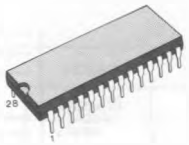
SGS-THOMSON MICROELECTRONICS

ST27128AP

128K (16K x 8) NMOS ONE TIME PROGRAMMABLE ROM

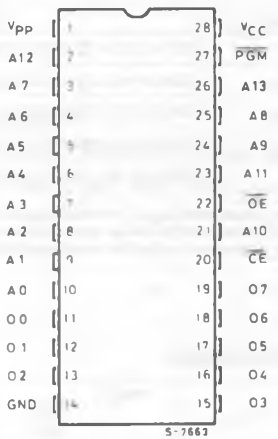
- FAST ACCESS TIME: 150ns
- 0 to +70°C STANDARD TEMPERATURE RANGE
- SINGLE +5V POWER SUPPLY
- ±10% V_{CC} TOLERANCE AVAILABLE
- LOW STANDBY CURRENT (40mA MAX)
- TTL COMPATIBLE DURING READ AND PROGRAM
- FAST PROGRAMMING ALGORITHM
- ELECTRONIC SIGNATURE



P
DIP-28
(Plastic Package)

(Ordering Information at the end of the datasheet)

PIN CONNECTIONS



DESCRIPTION

The ST27128AP is a 131,072-bit one time programmable read only memory (OTP ROM). It is organized as 16,384 words by 8 bits and manufactured using SGS-THOMSON' NMOS-E3 process.

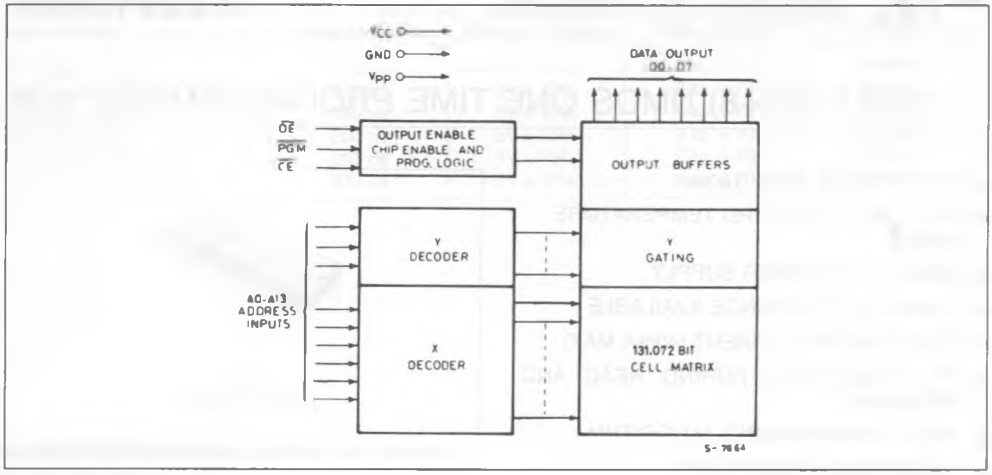
The ST27128AP with its single +5V power supply and with an access time of 200ns, is ideal for use with high performance +5V microprocessor such as Z8, Z80 and Z8000. The ST27128AP has an important feature which is to separate the output control, Ouptut Enable ($\overline{OE}$) from the Chip Enable control ($\overline{CE}$). The $\overline{OE}$ control eliminates bus contention in multiple bus microprocessor systems.

The ST27128AP also features a standby mode which reduces the power dissipation without increasing access time. The active current is 85mA while the maximum standby current is only 40mA, a 53% saving. The standby mode is achieved by applying a TTL-high signal to the $\overline{CE}$ input. The ST27128AP has an "Electronic Signature" that allows programmers to automatically identify device type and pinout. The ST27128AP is available in a 28-lead dual in-line plastic package and therefore cannot be rewritten.

