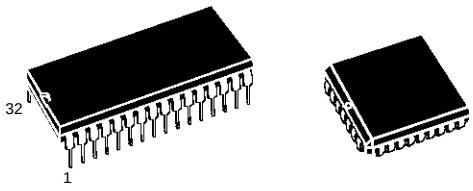
SGS-THOMSON MICROELECTRONICS

M28F256

256K (32K x 8, Chip Erase) FLASH MEMORY

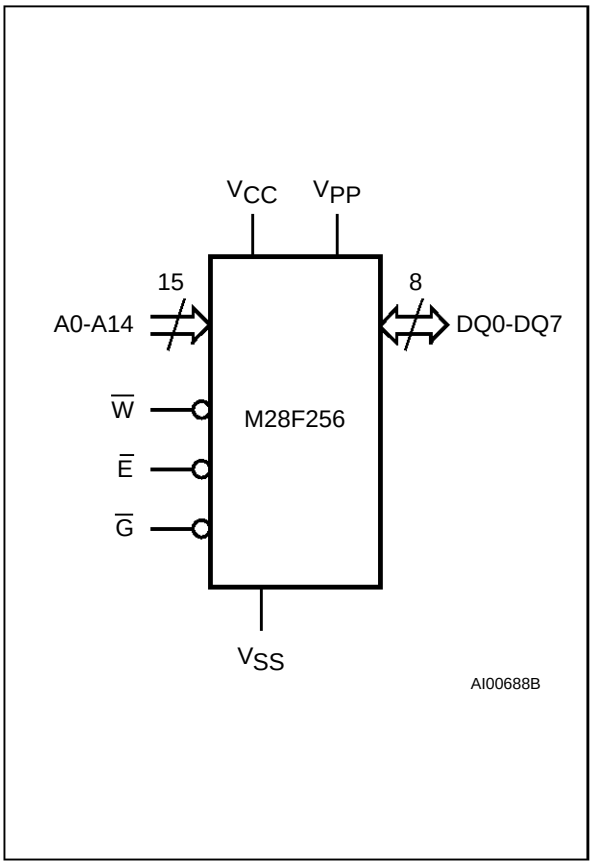
- FAST ACCESS TIME: 90ns
- LOW POWER CONSUMPTION
  - Standby Current: 100µA Max
- 10,000 ERASE/PROGRAM CYCLES
- 12V PROGRAMMING VOLTAGE
- TYPICAL BYTE PROGRAMMING TIME 10µs (PRESTO F ALGORITHM)
- ELECTRICAL CHIP ERASE IN 1s RANGE
- INTEGRATED ERASE/PROGRAM STOP TIMER
- EXTENDED TEMPERATURE RANGES



PDIP32 (B)

PLCC32 (C)

Figure 1. Logic Diagram



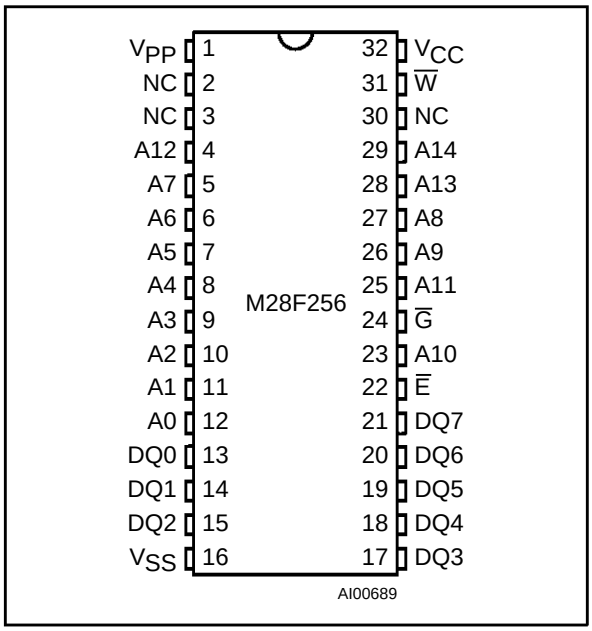
DESCRIPTION

The M28F256 FLASH Memory Is a non-volatile memory which may be erased electrically at the chip level and programmed byte-by-byte. It is organised as 32K bytes of 8 bits. It uses a command register architecture to select the operating modes and thus provides a simple microprocessor interface. The M28F256 FLASH Memory is suitable for applications where the memory has to be reprogrammed in the equipment. The access time of 100ns makes the device suitable for use in high speed microprocessor systems.

Table 1. Signal Names

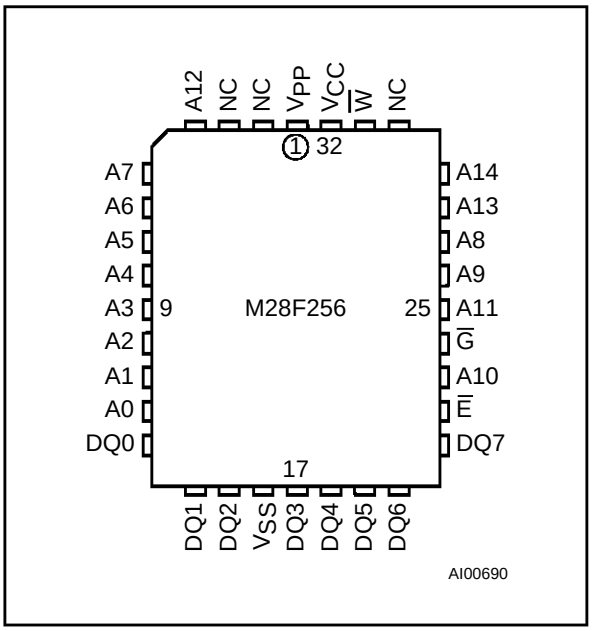
A0 - A14	Address Inputs
DQ0 - DQ7	Data Inputs / Outputs
$\overline{E}$	Chip Enable
$\overline{G}$	Output Enable
$\overline{W}$	Write Enable
V_{PP}	Program Supply
V_{CC}	Supply Voltage
V_{SS}	Ground

Figure 2A. DIP Pin Connections



Warning: NC = Not Connected

Figure 2B. LCC Pin Connections



Warning: NC = Not Connected

Table 2. Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
T_A	Ambient Operating Temperature	–40 to 125	°C
T_{STG}	Storage Temperature	–65 to 150	°C
V_{IO}	Input or Output Voltages	–0.6 to 7	V
V_{CC}	Supply Voltage	–0.6 to 7	V
V_{A9}	A9 Voltage	–0.6 to 13.5	V
V_{PP}	Program Supply Voltage, during Erase or Programming	–0.6 to 14	V

Note: Except for the rating "Operating Temperature Range", stresses above those listed in the Table "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the SGS-THOMSON SURE Program and other relevant quality documents.

DEVICE OPERATION

The M28F256 FLASH Memory employs a technology similar to a 256K EPROM but adds to the device functionality by providing electrical erasure and programming. These functions are managed by a command register. The functions that are addressed via the command register depend on the voltage applied to the V_{PP}, program voltage, input. When V_{PP} is less than or equal to 6.5V, the command register is disabled and M28F256 functions as a read only memory providing operating modes similar to an EPROM (Read, Output Disable, Electronic Signature Read and Standby). When V_{PP} is raised to 12V the command register is enabled and this provides, in addition, Erase and Program operations.

Table 3. Operations (1)

	V_{PP}	Operation	$\overline{E}$	$\overline{G}$	$\overline{W}$	A9	DQ0 - DQ7
Read Only	V_{PPL}	Read	V_{IL}	V_{IL}	V_{IH}	A9	Data Output
		Output Disable	V_{IL}	V_{IH}	V_{IH}	X	Hi-Z
		Standby	V_{IH}	X	X	X	Hi-Z
		Electronic Signature	V_{IL}	V_{IL}	V_{IH}	V_{ID}	Codes
Read/Write (2)	V_{PPH}	Read	V_{IL}	V_{IL}	V_{IH}	A9	Data Output
		Write	V_{IL}	V_{IH}	V_{IL} Pulse	A9	Data Input
		Output Disable	V_{IL}	V_{IH}	V_{IH}	X	Hi-Z
		Standby	V_{IH}	X	X	X	Hi-Z

Notes: 1. X = V_{IL} or V_{IH}
2. Refer also to the Command Table

Table 4. Electronic Signature

Identifier	A0	DQ7	DQ6	DQ5	DQ4	DQ3	DQ2	DQ1	DQ0	Hex Data
Manufacturer's Code	V_{IL}	0	0	1	0	0	0	0	0	20h
Device Code	V_{IH}	1	0	1	0	1	0	0	0	0A8h

READ ONLY MODES, $V_{PP} \leq$ 6.5V

For all Read Only Modes, except Standby Mode, the Write Enable input $\overline{W}$ should be High. In the Standby Mode this input is 'don't care'.

Read Mode. The M28F256 has two enable inputs, $\overline{E}$ and $\overline{G}$, both of which must be Low in order to output data from the memory. The Chip Enable ($\overline{E}$) is the power control and should be used for device selection. Output Enable ($\overline{G}$) is the output control and should be used to gate data on to the output, independant of the device selection.

Standby Mode. In the Standby Mode the maximum supply current is reduced to 100µA. The device is placed in the Standby Mode by applying a High to the Chip Enable ($\overline{E}$) input. When in the Standby Mode the outputs are in a high impedance state, independant of the Output Enable ($\overline{G}$) input.

Output Disable Mode. When the Output Enable ($\overline{G}$) is High the outputs are in a high impedance state.

Electronic Signature Mode. This mode allows the read out of two binary codes from the device which identify the manufacturer and device type. This mode is intended for use by programming equipment to automatically select the correct erase and programming algorithms. The Electronic Signature Mode is active when a high voltage (11.5V to 13V) is applied to address line A9 with $\overline{E}$ and $\overline{G}$ Low. With A0 Low the output data is the manufacturer code, when A0 is High the output is the device type code. All other address lines should be maintained Low while reading the codes. The electronic signature may also be accessed in Read/Write modes.

READ/WRITE MODES, 11.4V $\leq V_{PP} \leq$ 12.6V

When V_{PP} is High both read and write operations may be performed. These are defined by the contents of an internal command register. Commands may be written to this register to set-up and execute, Erase, Erase Verify, Program, Program Verify and Reset modes. Each of these modes needs 2

Table 5. Commands (1)

Command	Cycles	1st Cycle			2nd Cycle		
		Operation	A0-A14	DQ0-DQ7	Operation	A0-A14	DQ0-DQ7
Read	1	Write	X	00h			
Electronic Signature	2	Write	X	90h	Read	0000h	20h
					Read	0001h	0A8h
Setup Erase/ Erase	2	Write	X	20h			
					Write	X	20h
Erase Verify	2	Write	A0-A14	0A0h	Read	X	Data Output
Setup Program/ Program	2	Write	X	40h			
					Write	A0-A14	Data Input
Program Verify	2	Write	X	0C0h	Read	X	Data Output
Reset	2	Write	X	0FFh	Write	X	0FFh

Note: 1. X = V_{IL} or V_{IH}

READ/WRITE MODES (cont'd)

cycles. Every mode starts with a write operation to set-up the command, this is followed by either read or write operations. The device expects the first cycle to be a write operation and does not corrupt data at any location in memory. Read mode is set-up with one cycle only and may be followed by any number of read operations to output data. Electronic Signature Read mode is set-up with one cycle and followed by a read cycle to output the manufacturer or device codes.

A write to the command register is made by bringing $\overline{W}$ Low while $\overline{E}$ is Low. The falling edge of $\overline{W}$ latches Addresses, while the rising edge latches Data, which are used for those commands that require address inputs, command input or provide data output.

The supply voltage V_{CC} and the program voltage V_{PP} can be applied in any order. When the device is powered up or when V_{PP} is ≤ 6.5V the contents of the command register default to 00h, thus automatically setting-up Read operations. In addition a specific command may be used to set the command register to 00h for reading the memory.

The system designer may choose to provide a constant high V_{PP} and use the register commands for all operations, or to switch the V_{PP} from low to high only when needing to erase or program the memory. All command register access is inhibited when V_{CC} falls below the Erase/Write Lockout Voltage (V_{LKO}) at 2.5V.

If the device is deselected during Erasure, Programming or Verification it will draw active supply currents until the operations are terminated.

The device is protected against stress caused by long erase or program times. If the end of Erase or Programming operations are not terminated by a Verify cycle within a maximum time permitted, an internal stop timer automatically stops the operation. The device remains in an inactive state, ready to start a Verify or Reset Mode operation.

Read Mode. The Read Mode is the default at power up or may be set-up by writing 00h to the command register. Subsequent read operations output data from the memory. The memory remains in the Read Mode until a new command is written to the command register.

AC MEASUREMENT CONDITIONS

Input Rise and Fall Times	≤ 10ns
Input Pulse Voltages	0.45V to 2.4V
Input and Output Timing Ref. Voltages	0.8V to 2V

Note that Output Hi-Z is defined as the point where data is no longer driven.

Figure 3. AC Testing Input Output Waveforms

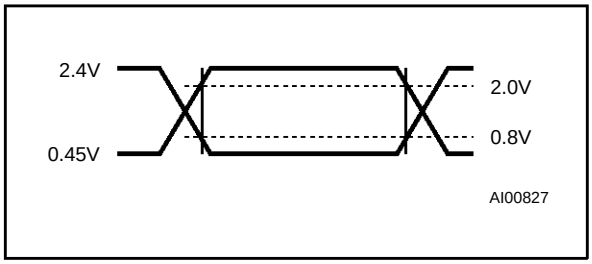


Figure 4. AC Testing Load Circuit

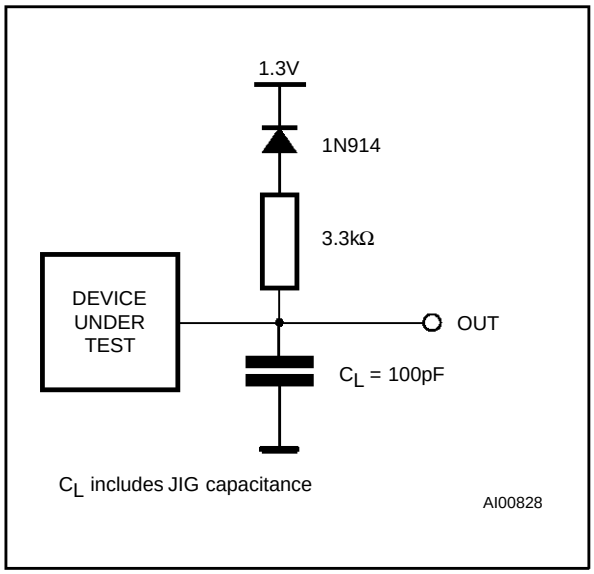


Table 6. Capacitance (1) (T_A = 25 °C, f = 1 MHz)

Symbol	Parameter	Test Condition	Min	Max	Unit
C_{IN}	Input Capacitance	V_{IN} = 0V		6	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V		12	pF

Note: 1. Sampled only, not 100% tested

Electronic Signature Mode. In order to select the correct erase and programming algorithms for on-board programming, the manufacturer and devices code may be read directly. It is not neccessary to apply a high voltage to A9 when using the command register. The Electronic Signature Mode is set-up by writing 90h to the command register. The following read cycle, with address inputs 0000h or 0001h, output the manufacturer or device type codes. The command is terminated by writing another valid command to the command register (for example Reset).

