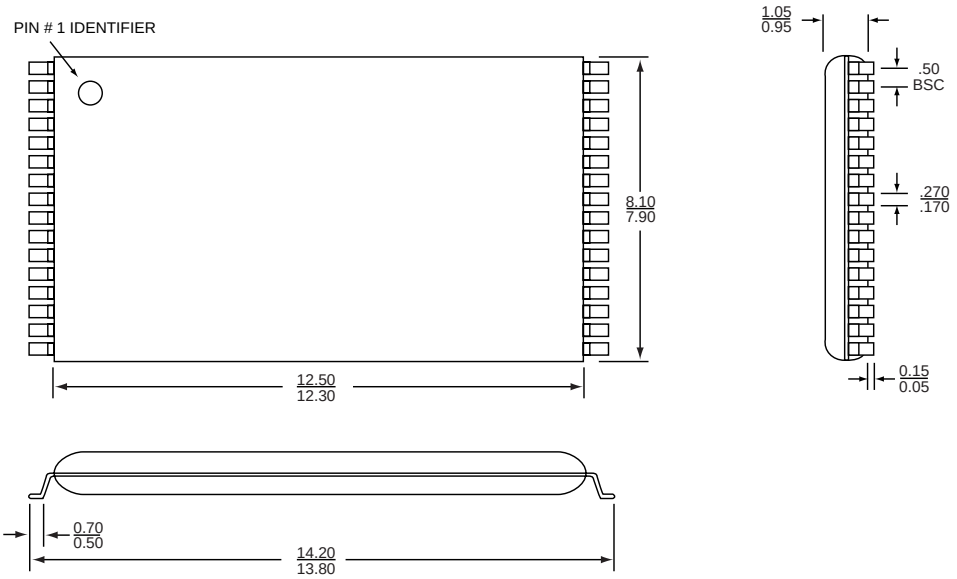
Read Access Speed
70 = 70 ns, 90 = 90 ns

Valid combinations

SST27SF020- 70-3C-WH	SST27SF020- 70-3C-NH	SST27SF020- 70-3C-PH
SST27SF020- 90-3C-WH	SST27SF020- 90-3C-NH	SST27SF020- 90-3C-PH
SST27SF020- 70-3I-WH	SST27SF020- 70-3I-NH	
SST27SF020- 90-3I-WH	SST27SF020- 90-3I-NH	SST27SF020- 90-3C-U1

Example: Valid combinations are those products in mass production or will be in mass production. Consult your SST sales representative to confirm availability of valid combinations and to determine availability of new combinations.

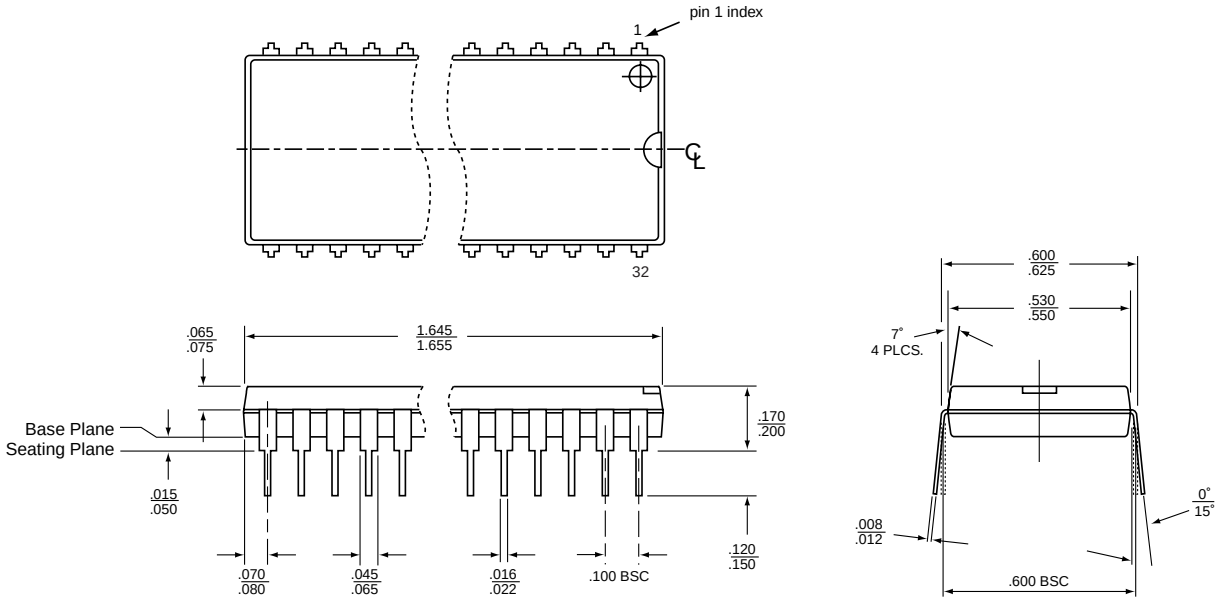
PACKAGING DIAGRAMS



Note: 1. Complies with JEDEC publication 95 MO-142 BA dimensions, although some dimensions may be more stringent.
2. All linear dimensions are in metric (min/max).
3. Coplanarity: 0.1 (±.05) mm.