PIN NAMES

A0-A13	ADDRESS INPUT
$\overline{CE}$	CHIP ENABLE INPUT
$\overline{OE}$	OUTPUT ENABLE INPUT
$\overline{PGM}$	PROGRAM
O0-O7	DATA INPUT/OUTPUT

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Values	Unit
V_I	All Input or Output voltages with respect to ground	+6.25 to −0.6	V
V_{PP}	Supply voltage with respect to ground	+14 to −0,6	V
T_{amb}	Ambient temperature under bias	−10 to +80	°C
T_{stg}	Storage temperature range	− 65 to +125	°C
	Voltage on pin 24 with respect to ground	+13.5 to −0.6	V

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

OPERATING MODES

MODE \ PINS	$\overline{CE}$ (20)	$\overline{OE}$ (22)	A9 (24)	$\overline{PGM}$ (27)	V_{PP} (1)	V_{CC} (28)	OUTPUTS (11-13, 15-19)
READ	V_{IL}	V_{IL}	X	V_{IH}	V_{CC}	V_{CC}	D_{OUT}
OUTPUT DISABLE	V_{IL}	V_{IH}	X	V_{IH}	V_{CC}	V_{CC}	HIGH Z
STANDBY	V_{IH}	X	X	X	V_{CC}	V_{CC}	HIGH Z
FAST PROGRAMMING	V_{IL}	V_{IH}	X	V_{IL}	V_{PP}	V_{CC}	D_{IN}
VERIFY	V_{IL}	V_{IL}	X	V_{IH}	V_{PP}	V_{CC}	D_{OUT}
PROGRAM INHIBIT	V_{IH}	X	X	X	V_{PP}	V_{CC}	HIGH Z
ELECTRONIC SIGNATURE	V_{IL}	V_{IL}	V_H	V_{IH}	V_{CC}	V_{CC}	CODES

NOTE: X can be V_{IH} or V_{IL} V_H = 12V ±0.5V

READ OPERATION

DC AND AC CONDITIONS

Selection Code	–15X/–20X	–20/–25/–30
Operating Temperature Range	0 to 70°C	0 to 70°C
V_{CC} Power Supply (1,2)	5V ±5%	5V ±10%
V_{PP} Voltage (2)	$V_{PP} = V_{CC}$	$V_{PP} = V_{CC}$

DC AND OPERATING CHARACTERISTICS

Symbol	Parameter	Test Conditions	Values			Unit
			Min.	Typ. (3)	Max.	
I_{LI}	Input Load Current	$V_{IN} = 5.5V$			10	µA
I_{LO}	Output Leakage Current	$V_{OUT} = 5.5V$			10	µA
I_{PP1}(2)	V_{PP} Current Read Standby	$V_{PP} = 5.5V$			5	mA
I_{CC1}(2)	V_{CC} Current Standby	$\overline{CE} = V_{IH}$			40	mA
I_{CC2}(2)	V_{CC} Current Active	$\overline{CE} = \overline{OE} = V_{IL}$ $V_{PP} = V_{CC}$			85	mA
V_{IL}	Input Low Voltage		–0.1		+0.8	V
V_{IH}	Input High Voltage		2.0		$V_{CC}+1$	V
V_{OL}	Output Low Voltage	$I_{OL} = 2.1$ mA			0.45	V
V_{OH}	Output High Voltage	$I_{OH} = -400$ µA	2.4			V
V_{PP}(2)	V_{PP} Read Voltage	$V_{CC} = 5V \pm 0.25V$	3.8		V_{CC}	V

AC CHARACTERISTICS

Symbol	Parameter	V_{CC} ± 5% V_{CC} ±10% Test Conditions	27128A-15X Min	 Max	27128A-20X 27128A-20 Min	 Max	27128A-25 Min	 Max	27128A-30 Min	 Max	Unit
t_{ACC}	Address to Output Delay	$\overline{CE} = \overline{OE} = V_{IL}$		150		200		250		300	ns
t_{CE}	$\overline{CE}$ to Output Delay	$\overline{OE} = V_{IL}$		150		200		250		300	ns
t_{OE}	$\overline{OE}$ to Output Delay	$\overline{CE} = V_{IL}$		65		75		100		120	ns
t_{DF}(4)	$\overline{OE}$ High to Output Float	$\overline{CE} = V_{IL}$		55	0	55	0	60	0	105	ns
t_{OH}	Output Hold from Address, $\overline{CE}$ or $\overline{OE}$ Whichever Occurred First	$\overline{CE} = \overline{OE} = V_{IL}$	0		0		0		0		ns