Erase and Erase Verify Modes. The memory is erased by first Programming all bytes to 00h, the Erase command then erases them to 0FFh. The Erase Verify command is then used to read the memory byte-by-byte for a content of 0FFh.

The Erase Mode is set-up by writing 20h to the command register. The write cycle is then repeated to start the erase operation. Erasure starts on the rising edge of $\overline{W}$ during this second cycle. Erase is followed by an Erase Verify which reads an addressed byte.

Erase Verify Mode is set-up by writing 0A0h to the command register and at the same time supplying the address of the byte to be verified. The rising edge of $\overline{W}$ during the set-up of the first Erase Verify Mode stops the Erase operation. The following read cycle is made with an internally generated margin voltage applied; reading 0FFh indicates that all bits of the addressed byte are fully erased. The whole contents of the memory are verified by repeating the Erase Verify Operation, first writing the set-up code 0A0h with the address of the byte to be verified and then reading the byte contents in a second read cycle.

As the Erase algorithm flow chart shows, when the data read during Erase Verify is not 0FFh, another Erase operation is performed and verification continues from the address of the last verified byte. The command is terminated by writing another valid command to the command register (for example Program or Reset).

Table 7. DC Characteristics
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; V_{CC} = 5V ± 5% or 5V ± 10%)

Symbol	Parameter	Test Condition	Min	Max	Unit
I_{LI}	Input Leakage Current	$0V \le V_{IN} \le V_{CC}$		±1	µA
I_{LO}	Output Leakage Current	$0V \le V_{OUT} \le V_{CC}$		±10	µA
I_{CC}	Supply Current (Read)	$\overline{E} = V_{IL}$, f = 6MHz		30	mA
I_{CC1}	Supply Current (Standby) TTL	$\overline{E} = V_{IH}$		1	mA
	Supply Current (Standby) CMOS	$\overline{E} = V_{CC} \pm 0.2V$		100	µA
I_{CC2} (1)	Supply Current (Programming)	During Programming		10	mA
I_{CC3} (1)	Supply Current (Program Verify)	During Verify		10	mA
I_{CC4} (1)	Supply Current (Erase)	During Erasure		10	mA
I_{CC5} (1)	Supply Current (Erase Verify)	During Erase Verify		10	mA
I_{LPP}	Program Leakage Current	$V_{PP} \le V_{CC}$		±10	µA
I_{PP}	Program Current (Read or Standby)	$V_{PP} > V_{CC}$		200	µA
		$V_{PP} \le V_{CC}$		±10	µA
I_{PP1}(1)	Program Current (Programming)	$V_{PP} = V_{PPH}$, During Programming		10	mA
I_{PP2}(1)	Program Current (Program Verify)	$V_{PP} = V_{PPH}$, During Verify		10	mA
I_{PP3}(1)	Program Current (Erase)	$V_{PP} = V_{PPH}$, During Erase		5	mA
I_{PP4}(1)	Program Current (Erase Verify)	$V_{PP} = V_{PPH}$, During Erase Verify		5	mA
V_{IL}	Input Low Voltage		–0.5	0.8	V
V_{IH}	Input High Voltage TTL		2	V_{CC} + 0.5	V
	Input High Voltage CMOS		0.7 V_{CC}	V_{CC} + 0.5	V
V_{OL}	Output Low Voltage	I_{OL} = 5.8mA (grade 1)		0.45	V
		I_{OL} = 2.1mA (grade 6)		0.45	V
V_{OH}	Output High Voltage CMOS	I_{OH} = –100µA	4.1		V
		I_{OH} = –1mA	V_{CC} –0.8		V
		I_{OH} = –2.5mA (grade 1)	V_{CC} –0.8		V
	Output High Voltage TTL	I_{OH} = –2.5mA	2.4		V
V_{PPL}	Program Voltage (Read Operations)		0	6.5	V
V_{PPH}	Program Voltage (Read/Write Operations)		11.4	12.6	V
V_{ID}	A9 Voltage (Electronic Signature)		11.5	13	V
I_{ID} (1)	A9 Current (Electronic Signature)	$A9 = V_{ID}$		200	µA
V_{LKO}	Supply Voltage, Erase/Program Lock-out		2.5		V

Note: 1. Not 100% Tested. Characterisation Data available.

Table 8A. Read Only Mode AC Characteristics
(T_A = 0 to 70 °C, –40 to 85 °C, –40 to 125 °C; V_{CC} = 5V ± 5% or 5V ± 10%; 0V ≤ V_{PP} ≤ 6.5V)

Symbol	Alt	Parameter	Test Condition	M28F256						Unit
				-90		-10		-12		
				Min	Max	Min	Max	Min	Max	
t_{AVAV}	t_{RC}	Read Cycle Time	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	90		100		120		ns
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		90		100		120	ns
t_{ELQX}	t_{LZ}	Chip Enable Low to Output Transition	$\overline{G}$ = V_{IL}	0		0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		90		100		120	ns
t_{GLQX}	t_{OLZ}	Output Enable Low to Output Transition	$\overline{E}$ = V_{IL}	0		0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		35		40		50	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}	0	20	0	30	0	40	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}	0	20	0	30	0	30	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		0		0		ns

Note: 1. Sampled only, not 100% tested

Table 8B. Read Only Mode AC Characteristics
(((T_A = 0 to 70 °C, –40 to 85 °C, –40 to 125 °C; V_{CC} = 5V ± 5% or 5V ± 10%; 0V ≤ V_{PP} ≤ 6.5V)

Symbol	Alt	Parameter	Test Condition	M28F256				Unit
				-15		-20		
				Min	Max	Min	Max	
t_{AVAV}	t_{RC}	Read Cycle Time	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	150		200		ns
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		150		200	ns
t_{ELQX}	t_{LZ}	Chip Enable Low to Output Transition	$\overline{G}$ = V_{IL}	0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		150		200	ns
t_{GLQX}	t_{OLZ}	Output Enable Low to Output Transition	$\overline{E}$ = V_{IL}	0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		55		60	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}	0	55	0	60	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}	0	35	0	40	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		0		ns

Note: 1. Sampled only, not 100% tested

Figure 5. Read Mode AC Waveforms

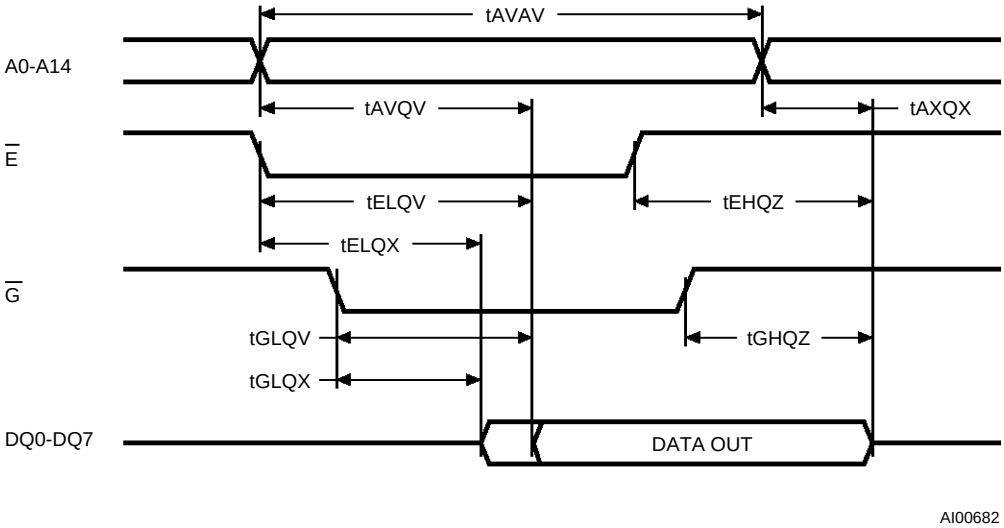


Figure 6. Read Command Waveforms

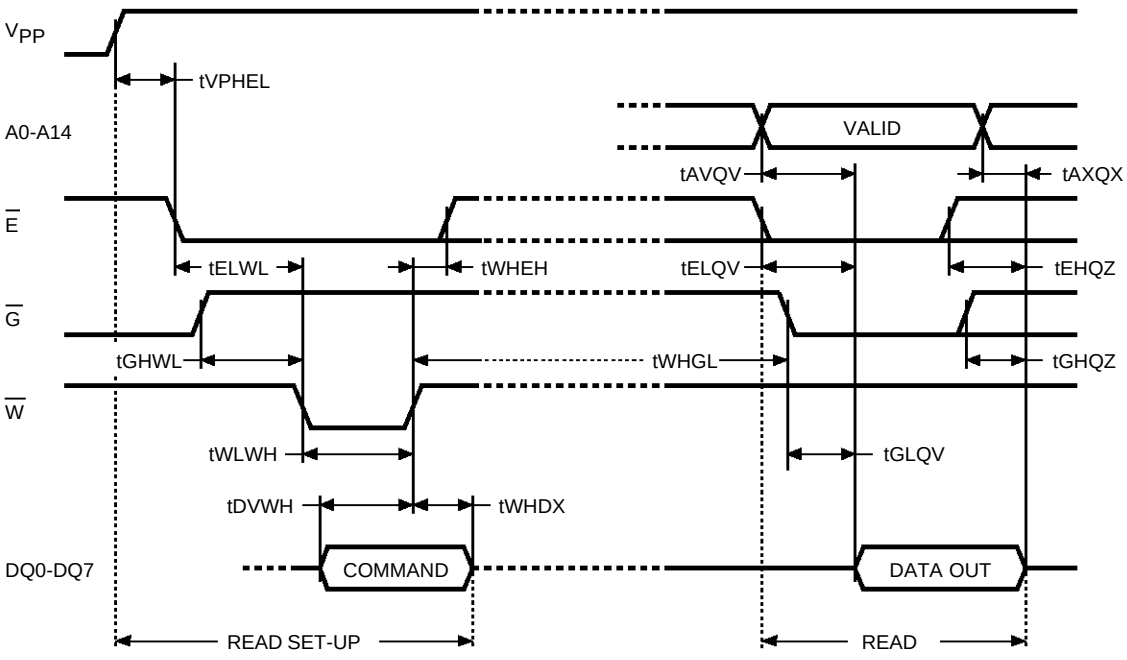
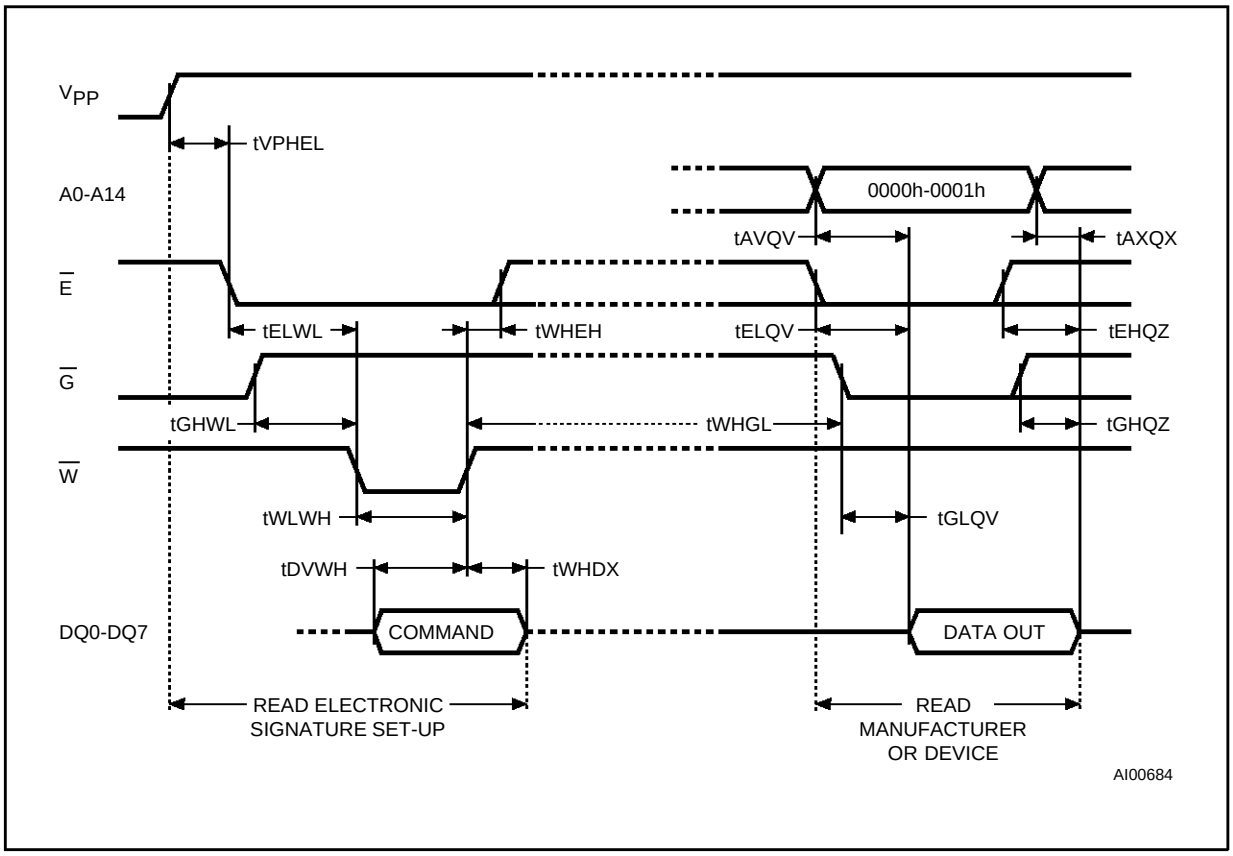


Figure 7. Electronic Signature Command Waveforms



Program and Program Verify Modes. The Program Mode is set-up by writing 40h to the command register. This is followed by a second write cycle which latches the address and data of the byte to be programmed. The rising edge of $\overline{W}$ during this second cycle starts the programming operation. Programming is followed by a Program Verify of the data written.

Program Verify Mode is set-up by writing 0C0h to the command register. The rising edge of $\overline{W}$ during the set-up of the Program Verify Mode stops the Programming operation. The following read cycle, of the address already latched during programming, is made with an internally generated margin voltage applied, reading valid data indicates that all bits have been programmed.

Reset Mode. This command is used to safely abort Erase or Program Modes. The Reset Mode is set-up and performed by writing 0FFh two times to the command register. The command should be followed by writing a valid command to the the command register (for example Read).