32.TSOP-WH-ILL.2

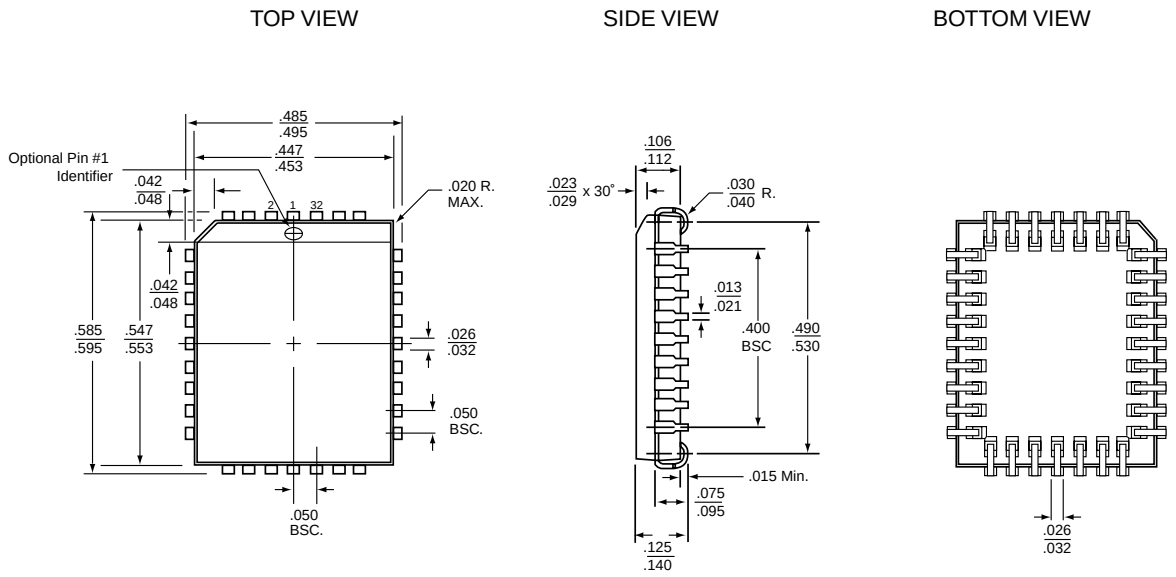
32-LEAD THIN SMALL OUTLINE PACKAGE (TSOP)
SST PACKAGE CODE: WH



Note: 1. Complies with JEDEC publication 95 MO-015 AP dimensions, although some dimensions may be more stringent.
2. All linear dimensions are in inches (min/max).
3. Dimensions do not include mold flash. Maximum allowable mold flash is .010 inches.

32.pdipPH-ILL.1

32-LEAD PLASTIC DUAL-IN-LINE PACKAGE (PDIP)
SST PACKAGE CODE: PH



Note: 1. Complies with JEDEC publication 95 MS-016 AE dimensions, although some dimensions may be more stringent.
2. All linear dimensions are in inches (min/max).
3. Dimensions do not include mold flash. Maximum allowable mold flash is .008 inches.

32.PLCC.NH-ILL.1

32-LEAD PLASTIC LEAD CHIP CARRIER (PLCC)
SST PACKAGE CODE: NH

SALES OFFICES

SST Area Offices

Customer Service	(408) 523-7754
Northwest USA, Rocky Mtns. & West Canada	(408) 523-7661
Central & Southwest USA	(727) 771-8819
East USA & East Canada	(978) 356-3845
North America - Distribution	(941) 505-8893
Asia Pacific	(408) 523-7762
East Asia	(81) 45-471-1851
Europe	(44) 1932-230555