CAPACITANCE(5) ($T_{amb} = 25°C$, f = 1 MHz)

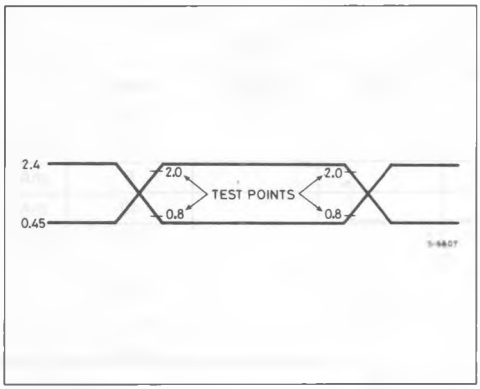
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 0V$		4	6	pF
C_{OUT}	Output Capacitance	$V_{OUT} = 0V$		8	12	pF

Notes:
1. V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.
2. V_{PP} may be connected directly to V_{CC} except during programming. The supply current would then be the sum of I_{CC} and I_{PP1}.
3. Typical values are for $T_{amb} = 25°C$ and nominal supply voltages.
4. This parameter is only sampled and not 100% tested. Output Float is defined as the point where data is no longer driven. (See timing diagram)
5. This parameter is only sampled and is not 100% tested.

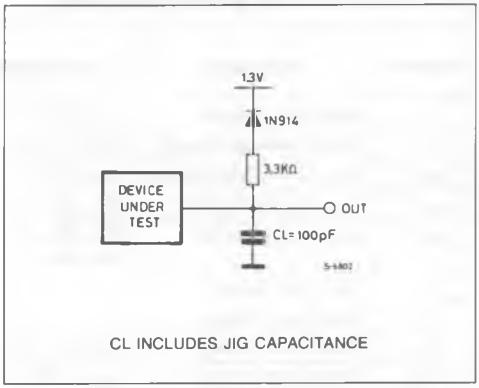
READ OPERATION (Continued)

AC TEST CONDITIONS
Output Load: 100pF + 1TTL Gate
Input Rise and Fall Times: ≤ 20ns
Input Pulse Levels: 0.45 to 2.4V
Timing Measurement Reference Levels: Inputs 0.8 and 2V
Outputs 0.8 and 2V