Table 9A. Read/Write Mode AC Characteristics, $\overline{W}$ and $\overline{E}$ Controlled
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; V_{CC} = 5V ± 5% or 5V ± 10%; V_{PP} = 12V)

Symbol	Alt	Parameter	M28F256						Unit
			-90		-10		-12		
			Min	Max	Min	Max	Min	Max	
t_{VPHEL}		V_{PP} High to Chip Enable Low	100		100		100		ns
t_{VPHWL}		V_{PP} High to Write Enable Low	100		100		100		ns
t_{WHWH3}	t_{WC}	Write Cycle Time	90		100		120		ns
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	0		0		0		ns
t_{AVEL}		Address Valid to Chip Enable Low	0		0		0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition	45		50		60		ns
t_{ELAX}		Chip Enable Low to Address Transition	50		60		80		ns
t_{ELWL}	t_{CS}	Chip Enable Low to Write Enable Low	15		15		20		ns
t_{WLEL}		Write Enable Low to Chip Enable Low	0		0		0		ns
t_{GHWL}		Output Enable High to Write Enable Low	0		0		0		µs
t_{GHEL}		Output Enable High to Chip Enable Low	0		0		0		µs
t_{DVWH}	t_{DS}	Input Valid to Write Enable High	45		50		50		ns
t_{DVEH}		Input Valid to Chip Enable High	35		40		50		ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High (Write Pulse)	45		50		60		ns
t_{ELEH}		Chip Enable Low to Chip Enable High (Write Pulse)	45		45		70		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition	10		10		10		ns
t_{EHDX}		Chip Enable High to Input Transition	10		10		10		ns
t_{WHWH1}		Duration of Program Operation	9.5		9.5		9.5		µs
t_{EHEH1}		Duration of Program Operation	9.5		9.5		9.5		µs
t_{WHWH2}		Duration of Erase Operation	9.5		9.5		9.5		ms
t_{WHEH}	t_{CH}	Write Enable High to Chip Enable High	0		0		0		ns
t_{EHWH}		Chip Enable High to Write Enable High	0		0		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low	20		20		20		ns
t_{EHEL}		Chip Enable High to Chip Enable Low	20		20		20		ns
t_{WHGL}		Write Enable High to Output Enable Low	6		6		6		µs
t_{EHGL}		Chip Enable High to Output Enable Low	6		6		6		µs
t_{AVQV}	t_{ACC}	Addess Valid to data Output		90		100		120	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	0		0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid		90		100		120	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	0		0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid		35		45		50	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z		20		30		50	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z		20		30		30	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	0		0		0		ns

Notes: 1. Sampled only, not 100% tested
2. A Write is enabled by a valid combination of Chip Enable ($\overline{E}$) and Write Enable ($\overline{W}$). When Write is controlled by Chip Enable (with a Chip Enable pulse width smaller than Write Enable), all timings should be measured relative to Chip Enable waveform.

Table 9B. Read/Write Mode AC Characteristics, $\overline{W}$ and $\overline{E}$ Controlled
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; V_{CC} = 5V ± 5% or 5V ± 10%; V_{PP} = 12V)

Symbol	Alt	Parameter	M28F256				Unit
			-15		-20		
			Min	Max	Min	Max	
t_{VPHEL}		V_{PP} High to Chip Enable Low	100		100		ns
t_{VPHWL}		V_{PP} High to Write Enable Low	100		100		ns
t_{WHWH3}	t_{WC}	Write Cycle Time	150		200		ns
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	0		0		ns
t_{AVEL}		Address Valid to Chip Enable Low	0		0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition	60		60		ns
t_{ELAX}		Chip Enable Low to Address Transition	80		80		ns
t_{ELWL}	t_{CS}	Chip Enable Low to Write Enable Low	20		20		ns
t_{WLEL}		Write Enable Low to Chip Enable Low	0		0		ns
t_{GHWL}		Output Enable High to Write Enable Low	0		0		µs
t_{GHEL}		Output Enable High to Chip Enable Low	0		0		µs
t_{DVWH}	t_{DS}	Input Valid to Write Enable High	50		50		ns
t_{DVEH}		Input Valid to Chip Enable High	50		50		ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High (Write Pulse)	60		60		ns
t_{ELEH}		Chip Enable Low to Chip Enable High (Write Pulse)	70		70		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition	10		10		ns
t_{EHDX}		Chip Enable High to Input Transition	10		10		ns
t_{WHWH1}		Duration of Program Operation	9.5		9.5		µs
t_{EHEH1}		Duration of Program Operation	9.5		9.5		µs
t_{WHWH2}		Duration of Erase Operation	9.5		9.5		ms
t_{WHEH}	t_{CH}	Write Enable High to Chip Enable High	0		0		ns
t_{EHWH}		Chip Enable High to Write Enable High	0		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low	20		20		ns
t_{EHEL}		Chip Enable High to Chip Enable Low	20		20		ns
t_{WHGL}		Write Enable High to Output Enable Low	6		6		µs
t_{EHGL}		Chip Enable High to Output Enable Low	6		6		µs
t_{AVQV}	t_{ACC}	Addess Valid to data Output		150		200	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid		150		200	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid		55		60	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z		55		60	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z		35		40	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	0		0		ns

Notes: 1. Sampled only, not 100% tested
2. A Write is enabled by a valid combination of Chip Enable ($\overline{E}$) and Write Enable ($\overline{W}$). When Write is controlled by Chip Enable (with a Chip Enable pulse width smaller than Write Enable), all timings should be measured relative to Chip Enable waveform.

Figure 8. Erase Set-up and Erase Verify Commands Waveforms, $\overline{W}$ Controlled

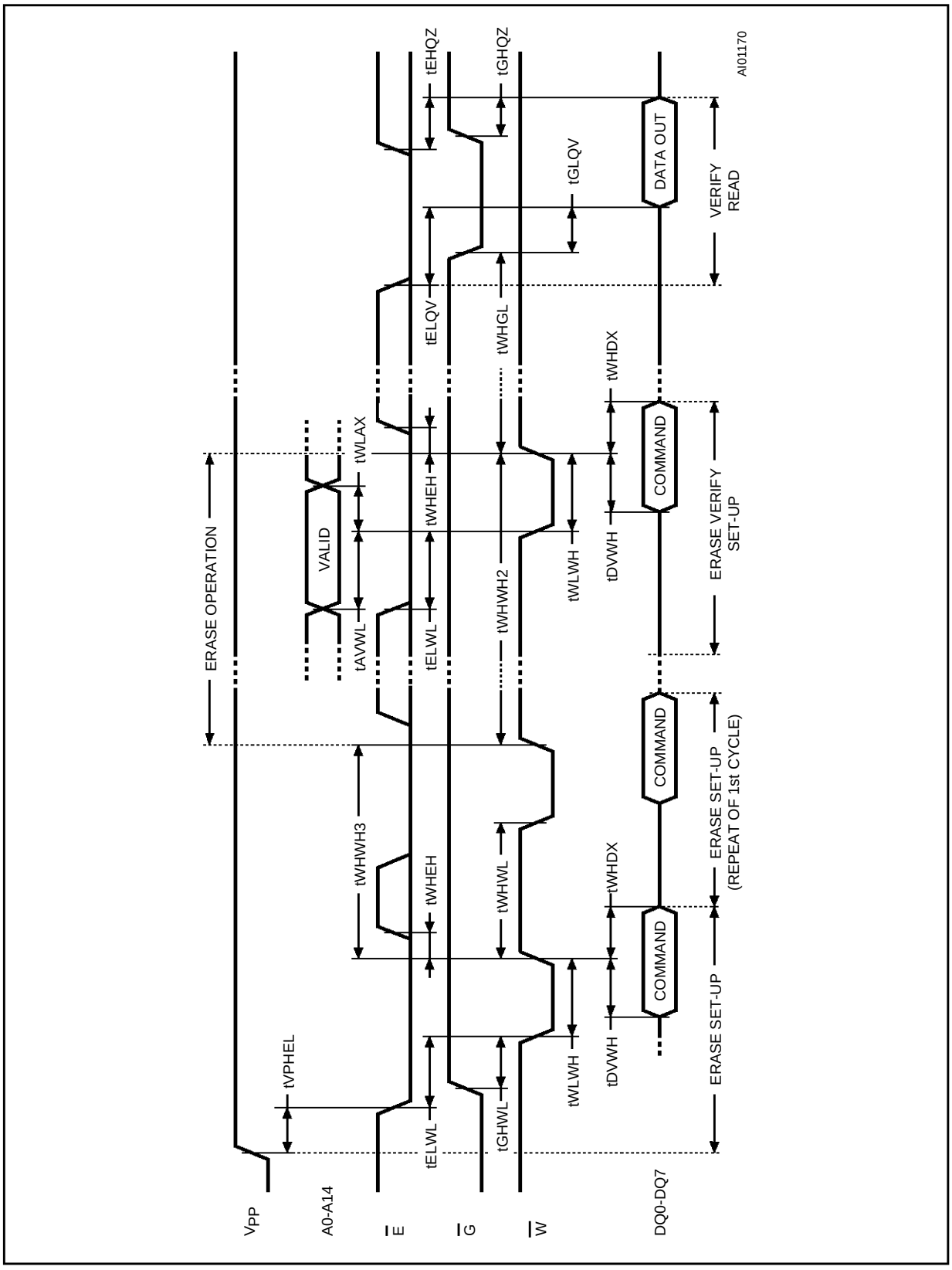


Figure 9. Erase Set-up and Erase Verify Commands Waveforms, $\overline{E}$ Controlled

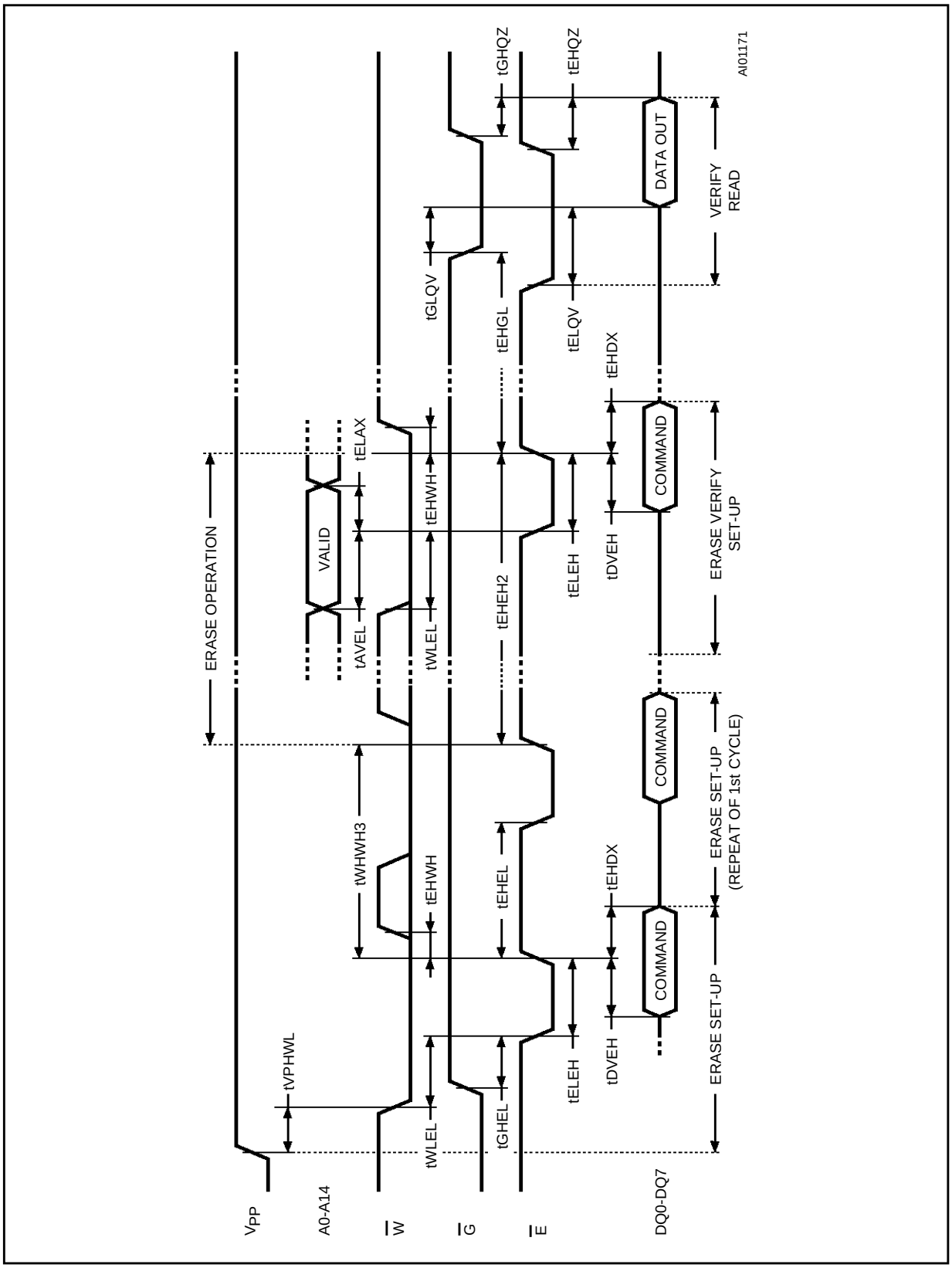


Figure 10. Program Set-up and Program Verify Commands Waveforms, $\overline{W}$ Controlled

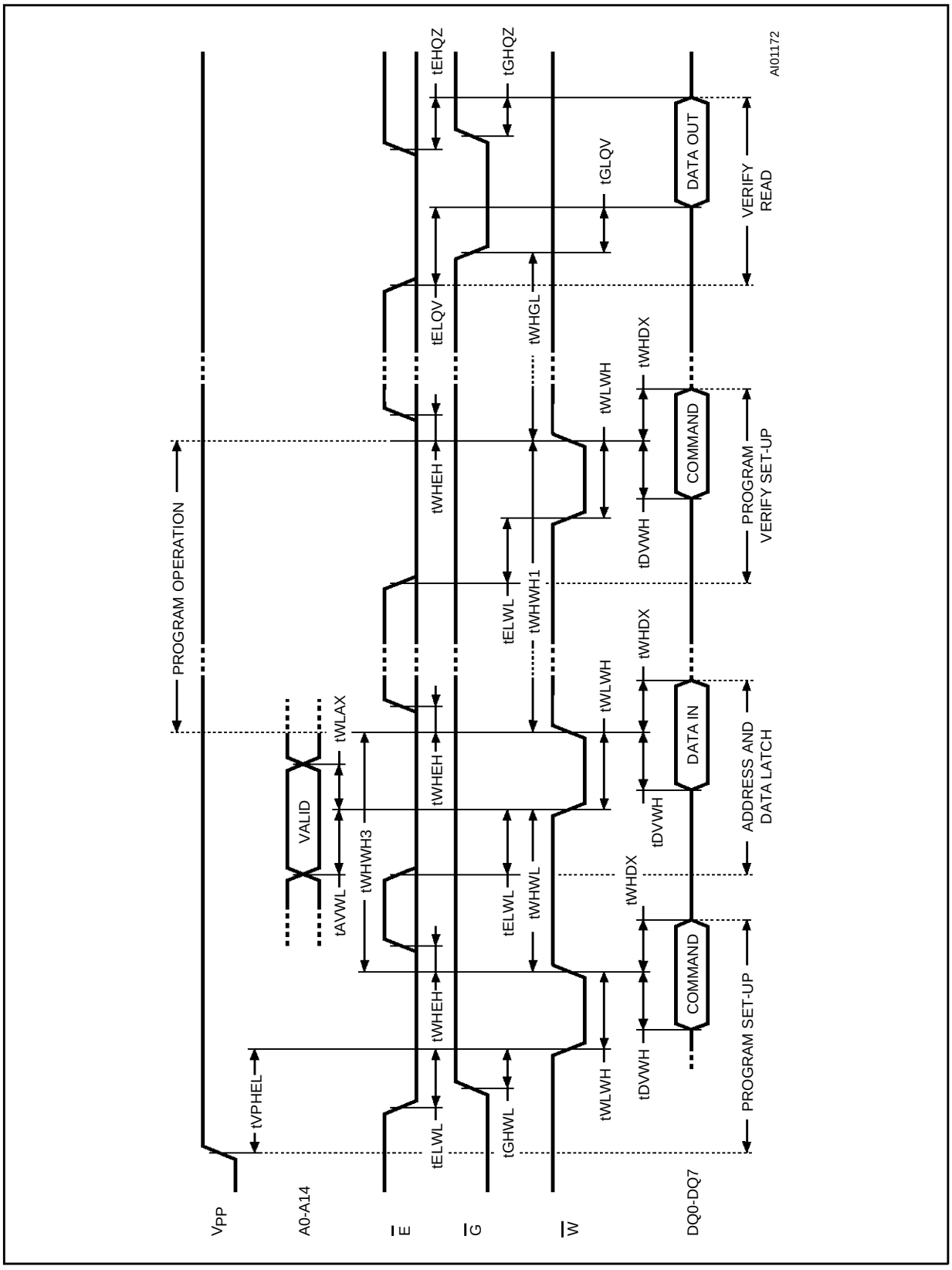


Figure 11. Program Set-up and Program Verify Commands Waveforms, $\overline{E}$ Controlled