North American Sales Representatives

Alabama M-Squared, Inc. - Huntsville	(205) 830-0498
Arizona QuadRep, Inc.	(602) 839-2102
California	
Costar - Northern	(408) 946-9339
Falcon Sales & Technology - San Marcos	(760) 591-0504
Westar Rep Company, Inc. - Calabasas	(818) 880-0594
Westar Rep Company, Inc. - Irvine	(949) 453-7900
Colorado Lange Sales, Inc.	(303) 795-3600
Florida	
M-Squared, Inc. - Clearwater	(727) 669-2408
M-Squared, Inc. - Coral Springs	(954) 753-5314
M-Squared, Inc. - Longwood	(407) 682-6662
Georgia M-Squared, Inc. - Atlanta	(770) 447-6124
Illinois	
Oasis Sales Corporation - Northern	(847) 640-1850
Rush & West Associates - Southern	(314) 965-3322
Indiana Applied Data Management	(317) 257-8949
Iowa Rush & West Associates	(319) 398-9679
Kansas Rush & West Associates	(913) 764-2700
Maryland Nexus Technology Sales	(301) 663-4159
Massachusetts A/D Sales	(978) 851-5400
Michigan Applied Data Management	(734) 741-9292
Minnesota Cahill, Schmitz & Cahill	(612) 699-0200
Missouri Rush & West Associates	(314) 965-3322
North Carolina	
M-Squared, Inc. - Charlotte	(704) 522-1150
M-Squared, Inc. - Raleigh	(919) 848-4300
New Jersey Nexus Technology Sales	(201) 947-0151
New Mexico QuadRep, Inc.	(505) 332-2417
New York	
Nexus Technology Sales	(516) 843-0100
Reagan/Compar - Endwell	(607) 754-2171
Reagan/Compar - E. Rochester	(716) 218-4370
Ohio	
Applied Data Management - Cincinnati	(513) 579-8108
Applied Data Management - Cleveland	(440) 946-6812
Oregon Thorson Pacific, Inc.	(503) 293-9001
Pennsylvania Nexus Technology Sales	(215) 675-9600
Texas	
Technical Marketing, Inc. - Carrollton	(972) 387-3601
Technical Marketing, Inc. - Houston	(713) 783-4497
Technical Marketing, Inc. - Austin	(512) 343-6976
Utah Lange Sales, Inc.	(801) 487-0843
Washington Thorson Pacific, Inc.	(425) 603-9393
Wisconsin Oasis Sales Corporation	(414) 782-6660
Canada	
Electronics Sales Professionals - Ottawa	(613) 828-6881
Electronics Sales Professionals - Toronto	(905) 856-8448
Electronics Sales Professionals - Montreal	(514) 388-6596
Thorson Pacific, Inc. - B.C.	(604) 294-3999

International Sales Representatives & Distributors

Australia ACD	(61) 3-762 7644
Belgium Memec Benelux	(32) 1540-0080
China/Hong Kong	
Actron Technology Co., Ltd. (HQ) Hong Kong	(852) 2727-3978
Actron Technology Co., Ltd. - Shanghai	(86) 21-6482-8021
Actron Technology Co., Ltd. - Shenzhen	(86) 755-376-2763
Actron Technology Co., Ltd. - Chengdu	(86) 28-553-2896
Actron Technology Co., Ltd. - Beijing	(86) 10-6261-0042
Actron Technology Co., Ltd. - Wuhan	(86) 27-8788-7226
Actron Technology Co., Ltd. - Xian	(86) 29-831-4585
MetaTech Limited (HQ) - Hong Kong	(852) 2421-2379
MetaTech Limited - Beijing	(86) 10-6858-2188
MetaTech Limited - Shanghai	(86) 21-6485-7530
MetaTech Limited - Chengdu	(86) 28-5577-415
MetaTech Limited - Fuzhou	(86) 591-378-1033
MetaTech Limited - Shenzhen	(86) 755-321-9726
Serial System Ltd. - Hong Kong	(852) 2950-0820
Serial System Ltd. - Chengdu	(86) 28-524-0208
Serial System Ltd. - Shanghai	(86) 21-6473-2080
Serial System Ltd. - Shenzhen	(86) 755-212-9076
France	
A2M - Bron	(33) 4 72 37 0414
A2M - Sevres	(33) 1 46 23 7900
Germany	
Endrich Bauelemente Vertriebs GMBH - Bramstedt	(49) 4192-897910
Endrich Bauelemente Vertriebs GMBH - Nagold	(49) 7452-60070
India	
Team Technology - Bangalore	(91) 80-526-1102
Team Technology - Hyderabad	(91) 40-231130
Team Technology - New Delhi	(91) 11-220-5624
Ireland Curragh Technology	(353) 61 316116
Israel Spectec Electronics	(972) 3-6498404
Italy Carlo Gavazzi Cefra SpA	(39) 2-424-1471
Japan	
Asahi Electronics Co., Ltd. - Tokyo	(81) 3-3350-5418
Asahi Electronics Co., Ltd. - Kitakyushu	(81) 93-511-6471
Microtek, Inc. - Osaka	(81) 6-6263-5080
Microtek, Inc. - Tokyo	(81) 3-5300-5515
Ryoden Trading Co., Ltd. - Osaka	(81) 6-6399-3443
Ryoden Trading Co., Ltd. - Tokyo	(81) 3-5396-6218
Silicon Technology Co., Ltd.	(81) 3-3795-6461
Korea Bigshine Korea Co., Ltd.	(82) 2-832-8881
Malaysia	
MetaTech (M) SDN BHD	(60)4-658-4276
Serial System SDN BHD	(60) 4-657-0204
Serial System - Kuala Lumpur	(60) 3-737-1243
Netherlands Memec Benelux	(31) 40-265-9399
Singapore	
MetaTech (S) Pte Ltd.	(65) 748-4844
Serial System Ltd. (HQ)	(65) 280-0200
South Africa KH Distributors	(27) 11 845-5011
Spain Tekelec Espana S.A.	(34) 91 371-7768
Switzerland Leading Technologies	(41) 27-721-7440/43
Taiwan, R.O.C.	
GCH-Sun Systems Co., Ltd. (GSS)	(886) 2-2555-0880
PCT Limited	(886) 2-2698-0098
Tonsam Corporation	(886) 2-2651-0011
United Kingdom Ambar Components, Ltd.	(44) 1296-397396

Revised 3-11-99