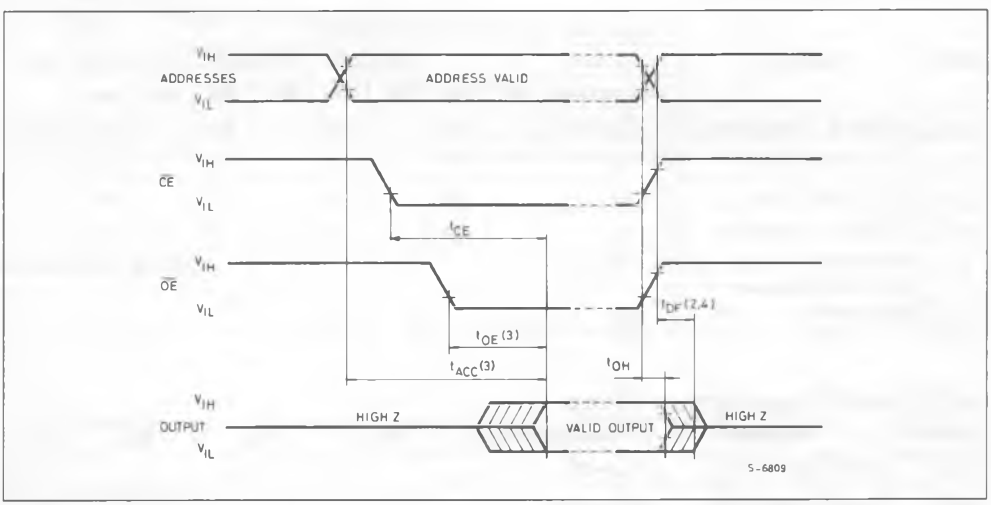
AC TESTING INPUT/OUTPUT WAVEFORM



AC TESTING LOAD CIRCUIT



AC WAVEFORMS



Notes:
1. Typical values are for T_{amb} = 25°C and nominal supply voltage.
2. This parameter is only sampled and not 100% tested.
3. $\overline{OE}$ may be delayed up to $t_{ACC} - t_{OE}$ after the falling edge $\overline{CE}$ without impact on t_{ACC}.
4. t_{DF} is specified from $\overline{OE}$ or $\overline{CE}$ whichever occurs first.

DEVICE OPERATION

The seven modes of operations of the ST27128AP are listed in the Operating Modes. A single 5V power supply is required in the read mode. All inputs are TTL levels except for V_{PP} and 12V on A9 for Electronic Signature.

READ MODE

The ST27128AP has two control function, both of which must be logically satisfied in order to obtain data at the outputs. Chip Enable ($\overline{CE}$) is the power control and should be used for device selection. Output Enable ($\overline{OE}$) is the output control and should be used to gate data to the output pins, independent of device selection.

Assuming that addresses are stable, address access time (t_{ACC}) is equal to delay from $\overline{CE}$ to output (t_{CE}). Data is available at the outputs after the falling edge of $\overline{OE}$, assuming that $\overline{CE}$ has been low and addresses have been stable for at least t_{ACC}-t_{OE}.

STANDBY MODE

The ST27128AP has a standby mode which reduces the maximum active power current from 85 mA to 40 mA. The ST27128AP is placed in the standby mode by applying a TTL high signal to the $\overline{CE}$ input. When in the standby mode, the outputs are in a high impedance state, independent of the $\overline{OE}$ input.

OUTPUT OR-TIEING

Because OTPs are usually used in larger memory arrays, the product features a 2 line control function which accommodates the use of multiple memory connection. The two line control function allows:

a) the lowest possible memory power dissipation
b) complete assurance that output bus contention will not occur.

For the most efficient use of these two control lines, $\overline{CE}$ should be decoded and used as the primary device selecting function, while $\overline{OE}$ should be made a common connection to all devices in the array and connected to the $\overline{READ}$ line from the system control bus.

This assures that all deselected memory devices are in their low power standby mode and that the output pins are only active when data is desired from a particular memory device.

SYSTEM CONSIDERATIONS

The power switching characteristics of NMOS-E3 EPROMs require careful decoupling of the devices. The supply current, I_{CC}, has three segments that are of interest to the system designer: the standby current level, the active current level, and transient current peaks that are produced by the falling and rising edges of $\overline{CE}$. The magnitude of this transient current peaks is dependent on the output capacitive and inductive loading of the device. The associated transient voltage peaks can be suppressed by complying with the two line output control and by properly selected decoupling capacitors.

It is recommended that a 1 μF ceramic capacitor be used on every device between V_{CC} and GND. This should be a high frequency capacitor of low inherent inductance and should be placed as close to the device as possible. In addition, a 4.7 μF bulk electrolytic capacitors should be used between V_{CC} and GND for every eight devices. The bulk capacitor should be located near where the power supply is connected to the array. The purpose of the bulk capacitor is to overcome the voltage drop caused by the inductive effects of PCB traces.

PROGRAMMING

Caution: exceeding 13V on pin 1 (V_{PP}) will damage the ST27128AP.

When delivered, all bits of the ST27128AP are in the "1" state. Data is introduced by selectively programming "0s" into the desired bit locations. Although only "0s" will be programmed, both "1s" and "0s" can be present in the data word.

The ST27128AP is in the programming mode when V_{PP} input is at 12.5V and $\overline{CE}$ and $\overline{PGM}$ are at TTL low. The data to be programmed is applied 8 bits in parallel to the data output pins. The levels required for the address and data inputs are TTL.