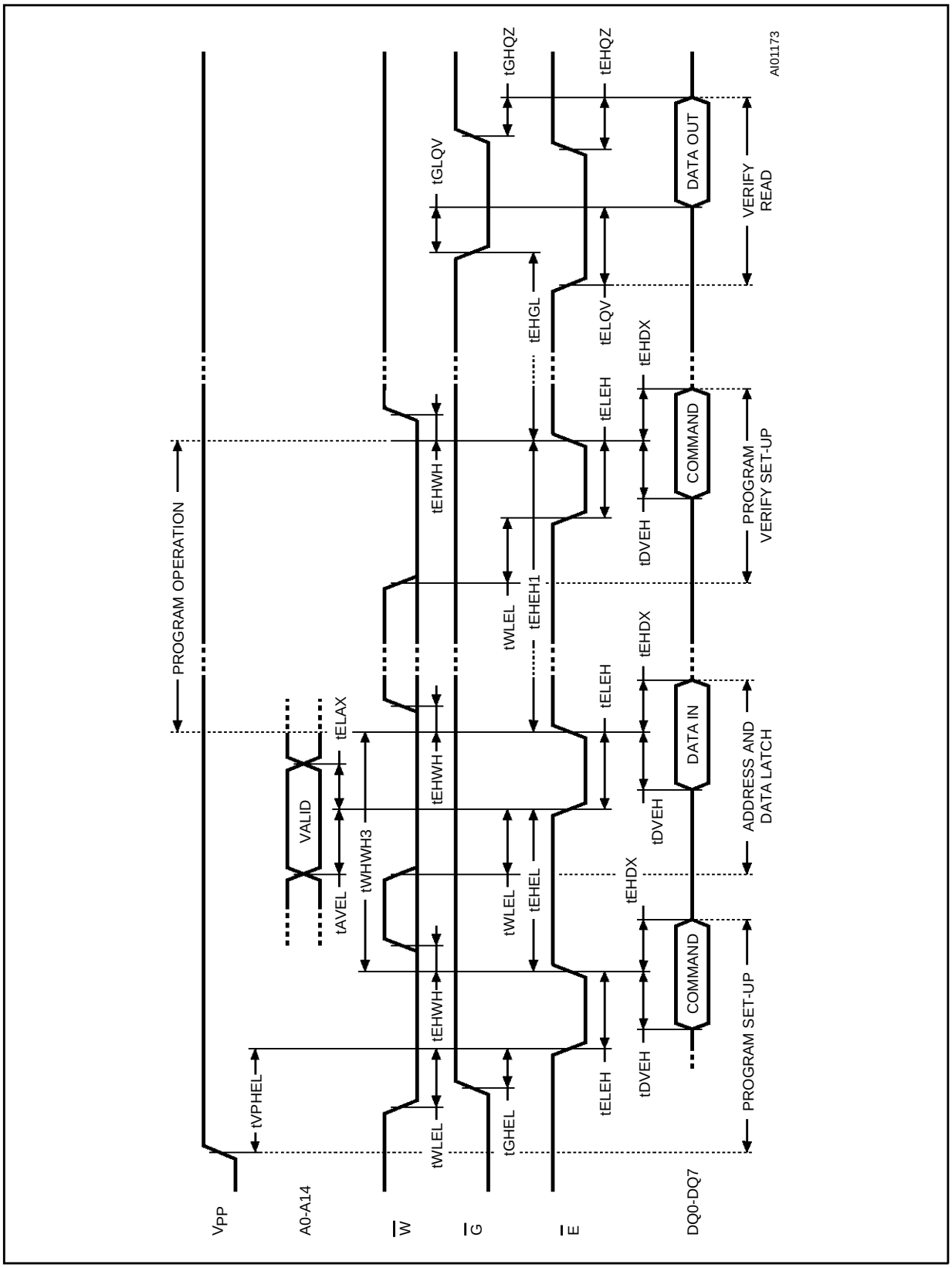


Figure 12. Erasing Flowchart

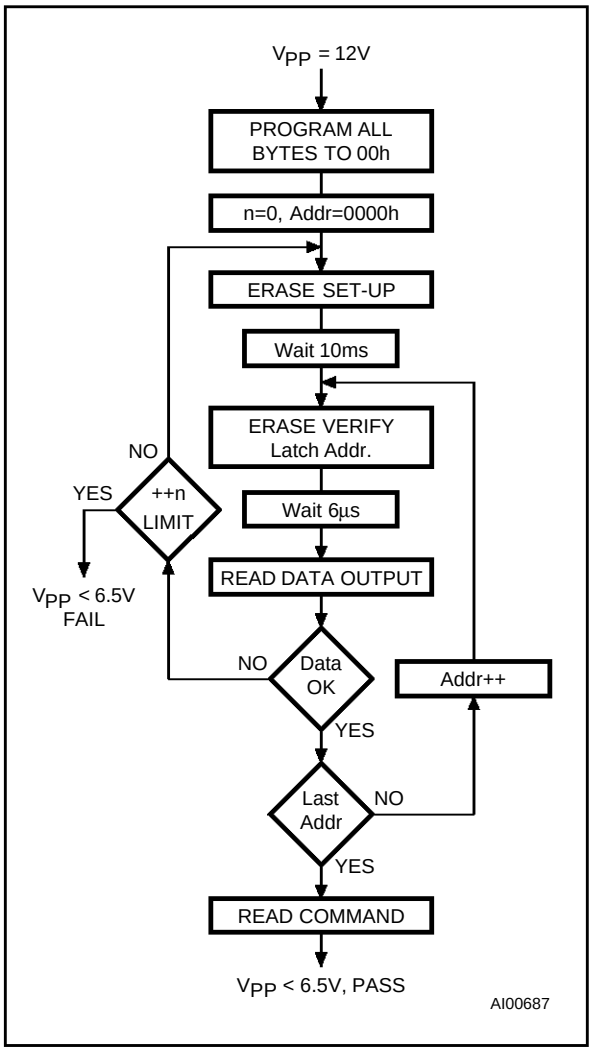
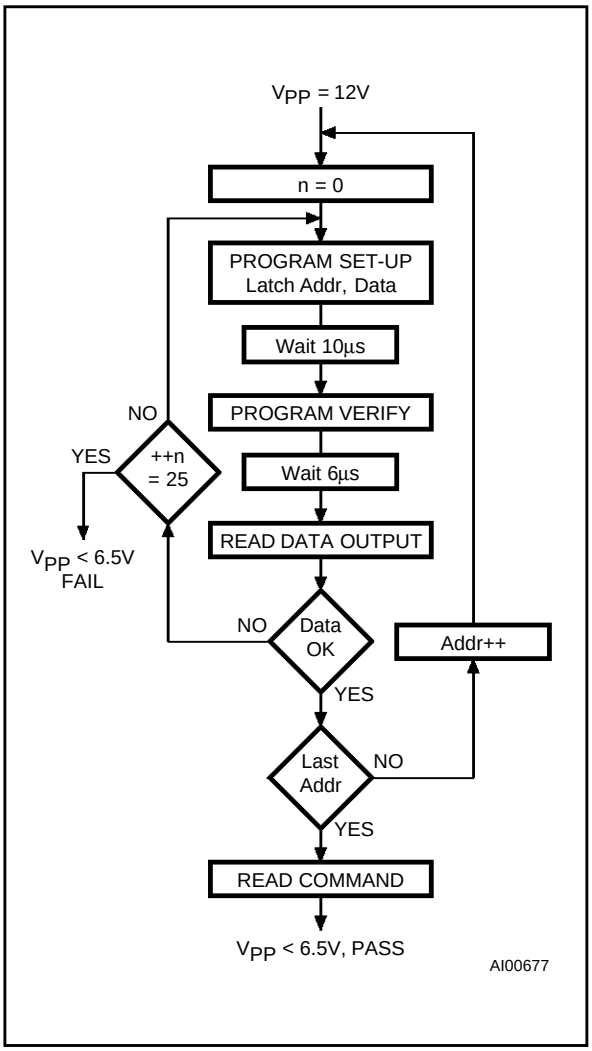


Figure 13. Programming Flowchart



PRESTO F ERASE ALGORITHM

The PRESTO F Erase Algorithm guarantees that the device will be erased in a reliable way. The algorithm first programs all bytes to 00h in order to ensure uniform erasure. The programming follows the Presto F Programming Algorithm (see below). Erase is set-up by writing 20h to the command register, the erasure is started by repeating this write cycle. Erase Verify is set-up by writing 0A0h to the command register together with the address of the byte to be verified. The subsequent read cycle reads the data which is compared to 0FFh. Erase Verify begins at address 0000h and continues to the last address or until the comparison of the data to 0FFh fails. If this occurs, the address of the last byte checked is stored and a new Erase operation performed. Erase Verify then continues from the address of the stored location.

PRESTO F PROGRAM ALGORITHM

The PRESTO F Programming Algorithm applies a series of 10µs programming pulses to a byte until a correct verify occurs. Up to 25 programming operations are allowed for one byte. Program is set-up by writing 40h to the command register, the programming is started after the next write cycle which also latches the address and data to be programmed. Program Verify is set-up by writing 0C0h to the command register, followed by a read cycle and a compare of the data read to the data expected. During Program and Program Verify operations a MARGIN MODE circuit is activated to guarantee that the cell is programmed with a safety margin.

ORDERING INFORMATION SCHEME

Example: M28F256 -12 X B 1 TR

Speed		V_{CC} Tolerance		Package		Temp. Range		Option	
-90	90 ns	blank	± 10%	B	PDIP32	1	0 to 70 °C	TR	Tape & Reel Packing
-10	100 ns	X	± 5%	C	PLCC32	3	–40 to 125 °C		
-12	120 ns					6	–40 to 85 °C		
-15	150 ns								
-20	200 ns								

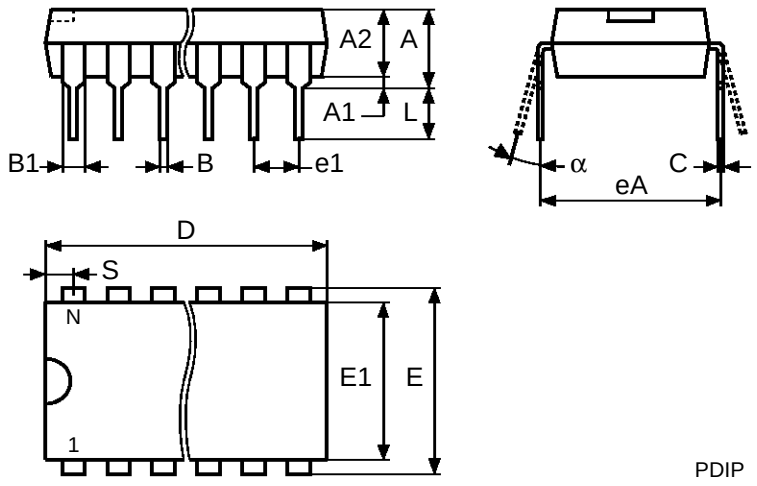
For a list of available options (Speed, V_{CC} Tolerance, Package, etc...) refer to the current Memory Shortform catalogue.

For further information on any aspect of this device, please contact the SGS-THOMSON Sales Office nearest to you.

PDIP32 - 32 pin Plastic DIP, 600 mils width

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A			4.83			0.190
A1		0.38	–		0.015	–
A2	–	–	–	–	–	–
B		0.41	0.51		0.016	0.020
B1		1.14	1.40		0.045	0.055
C		0.20	0.30		0.008	0.012
D		41.78	42.04		1.645	1.655
E		15.24	15.88		0.600	0.625
E1		13.46	13.97		0.530	0.550
e1	2.54	–	–	0.100	–	–
eA	15.24	–	–	0.600	–	–
L		3.18	3.43		0.125	0.135
S		1.78	2.03		0.070	0.080
α		0°	15°		0°	15°
N	32			32		

PDIP32



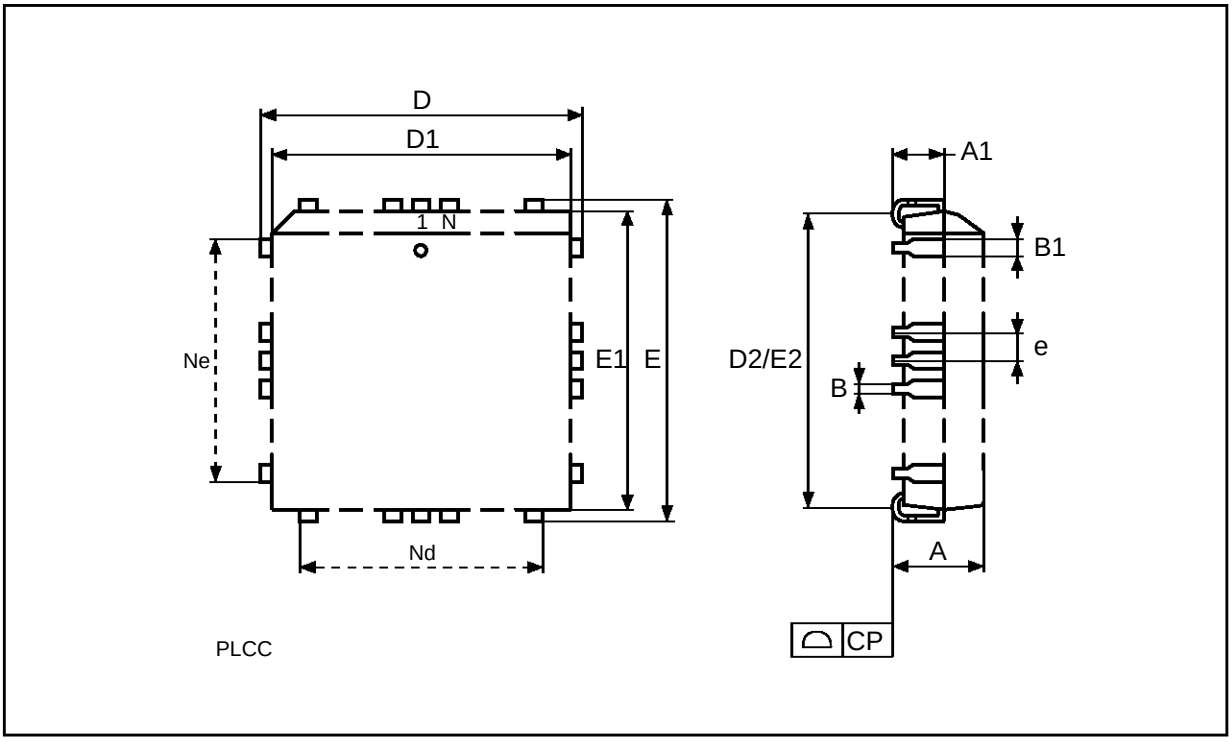
PDIP

Drawing is not to scale

PLCC32 - 32 lead Plastic Leaded Chip Carrier, rectangular

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A		2.54	3.56		0.100	0.140
A1		1.52	2.41		0.060	0.095
B		0.33	0.53		0.013	0.021
B1		0.66	0.81		0.026	0.032
D		12.32	12.57		0.485	0.495
D1		11.35	11.56		0.447	0.455
D2		9.91	10.92		0.390	0.430
E		14.86	15.11		0.585	0.595
E1		13.89	14.10		0.547	0.555
E2		12.45	13.46		0.490	0.530
e	1.27	–	–	0.050	–	–
N	32			32		
Nd	7			7		
Ne	9			9		
CP			0.10			0.004