FAST PROGRAMMING ALGORITHM

Fast Programming Algorithm rapidly programs ST27128AP EPROMs using an efficient and reliable method suited to the production programming environment. Programming reliability is also ensured as the incremental program margin of each bytes is continually monitored to determine when it has been successfully programmed. A flowchart of the ST27128AP Fast Programming Algorithm is shown on the last page. The Fast Programming Algorithm utilizes two different pulse types: initial and overprogram.

The duration of the initial $\overline{PGM}$ pulse (s) is one millisecond, which will then be followed by a longer overprogram pulse of length 3Xmsec. (X is an iteration counter and is equal to the number of the initial one millisecond pulses applied to a particular ST27128AP location), before a correct verify occurs. Up to 25 one-millisecond pulses per byte are provided for before the over program pulse is applied.

DEVICE OPERATION (Continued)

The entire sequence of program pulses and byte verifications is performed at $V_{CC} = 6V$ and $V_{PP} = 12.5V$. When the Fast Programming cycle has been completed, all bytes should be compared to the original data with $V_{CC} = V_{PP} = 5V$.

PROGRAM INHIBIT

Programming of multiple ST27128APs in parallel with different data is also easily accomplished. Except for $\overline{CE}$, all like inputs (including $\overline{OE}$) of the parallel M27128BA may be common. A TTL low pulse applied to a ST27128AP's $\overline{CE}$ input, with V_{PP} at 12.5V, will program that ST27128AP. A high level $\overline{CE}$ input inhibits the other ST27128AP from being programmed.

PROGRAM VERIFY

A verify should be performed on the programmed bits to determine that they were correctly programmed. The verify is accomplished with $\overline{OE}$ at V_{IL}, $\overline{CE}$ at V_{IL}, $\overline{PGM}$ at V_{IH} and V_{PP} at 12.5V.

ELECTRONIC SIGNATURE

The Electronic Signature mode allows the reading out of a binary code from an EPROM that will identify its manufacturer and type. This mode is intended for use by programming equipment for the purpose of automatically matching the device to be programmed with its corresponding programming algorithm. This mode is functional in the 25°C ±5°C ambient temperature range that is required when programming the ST27128AP. To activate this mode, the programming equipment must force 11.5V to 12.5V on address line A9 (pin 24) of the ST27128AP. Two identifier bytes may than be sequenced from the device outputs by toggling address line A0 (pin 10) from V_{IL} to V_{IH}. All other address lines must be held at V_{IL} during Electronic Signature mode. Byte 0 ($A0 = V_{IL}$) represents the manufacturer code and byte 1 ($A0 = V_{IH}$) the device identifier code. For the SGS-THOMSON ST27128AP, these two identifier bytes are given below. All identifiers for manufacturer and device codes will possess odd parity, with the MSB (07) defined as the parity bit.

ELECTRONIC SIGNATURE MODE

PINS / IDENTIFIER	A0 (10)	O7 (19)	O6 (18)	O5 (17)	O4 (16)	O3 (15)	O2 (13)	O1 (12)	O0 (11)	Hex Data
MANUFACTURER CODE	V_{IL}	0	0	1	0	0	0	0	0	20
DEVICE CODE	V_{IH}	1	0	0	0	1	0	0	1	89

PROGRAMMING OPERATION (T_{amb} = 25°C ±5°C, V_{CC}(1) = 6V ±0.25V, V_{PP}(1) = 12.5V ±0.3V)