PLCC32



PLCC

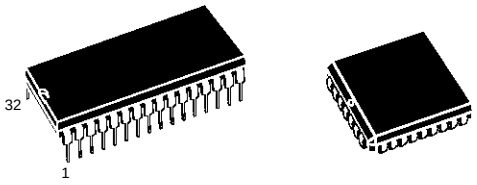
Drawing is not to scale

SGS-THOMSON MICROELECTRONICS

M28F512

512K (64K x 8, Chip Erase) FLASH MEMORY

- FAST ACCESS TIME: 90ns
- LOW POWER CONSUMPTION
  - Standby Current: 100µA Max
- 10,000 ERASE/PROGRAM CYCLES
- 12V PROGRAMMING VOLTAGE
- TYPICAL BYTE PROGRAMING TIME 10µs (PRESTO F ALGORITHM)
- ELECTRICAL CHIP ERASE in 1s RANGE
- INTEGRATED ERASE/PROGRAM-STOP TIMER
- EXTENDED TEMPERATURE RANGES



PDIP32 (B)

PLCC32 (C)

DESCRIPTION

The M28F512 FLASH Memory is a non-volatile memory which may be erased electrically at the chip level and programmed byte-by-byte. It is organised as 64K bytes of 8 bits. It uses a command register architecture to select the operating modes and thus provides a simple microprocessor interface. The M28F512 FLASH Memory is suitable for applications where the memory has to be reprogrammed in the equipment. The access time of 90ns makes the device suitable for use in high speed microprocessor systems.

Figure 1. Logic Diagram

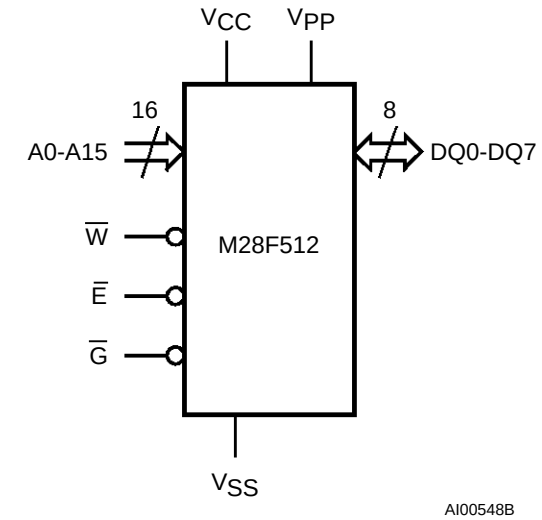
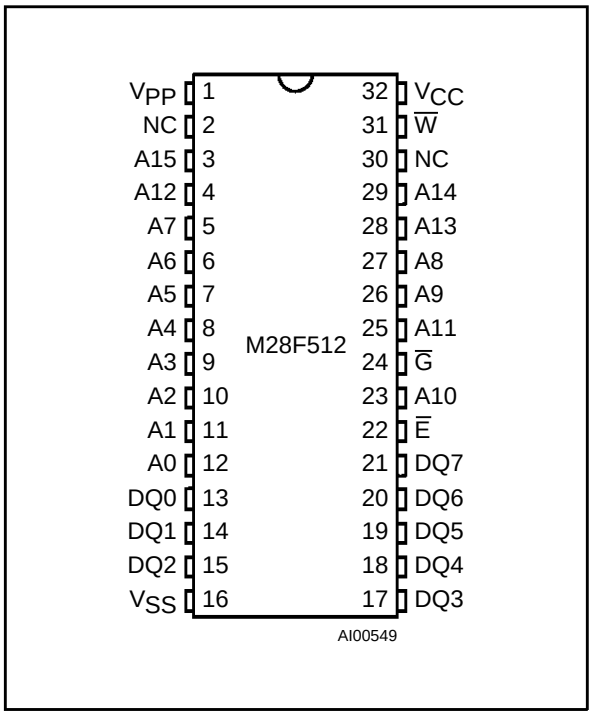


Table 1. Signal Names

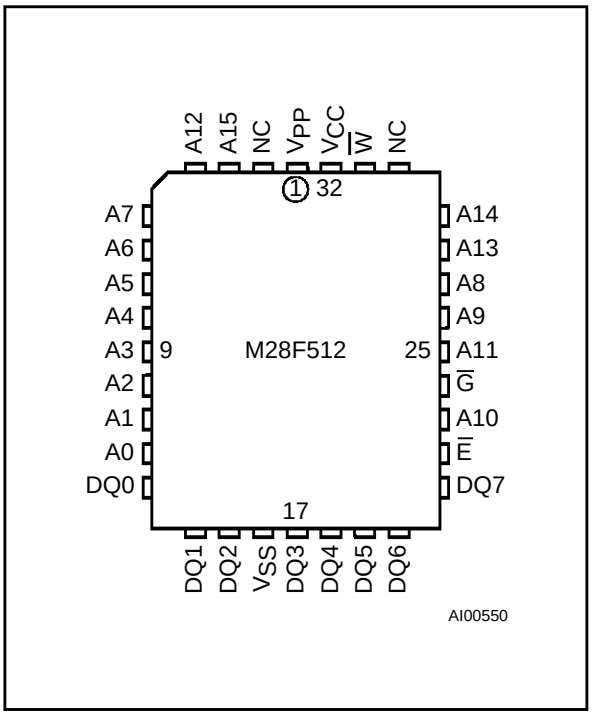
A0 - A15	Address Inputs
DQ0 - DQ7	Data Inputs / Outputs
$\overline{E}$	Chip Enable
$\overline{G}$	Output Enable
$\overline{W}$	Write Enable
V_{PP}	Program Supply
V_{CC}	Supply Voltage
V_{SS}	Ground

Figure 2A. DIP Pin Connections



Warning: NC = Not Connected

Figure 2B. LCC Pin Connections



Warning: NC = Not Connected

Table 2. Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
T_A	Ambient Operating Temperature	–40 to 125	°C
T_{STG}	Storage Temperature	–65 to 150	°C
V_{IO}	Input or Output Voltages	–0.6 to 7	V
V_{CC}	Supply Voltage	–0.6 to 7	V
V_{A9}	A9 Voltage	–0.6 to 13.5	V
V_{PP}	Program Supply Voltage, during Erase or Programming	–0.6 to 14	V

Note: Except for the rating "Operating Temperature Range", stresses above those listed in the Table "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the SGS-THOMSON SURE Program and other relevant quality documents.

DEVICE OPERATION

The M28F512 FLASH Memory employs a technology similar to a 512Kb EPROM but adds to the device functionality by providing electrical erasure and programming. These functions are managed by a command register. The functions that are addressed via the command register depend on the voltage applied to the V_{PP}, program voltage, input. When V_{PP} is less than or equal to 6.5V, the command register is disabled and M28F512 functions as a read only memory providing operating modes similar to an EPROM (Read, Output Disable, Electronic Signature Read and Standby). When V_{PP} is raised to 12V the command regsiter is enabled and this provides, in addition, Erase and Program operations.

Table 3. Operations (1)

	V_{PP}	Operation	$\overline{E}$	$\overline{G}$	$\overline{W}$	A9	DQ0 - DQ7
Read Only	V_{PPL}	Read	V_{IL}	V_{IL}	V_{IH}	A9	Data Output
		Output Disable	V_{IL}	V_{IH}	V_{IH}	X	Hi-Z
		Standby	V_{IH}	X	X	X	Hi-Z
		Electronic Signature	V_{IL}	V_{IL}	V_{IH}	V_{ID}	Codes
Read/Write (2)	V_{PPH}	Read	V_{IL}	V_{IL}	V_{IH}	A9	Data Output
		Write	V_{IL}	V_{IH}	V_{IL} Pulse	A9	Data Input
		Output Disable	V_{IL}	V_{IH}	V_{IH}	X	Hi-Z
		Standby	V_{IH}	X	X	X	Hi-Z

Notes: 1. X = V_{IL} or V_{IH}
2. Refer also to the Command Table

Table 4. Electronic Signature

Identifier	A0	DQ7	DQ6	DQ5	DQ4	DQ3	DQ2	DQ1	DQ0	Hex Data
Manufacturer's Code	V_{IL}	0	0	1	0	0	0	0	0	20h
Device Code	V_{IH}	0	0	0	0	0	1	1	1	02h

READ ONLY MODES, $V_{PP} \leq$ 6.5V

For all Read Only Modes, except Standby Mode, the Write Enable input $\overline{W}$ should be High. In the Standby Mode this input is don't care.

Read Mode. The M28F512 has two enable inputs, $\overline{E}$ and $\overline{G}$, both of which must be Low in order to output data from the memory. The Chip Enable ($\overline{E}$) is the power control and should be used for device selection. Output Enable ($\overline{G}$) is the output control and should be used to gate data on to the output, independant of the device selection.

Standby Mode. In the Standby Mode the maximum supply current is reduced to 100µA. The device is placed in the Standby Mode by applying a High to the Chip Enable ($\overline{E}$) input. When in the Standby Mode the outputs are in a high impedance state, independant of the Output Enable ($\overline{G}$) input.

Output Disable Mode. When the Output Enable ($\overline{G}$) is High the outputs are in a high impedance state.

Electronic Signature Mode. This mode allows the read out of two binary codes from the device which identify the manufacturer and device type. This mode is intended for use by programming equipment to automatically select the correct erase and programming algorithms. The Electronic Signature Mode is active when a high voltage (11.5V to 13V) is applied to address line A9 with $\overline{E}$ and $\overline{G}$ Low. With A0 Low the output data is the manufacturer code, when A0 is High the output is the device type code. All other address lines should be maintained Low while reading the codes. The electronic signature may also be accessed in Read/Write modes.

READ/WRITE MODES, 11.4V $\leq V_{PP} \leq$ 12.6V

When V_{PP} is High both read and write operations may be performed. These are defined by the contents of an internal command register. Commands may be written to this register to set-up and execute, Erase, Erase Verify, Program, Program Verify and Reset modes. Each of these modes needs 2

Table 5. Commands (1)

Command	Cycles	1st Cycle			2nd Cycle		
		Operation	A0-A16	DQ0-DQ7	Operation	A0-A16	DQ0-DQ7
Read	1	Write	X	00h			
Electronic Signature	2	Write	X	90h	Read	00000h	20h
					Read	00001h	02h
Setup Erase/ Erase	2	Write	X	20h			
					Write	X	20h
Erase Verify	2	Write	A0-A16	0A0h	Read	X	Data Output
Setup Program/ Program	2	Write	X	40h			
					Write	A0-A16	Data Input
Program Verify	2	Write	X	0C0h	Read	X	Data Output
Reset	2	Write	X	0FFh	Write	X	0FFh

Note: 1. X = V_{IL} or V_{IH}

READ/WRITE MODES (cont'd)

cycles. Every mode starts with a write operation to set-up the command, this is followed by either read or write operations. The device expects the first cycle to be a write operation and does not corrupt data at any location in memory. Read mode is set-up with one cycle only and may be followed by any number of read operations to output data. Electronic Signature Read mode is set-up with one cycle and followed by a read cycle to output the manufacturer or device codes.

A write to the command register is made by bringing $\overline{W}$ Low while $\overline{E}$ is Low. The falling edge of $\overline{W}$ latches Addresses, while the rising edge latches Data, which are used for those commands that require address inputs, command input or provide data output.

The supply voltage V_{CC} and the program voltage V_{PP} can be applied in any order. When the device is powered up or when V_{PP} is ≤ 6.5V the contents of the command register default to 00h, thus automatically setting-up Read operations. In addition a specific command may be used to set the command register to 00h for reading the memory.

The system designer may choose to provide a constant high V_{PP} and use the register commands for all operations, or to switch the V_{PP} from low to high only when needing to erase or program the memory. All command register access is inhibited when V_{CC} falls below the Erase/Write Lockout Voltage (V_{LKO}) of 2.5V.

If the device is deselected during Erasure, Programming or Verification it will draw active supply currents until the operations are terminated.

The device is protected against stress caused by long erase or program times. If the end of Erase or Programming operations are not terminated by a Verify cycle within a maximum time permitted, an internal stop timer automatically stops the operation. The device remains in an inactive state, ready to start a Verify or Reset Mode operation.

Read Mode. The Read Mode is the default at power up or may be set-up by writing 00h to the command register. Subsequent read operations output data from the memory. The memory remains in the Read Mode until a new command is written to the command register.

AC MEASUREMENT CONDITIONS

Input Rise and Fall Times	≤ 10ns
Input Pulse Voltages	0.45V to 2.4V
Input and Output Timing Ref. Voltages	0.8V to 2V

Note that Output Hi-Z is defined as the point where data is no longer driven.

Figure 3. AC Testing Input Output Waveforms

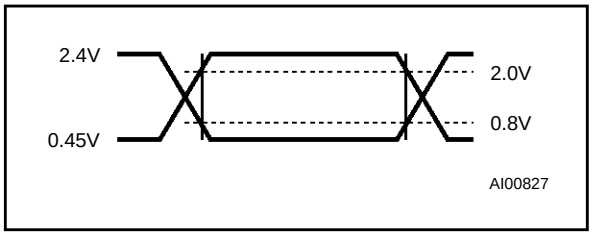


Figure 4. AC Testing Load Circuit

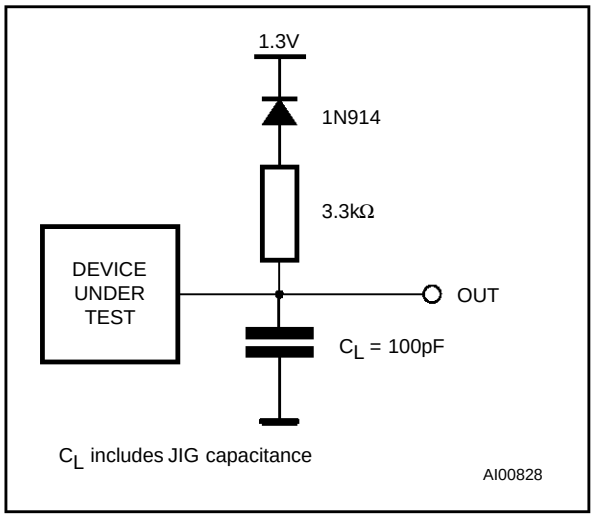


Table 6. Capacitance (1) (T_A = 25 °C, f = 1 MHz)

Symbol	Parameter	Test Condition	Min	Max	Unit
C_{IN}	Input Capacitance	V_{IN} = 0V		6	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V		12	pF

Note: 1. Sampled only, not 100% test.ed

Electronic Signature Mode. In order to select the correct erase and programming algorithms for on-board programming, the manufacturer and devices code may be read directly. It is not neccessary to apply a high voltage to A9 when using the command register. The Electronic Signature Mode is set-up by writing 90h to the command register. The following read cycle, with address inputs 00000h or 00001h, output the manufacturer or device type codes. The command is terminated by writing another valid command to the command register (for example Reset).

Erase and Erase Verify Modes. The memory is erased by first Programming all bytes to 00h, the Erase command then erases them to 0FFh. The Erase Verify command is then used to read the memory byte-by-byte for a content of 0FFh. The Erase Mode is set-up by writing 20h to the command register. The write cycle is then repeated to start the erase operation. Erasure starts on the rising edge of $\overline{W}$ during this second cycle. Erase is followed by an Erase Verify which reads an addressed byte.

Erase Verify Mode is set-up by writing 0A0h to the command register and at the same time supplying the address of the byte to be verified. The rising edge of $\overline{W}$ during the set-up of the first Erase Verify Mode stops the Erase operation. The following read cycle is made with an internally generated margin voltage applied; reading 0FFh indicates that all bits of the addressed byte are fully erased. The whole contents of the memory are verified by repeating the Erase Verify Operation, first writing the set-up code 0A0h with the address of the byte to be verified and then reading the byte contents in a second read cycle.

As the Erase algorithm flow chart shows, when the data read during Erase Verify is not 0FFh, another Erase operation is performed and verification continues from the address of the last verified byte. The command is terminated by writing another valid command to the command register (for example Program or Reset).

Table 7. DC Characteristics
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; V_{CC} = 5V ± 5% or 5V ± 10%)

Symbol	Parameter	Test Condition	Min	Max	Unit
I_{LI}	Input Leakage Current	$0V \le V_{IN} \le V_{CC}$		±1	µA
I_{LO}	Output Leakage Current	$0V \le V_{OUT} \le V_{CC}$		±10	µA
I_{CC}	Supply Current (Read)	$\overline{E} = V_{IL}$, f = 6MHz		30	mA
I_{CC1}	Supply Current (Standby) TTL	$\overline{E} = V_{IH}$		1	mA
	Supply Current (Standby) CMOS	$\overline{E} = V_{CC} \pm 0.2V$		100	µA
I_{CC2} (1)	Supply Current (Programming)	During Programming		10	mA
I_{CC3} (1)	Supply Current (Program Verify)	During Verify		10	mA
I_{CC4} (1)	Supply Current (Erase)	During Erasure		10	mA
I_{CC5} (1)	Supply Current (Erase Verify)	During Erase Verify		10	mA
I_{LPP}	Program Leakage Current	$V_{PP} \le V_{CC}$		±10	µA
I_{PP}	Program Current (Read or Standby)	$V_{PP} > V_{CC}$		200	µA
		$V_{PP} \le V_{CC}$		±10	µA
I_{PP1}(1)	Program Current (Programming)	$V_{PP} = V_{PPH}$, During Programming		15	mA
I_{PP2}(1)	Program Current (Program Verify)	$V_{PP} = V_{PPH}$, During Verify		5	mA
I_{PP3}(1)	Program Current (Erase)	$V_{PP} = V_{PPH}$, During Erase		15	mA
I_{PP4}(1)	Program Current (Erase Verify)	$V_{PP} = V_{PPH}$, During Erase Verify		5	mA
V_{IL}	Input Low Voltage		–0.5	0.8	V
V_{IH}	Input High Voltage TTL		2	V_{CC} + 0.5	V
	Input High Voltage CMOS		0.7 V_{CC}	V_{CC} + 0.5	V
V_{OL}	Output Low Voltage	I_{OL} = 5.8mA (grade 1)		0.45	V
		I_{OL} = 2.1mA (grade 6)		0.45	V
V_{OH}	Output High Voltage CMOS	I_{OH} = –100µA	4.1		V
		I_{OH} = –2.5mA	0.85 V_{CC}		V
	Output High Voltage TTL	I_{OH} = –2.5mA	2.4		V
V_{PPL}	Program Voltage (Read Operations)		0	6.5	V
V_{PPH}	Program Voltage (Read/Write Operations)		11.4	12.6	V
V_{ID}	A9 Voltage (Electronic Signature)		11.5	13	V
I_{ID} (1)	A9 Current (Electronic Signature)	A9 = V_{ID}		200	µA
V_{LKO}	Supply Voltage, Erase/Program Lock-out		2.5		V

Note: 1. Not 100% tested. Characterisation Data available.

Table 8A. Read Only Mode AC Characteristics
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; V_{CC} = 5V ± 5% or 5V ± 10%; 0V ≤ V_{PP} ≤ 6.5V)

Symbol	Alt	Parameter	Test Condition	M28F512						Unit
				-90		-10		-12		
				Min	Max	Min	Max	Min	Max	
t_{WHGL}		Write Enable High to Output Enable Low		6		6		6		µs
t_{AVAV}	t_{RC}	Read Cycle Time	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	90		100		120		ns
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		90		100		120	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	$\overline{G}$ = V_{IL}	0		0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		90		100		120	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	$\overline{E}$ = V_{IL}	0		0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		35		45		50	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}	0	45	0	45	0	55	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}	0	30	0	30	0	30	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		0		0		ns

Note: 1. Sampled only, not 100% tested

Table 8B. Read Only Mode AC Characteristics
(((T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; V_{CC} = 5V ± 5% or 5V ± 10%; 0V ≤ V_{PP} ≤ 6.5V)

Symbol	Alt	Parameter	Test Condition	M28F512				Unit
				-15		-20		
				Min	Max	Min	Max	
t_{WHGL}		Write Enable High to Output Enable Low		6		6		µs
t_{AVAV}	t_{RC}	Read Cycle Time	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	150		200		ns
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		150		200	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	$\overline{G}$ = V_{IL}	0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		150		200	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	$\overline{E}$ = V_{IL}	0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		55		60	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}	0	55	0	60	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}	0	35	0	40	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		0		ns

Note: 1. Sampled only, not 100% tested

Figure 5. Read Mode AC Waveforms

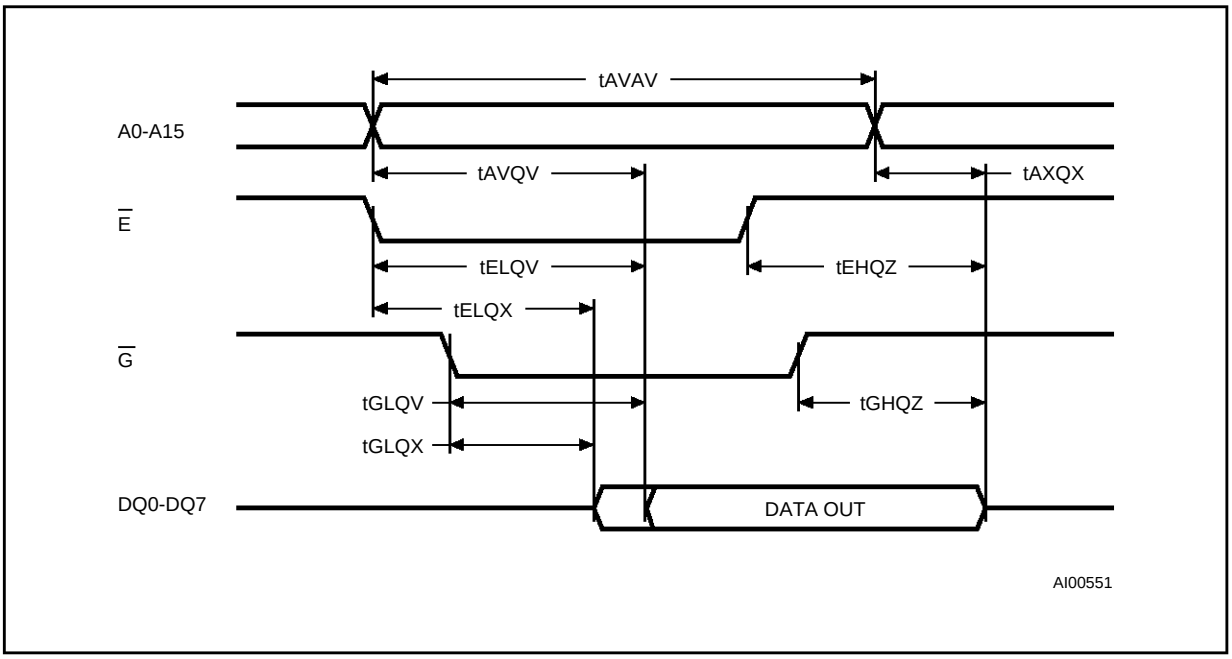


Figure 6. Read Command Waveforms

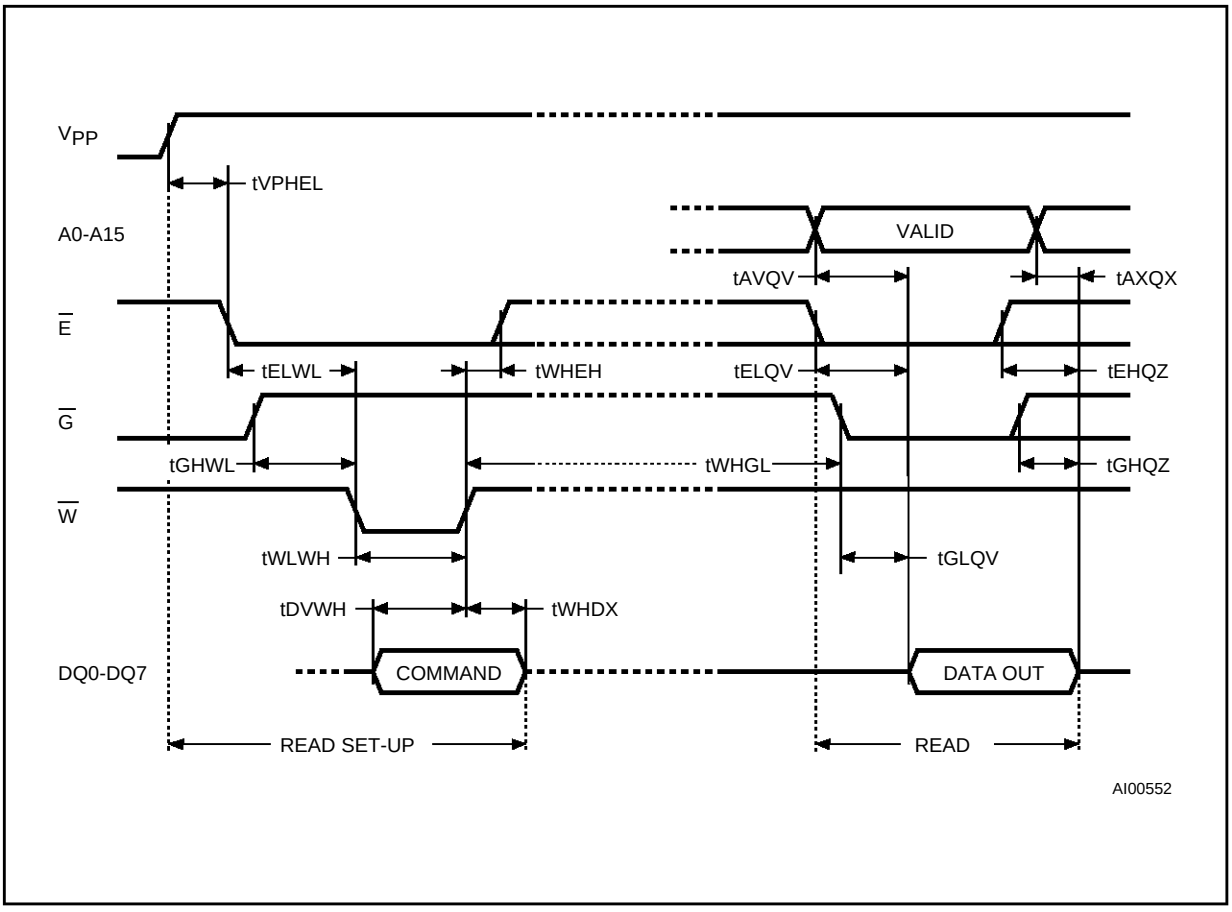
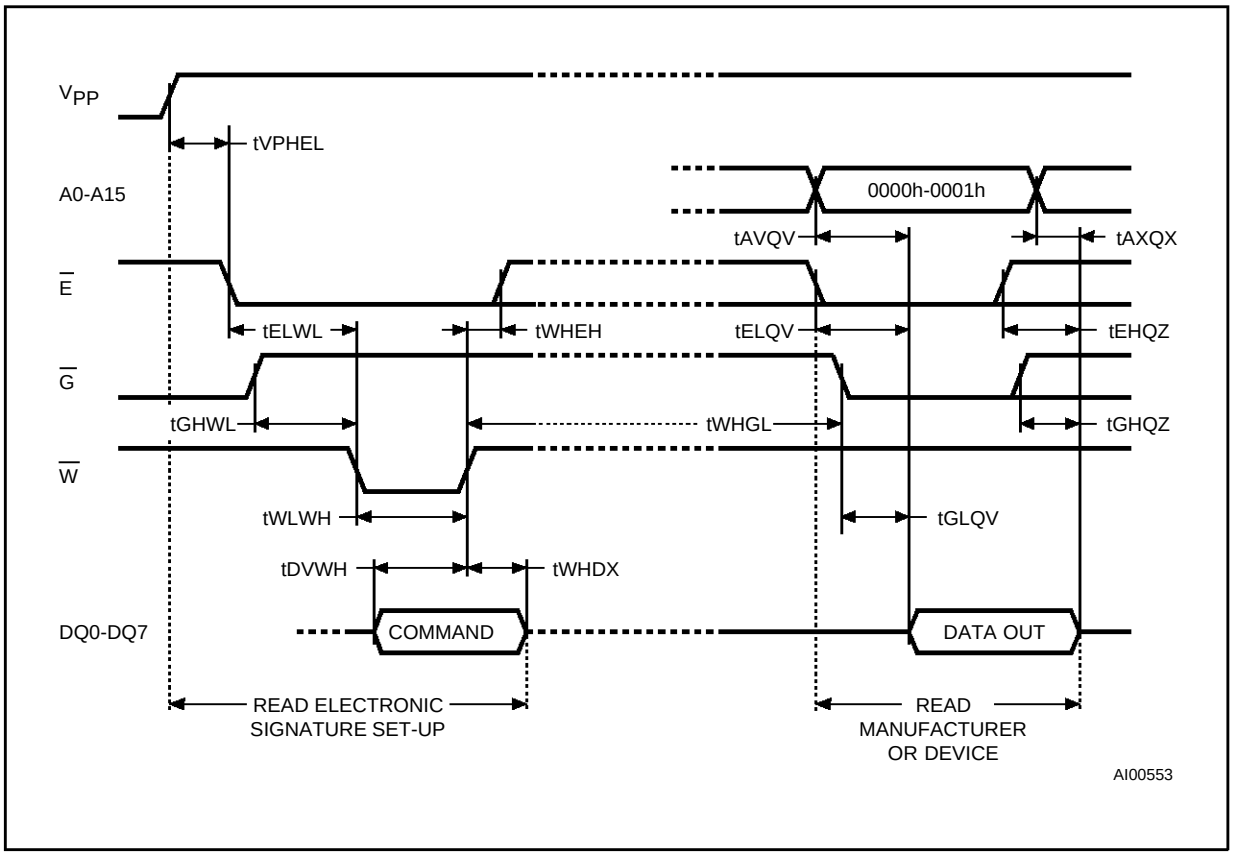


Figure 7. Electronic Signature Command Waveforms



Program and Program Verify Modes. The Program Mode is set-up by writing 40h to the command register. This is followed by a second write cycle which latches the address and data of the byte to be programmed. The rising edge of $\overline{W}$ during this secind cycle starts the programming operation. Programming is followed by a Program Verify of the data written.