DC AND OPERATING CHARACTERISTIC

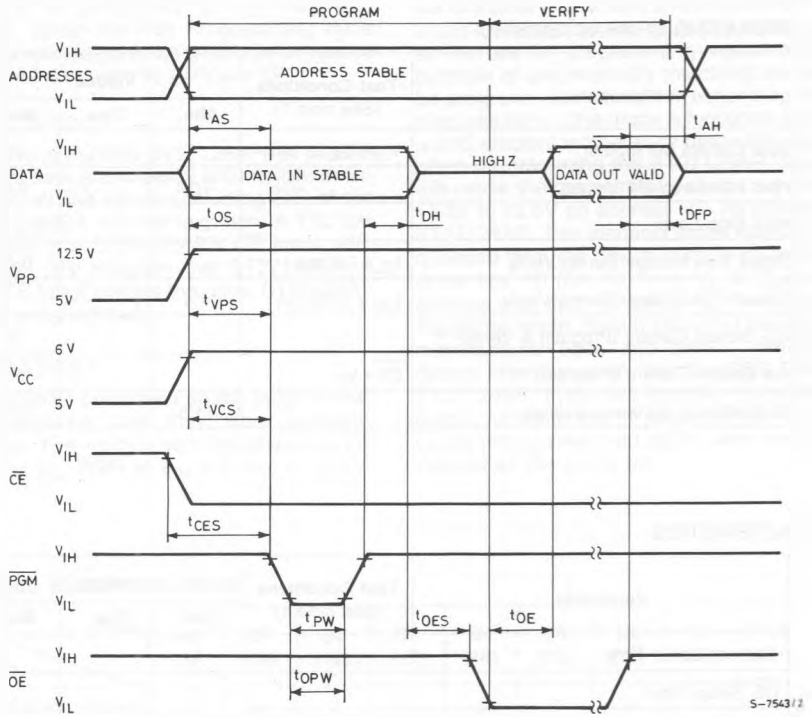
Symbol	Parameter	Test Conditions (See note 1)	Values			Unit
			Min.	Typ.	Max.	
I_{LI}	Input Current (All Inputs)	$V_{IN} = V_{IL}$ or V_{IH}			10	µA
V_{IL}	Input Low Level (All Inputs)		−0.1		0.8	V
V_{IH}	Input High Level		2.0		V_{CC} + 1	V
V_{OL}	Output Low Voltage During Verify	I_{OL} = 2.1 mA			0.45	V
V_{OH}	Output High Voltage During Verify	I_{OH} = −400 µA	2.4			V
I_{CC2}	V_{CC} Supply Current (Program & Verify)				100	mA
I_{PP2}	V_{PP} Supply Current (Program)	$\overline{CE} = V_{IL}$			50	mA
V_{ID}	A9 Electronic Signature Voltage		11.5		12.5	V

AC CHARACTERISTICS

Symbol	Parameter	Test Conditions (See note 1)	Values			Unit
			Min.	Typ.	Max.	
t_{AS}	Address Setup Time		2			µs
t_{OES}	$\overline{OE}$ Setup Time		2			µs
t_{DS}	Data Setup Time		2			µs
t_{AH}	Address Hold Time		0			µs
t_{DH}	Data Hold Time		2			µs
t_{DFP}(4)	Output Enable Output Float Delay		0		130	ns
t_{VPS}	V_{PP} Setup Time		2			µs
t_{VCS}	V_{CC} Setup Time		2			µs
t_{CES}	CE Setup Time		2			µs
t_{PW}	$\overline{PGM}$ Initial Program Pulse Width	(see Note 3)	0.95	1.0	1.05	ms
t_{OPW}	$\overline{PGM}$ Overprogram Pulse Width	(see Note 2)	2.85		78.75	ms
t_{OE}	Data Valid from $\overline{OE}$				150	ns