Program Verify Mode is set-up by writing 0C0h to the command register. The rising edge of $\overline{W}$ during the set-up of the Program Verify Mode stops the Programming operation. The following read cycle, of the address already latched during programming, is made with an internally generated margin voltage applied, reading valid data indicates that all bits have been programmed.

Reset Mode. This command is used to safely abort Erase or Program Modes. The Reset Mode is set-up and performed by writing 0FFh two times to the command register. The command should be followed by writing a valid command to the the command register (for example Read).

Table 9A. Read/Write Mode AC Characteristics, $\overline{W}$ and $\overline{E}$ Controlled
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; V_{CC} = 5V ± 5% or 5V ± 10%)

Symbol	Alt	Parameter	M28F512						Unit
			-90		-10		-12		
			Min	Max	Min	Max	Min	Max	
t_{VPHEL}		V_{PP} High to Chip Enable Low	1		1		1		µs
t_{VPHWL}		V_{PP} High to Write Enable Low	1		1		1		µs
t_{WHWH3}	t_{WC}	Write Cycle Time	90		100		120		ns
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	0		0		0		ns
t_{AVEL}		Address Valid to Chip Enable Low	0		0		0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition	40		40		60		ns
t_{ELAX}		Chip Enable Low to Address Transition	60		60		80		ns
t_{ELWL}	t_{CS}	Chip Enable Low to Write Enable Low	15		15		20		ns
t_{WLEL}		Write Enable Low to Chip Enable Low	0		0		0		ns
t_{GHWL}		Output Enable High to Write Enable Low	0		0		0		µs
t_{GHEL}		Output Enable High to Chip Enable Low	0		0		0		µs
t_{DVWH}	t_{DS}	Input Valid to Write Enable High	40		40		50		ns
t_{DVEH}		Input Valid to Chip Enable High	35		40		50		ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High (Write Pulse)	40		40		60		ns
t_{ELEH}		Chip Enable Low to Chip Enable High (Write Pulse)	45		45		70		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition	10		10		10		ns
t_{EHDX}		Chip Enable High to Input Transition	10		10		10		ns
t_{WHWH1}		Duration of Program Operation	9.5		9.5		9.5		µs
t_{EHEH1}		Duration of Program Operation	9.5		9.5		9.5		µs
t_{WHWH2}		Duration of Erase Operation	9.5		9.5		9.5		ms
t_{WHEH}	t_{CH}	Write Enable High to Chip Enable High	0		0		0		ns
t_{EHWH}		Chip Enable High to Write Enable High	0		0		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low	20		20		20		ns
t_{EHEL}		Chip Enable High to Chip Enable Low	20		20		20		ns
t_{WHGL}		Write Enable High to Output Enable Low	6		6		6		µs
t_{EHGL}		Chip Enable High to Output Enable Low	6		6		6		µs
t_{AVQV}	t_{ACC}	Addess Valid to data Output		90		100		120	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	0		0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid		90		100		120	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	0		0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid		35		45		50	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z		40		40		50	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z		30		30		30	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	0		0		0		ns

Note: 1. Sampled only, not 100% tested

Table 9B. Read/Write Mode AC Characteristics, $\overline{W}$ and $\overline{E}$ Controlled
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; V_{CC} = 5V ± 5% or 5V ± 10%)

Symbol	Alt	Parameter	M28F512				Unit
			-15		-20		
			Min	Max	Min	Max	
t_{VPHEL}		V_{PP} High to Chip Enable Low	1		1		µs
t_{VPHWL}		V_{PP} High to Write Enable Low	1		1		µs
t_{WHWH3}	t_{WC}	Write Cycle Time	150		200		ns
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	0		0		ns
t_{AVEL}		Address Valid to Chip Enable Low	0		0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition	60		75		ns
t_{ELAX}		Chip Enable Low to Address Transition	80		80		ns
t_{ELWL}	t_{CS}	Chip Enable Low to Write Enable Low	20		20		ns
t_{WLEL}		Write Enable Low to Chip Enable Low	0		0		ns
t_{GHWL}		Output Enable High to Write Enable Low	0		0		µs
t_{GHEL}		Output Enable High to Chip Enable Low	0		0		µs
t_{DVWH}	t_{DS}	Input Valid to Write Enable High	50		50		ns
t_{DVEH}		Input Valid to Chip Enable High	50		50		ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High (Write Pulse)	60		60		ns
t_{ELEH}		Chip Enable Low to Chip Enable High (Write Pulse)	70		70		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition	10		10		ns
t_{EHDX}		Chip Enable High to Input Transition	10		10		ns
t_{WHWH1}		Duration of Program Operation	9.5		9.5		µs
t_{EHEH1}		Duration of Program Operation	9.5		9.5		µs
t_{WHWH2}		Duration of Erase Operation	9.5		9.5		ms
t_{WHEH}	t_{CH}	Write Enable High to Chip Enable High	0		0		ns
t_{EHWH}		Chip Enable High to Write Enable High	0		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low	20		20		ns
t_{EHEL}		Chip Enable High to Chip Enable Low	20		20		ns
t_{WHGL}		Write Enable High to Output Enable Low	6		6		µs
t_{EHGL}		Chip Enable High to Output Enable Low	6		6		µs
t_{AVQV}	t_{ACC}	Addess Valid to data Output		150		200	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid		150		200	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid		55		60	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z		55		60	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z		35		40	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	0		0		ns

Note: 1. Sampled only, not 100% tested

Figure 8. Erase Set-up and Erase Verify Commands Waveforms, $\overline{W}$ Controlled

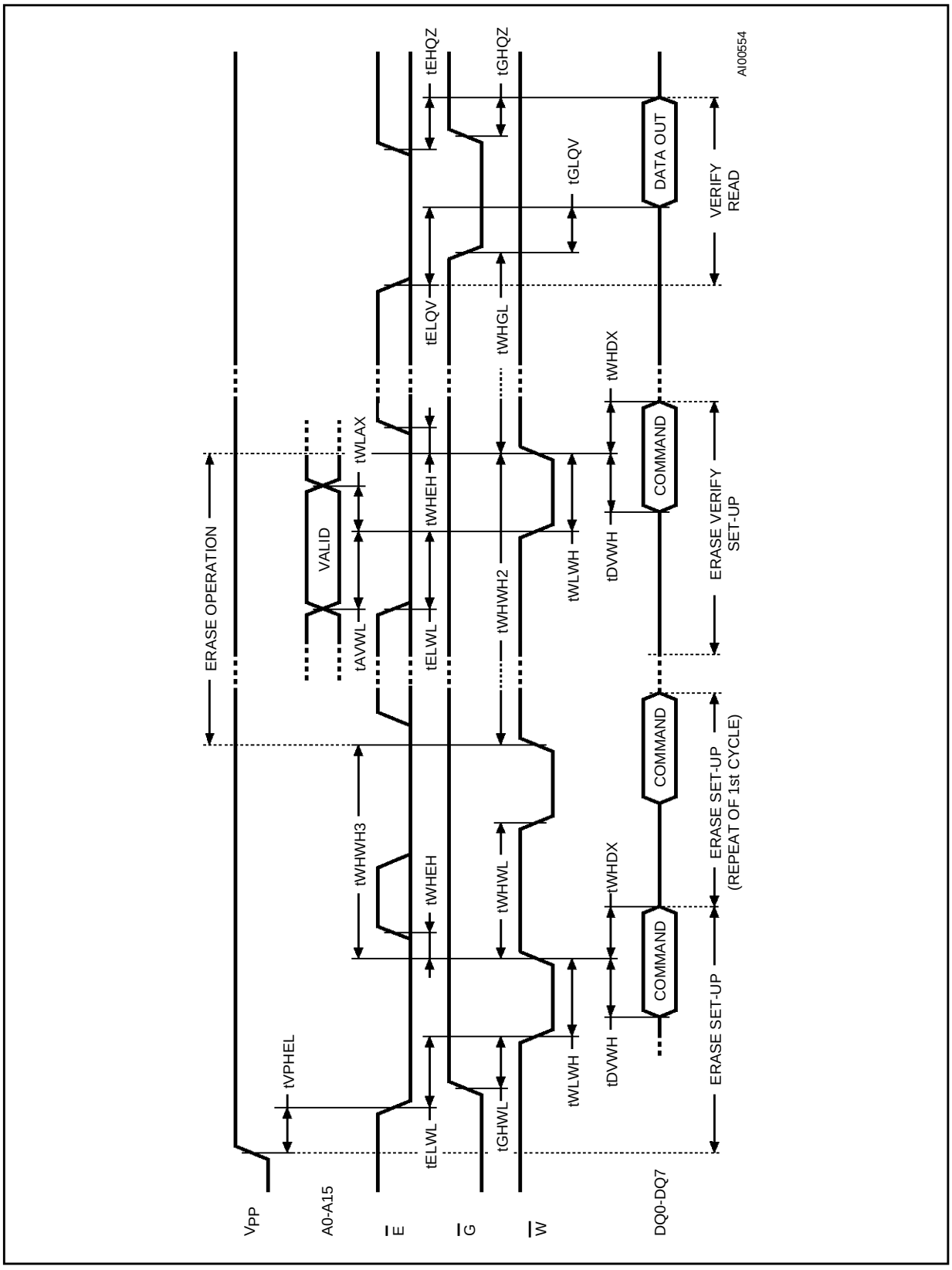


Figure 9. Erase Set-up and Erase Verify Commands Waveforms, $\overline{E}$ Controlled

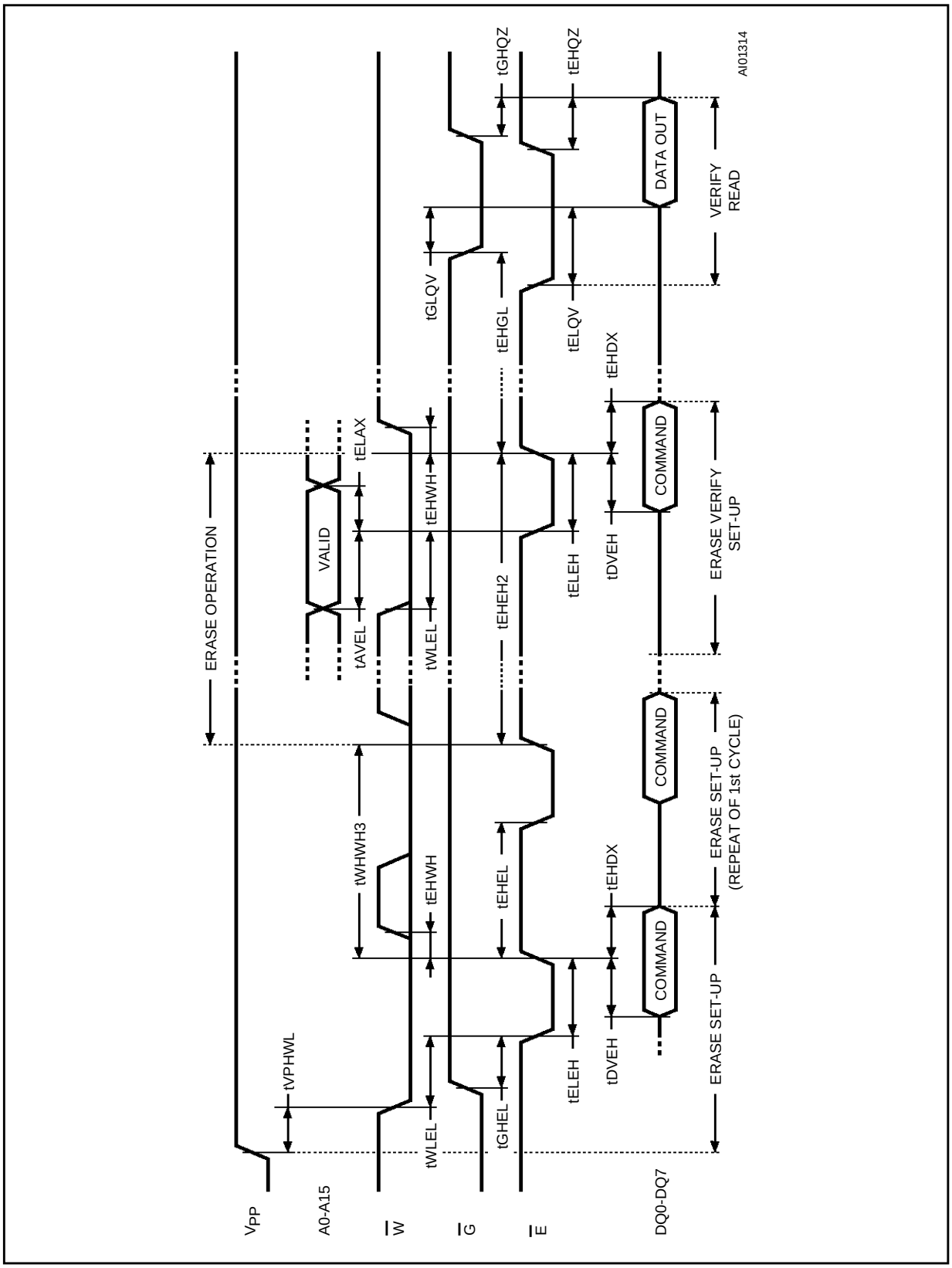


Figure 10. Program Set-up and Program Verify Commands Waveforms, $\overline{W}$ Controlled