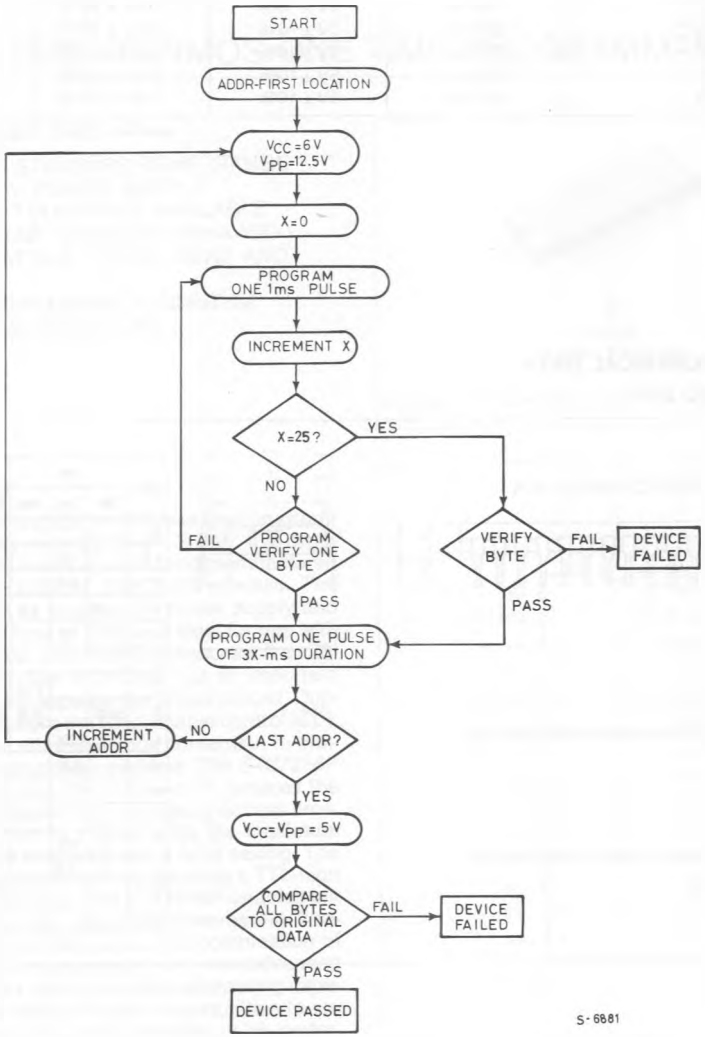
Notes:
1. V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.
2. The length of the overprogram pulse may vary from 2.85msec to 78.75msec as a function of the iteration counter value X.
3. Initial Program Pulse width tolerance is 1msec ±5%.
4. This parameter is only sampled and not 100% tested.
   Output Float is defined as the point where data is no longer driven (see timing diagram).

PROGRAMMING WAVEFORMS



Notes:
1. The input timing reference level is 0.8V for a V_{IL} and 2V for a V_{IH}.
2. t_{OE} and t_{DFP} are characteristics of the device but must be accommodated by the programmer.
3. When programming the ST27128AP a 0.1µF capacitor is required across V_{PP} and GROUND to suppress spurious voltage transients which can damage the device.

FAST PROGRAMMING FLOWCHART

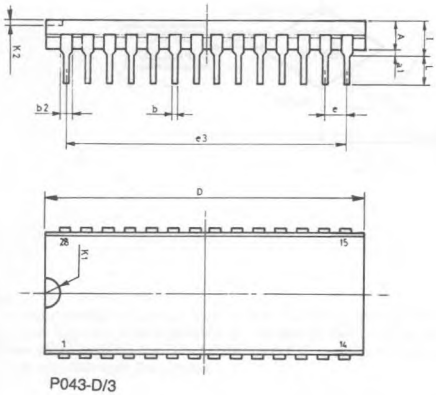


ORDERING INFORMATION

Part Number	Access Time	Supply Voltage	Temp. Range	Package
ST27128A-15XCP	150 ns	5V ± 5%	0 to +70°C	DIP-28
ST27128A-20XCP	200 ns	5V ± 5%	0 to +70°C	DIP-28
ST27128A-20CP	200 ns	5V ± 10%	0 to +70°C	DIP-28
ST27128A-25CP	250 ns	5V ± 10%	0 to +70°C	DIP-28
ST27128A-30CP	300 ns	5V ± 10%	0 to +70°C	DIP-28

PACKAGE MECHANICAL DATA

28-PIN PLASTIC DIP



P043-D/3

Dim.	mm			inches		
	Min	Typ	Max	Min	Typ	Max
A						
a 1		0.63			0.025	
B		0.45			0.018	
b 1	0.23		0.31	0.009		0.012
b 2		1.27			0.050	
C						
D			37.34			1.470
E	15.20		16.68	0.598		0.657
e		2.54			0.100	
e3		33.02			1.300	
e4						
F			14.10			0.555
I		4.45			0.175	
L		3.30			0.130	
K1						
K2						