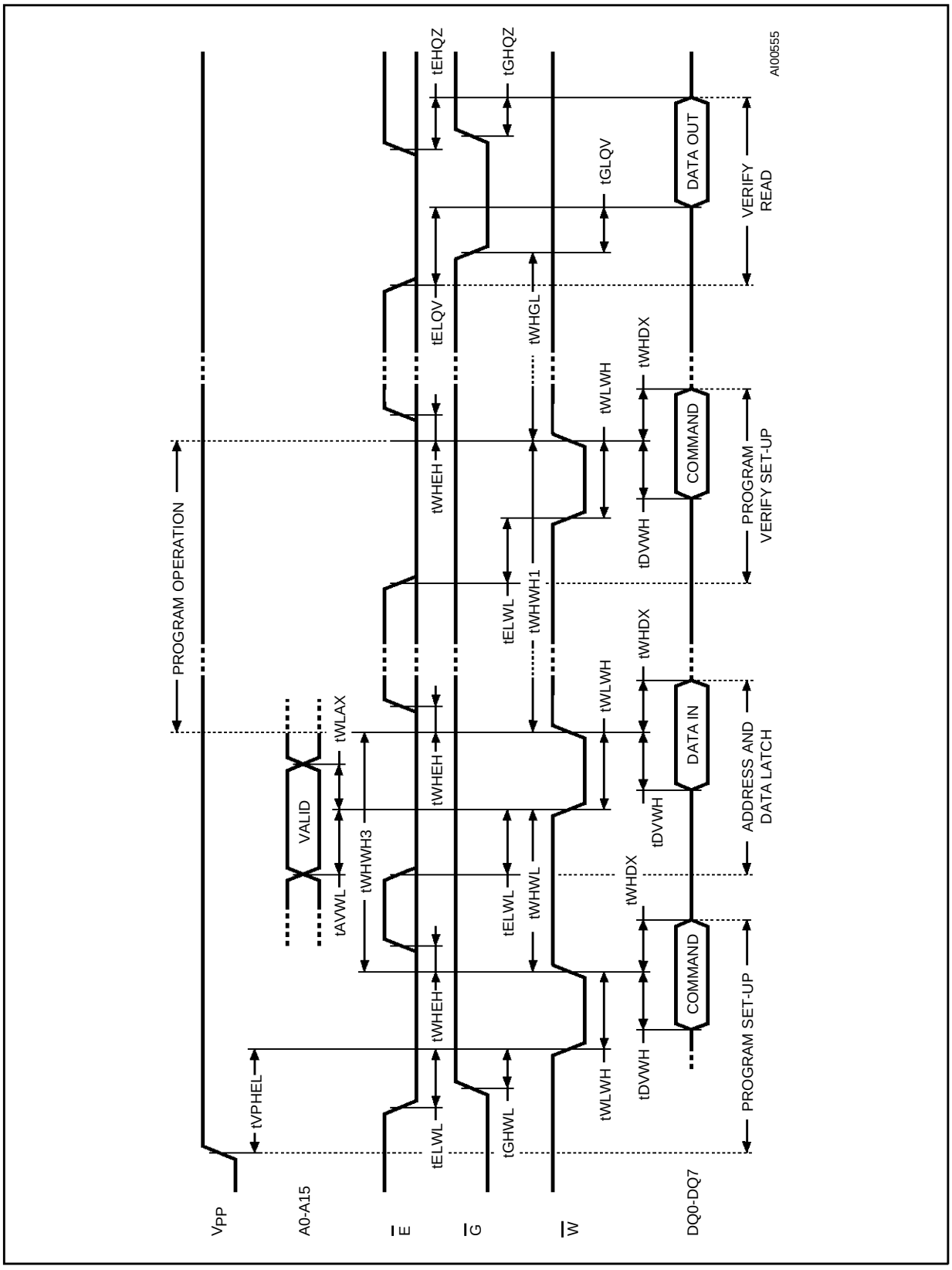


Figure 11. Program Set-up and Program Verify Commands Waveforms, $\overline{E}$ Controlled

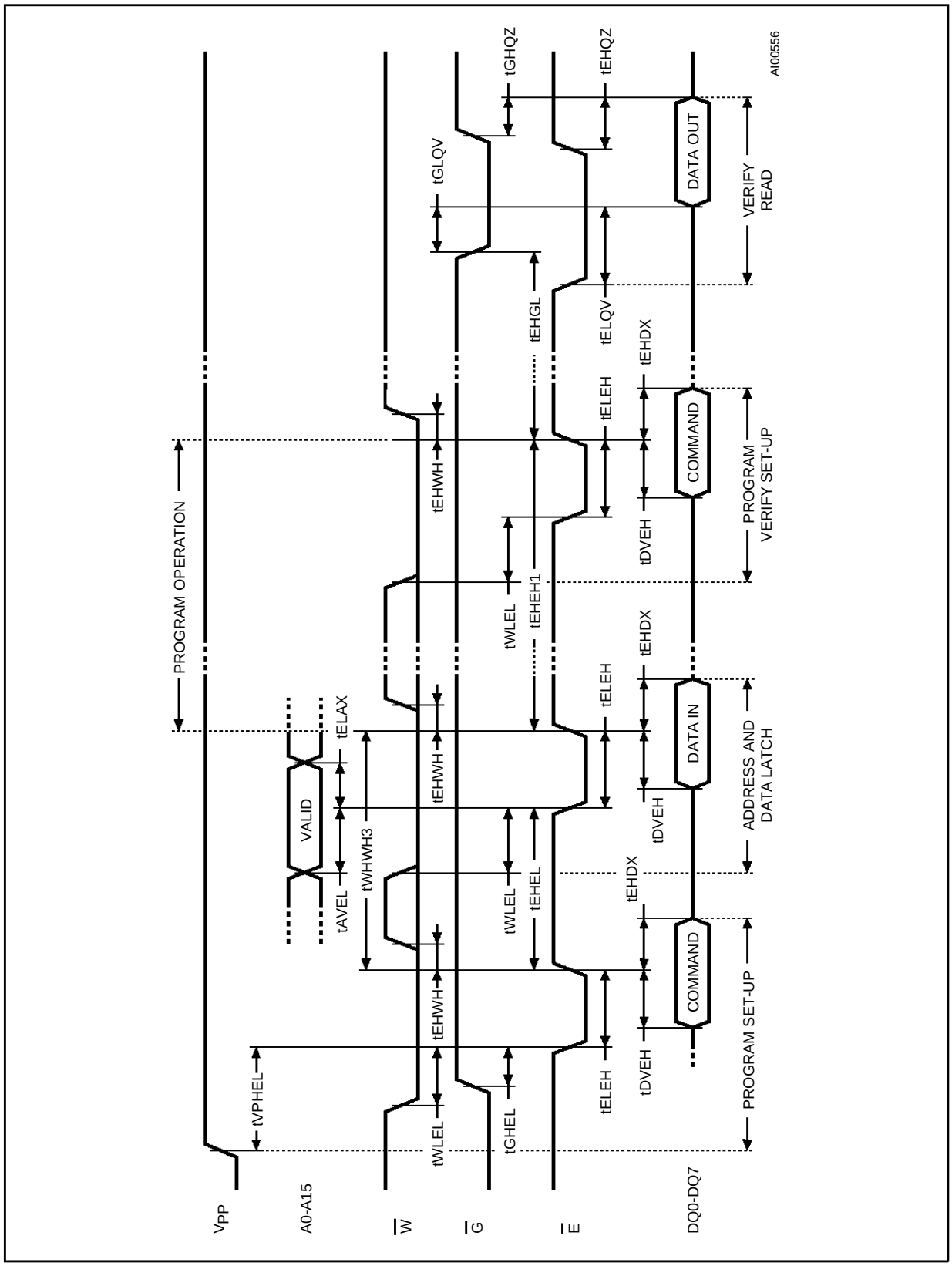


Figure 12. Erasing Flowchart

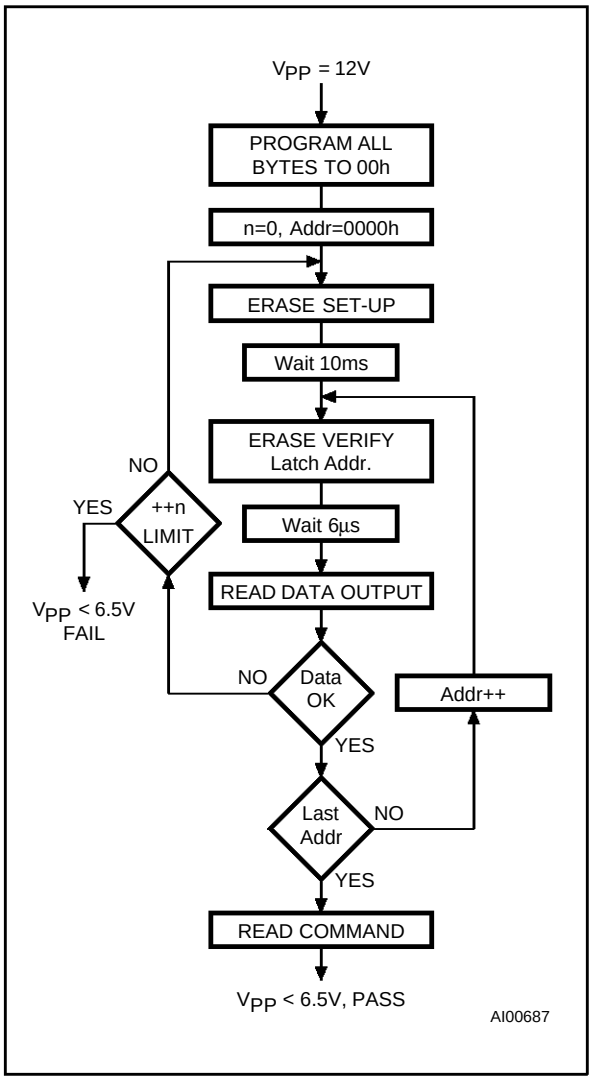
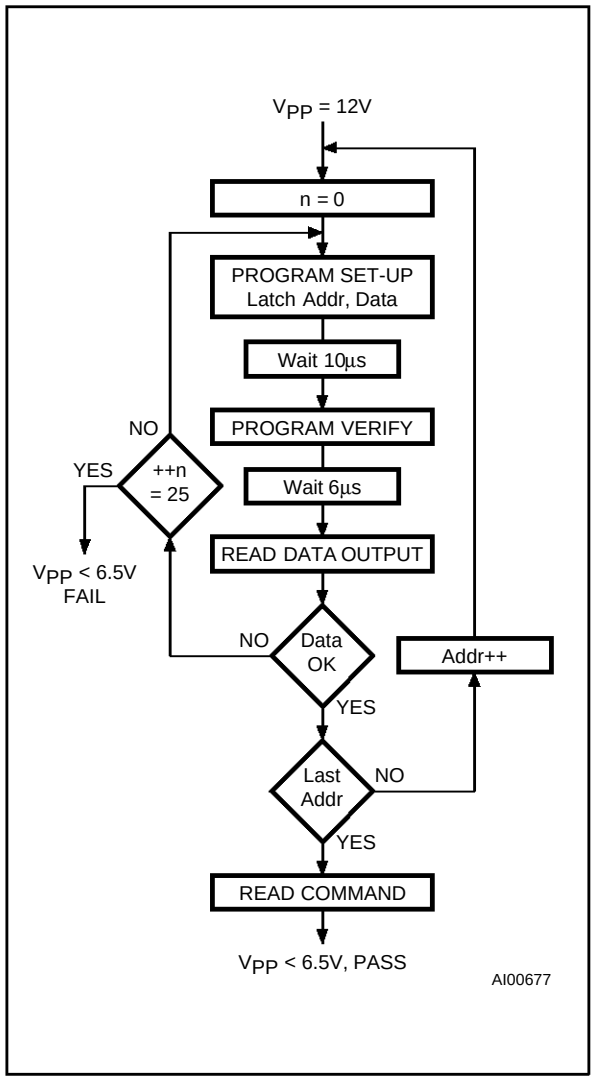


Figure 13. Programming Flowchart



PRESTO F ERASE ALGORITHM

The PRESTO F Erase Algorithm guarantees that the device will be erased in a reliable way. The algorithm first programms all bytes to 00h in order to ensure uniform erasure. The programming follows the Presto F Programming Algorithm (see below). Erase is set-up by writing 20h to the command register, the erasure is started by repeating this write cycle. Erase Verify is set-up by writing 0A0h to the command register together with the address of the byte to be verified. The subsequent read cycle reads the data which is compared to 0FFh. Erase Verify begins at address 0000h and continues to the last address or until the comparison of the data to 0FFh fails. If this occurs, the address of the last byte checked is stored and a new Erase operation performed. Erase Verify then continues from the address of the stored location.

PRESTO F PROGRAM ALGORITHM

The PRESTO F Programming Algorithm applies a series of 10µs programming pulses to a byte until a correct verify occurs. Up to 25 programming operations are allowed for one byte. Program is set-up by writing 40h to the command register, the programming is started after the next write cycle which also latches the address and data to be programmed. Program Verify is set-up by writing 0C0h to the command register, followed by a read cycle and a compare of the data read to the data expected. During Program and Program Verify operations a MARGIN MODE circuit is activated to guarantee that the cell is programmed with a safety margin.

ORDERING INFORMATION SCHEME

Example: M28F512 -90 X N 1 TR

Speed		V_{CC} Tolerance		Package		Temp. Range		Option	
-90	90 ns	blank	± 10%	B	PDIP32	1	0 to 70 °C	TR	Tape & Reel Packing
-10	100 ns	X	± 5%	C	PLCC32	3	–40 to 125 °C		
-12	120 ns					6	–40 to 85 °C		
-15	150 ns								
-20	200 ns								

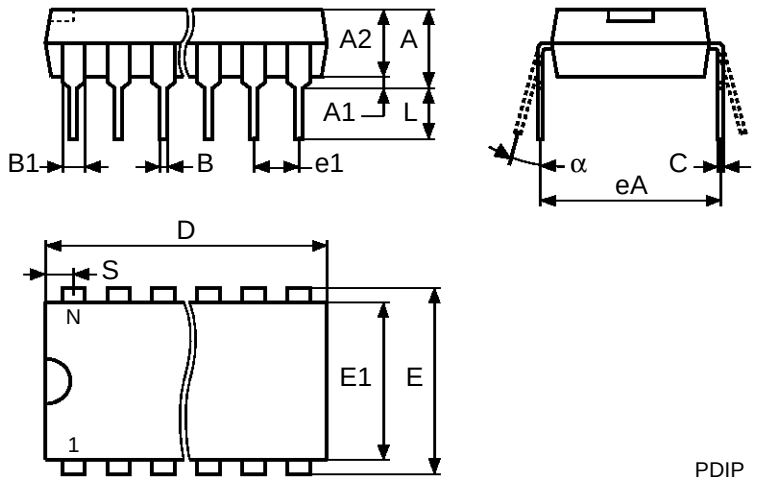
For a list of available options (Speed, V_{CC} Tolerance, Package, etc...) refer to the current Memory Shortform catalogue.

For further information on any aspect of this device, please contact the SGS-THOMSON Sales Office nearest to you.

PDIP32 - 32 pin Plastic DIP, 600 mils width

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A			4.83			0.190
A1		0.38	–		0.015	–
A2	–	–	–	–	–	–
B		0.41	0.51		0.016	0.020
B1		1.14	1.40		0.045	0.055
C		0.20	0.30		0.008	0.012
D		41.78	42.04		1.645	1.655
E		15.24	15.88		0.600	0.625
E1		13.46	13.97		0.530	0.550
e1	2.54	–	–	0.100	–	–
eA	15.24	–	–	0.600	–	–
L		3.18	3.43		0.125	0.135
S		1.78	2.03		0.070	0.080
α		0°	15°		0°	15°
N	32			32		

PDIP32



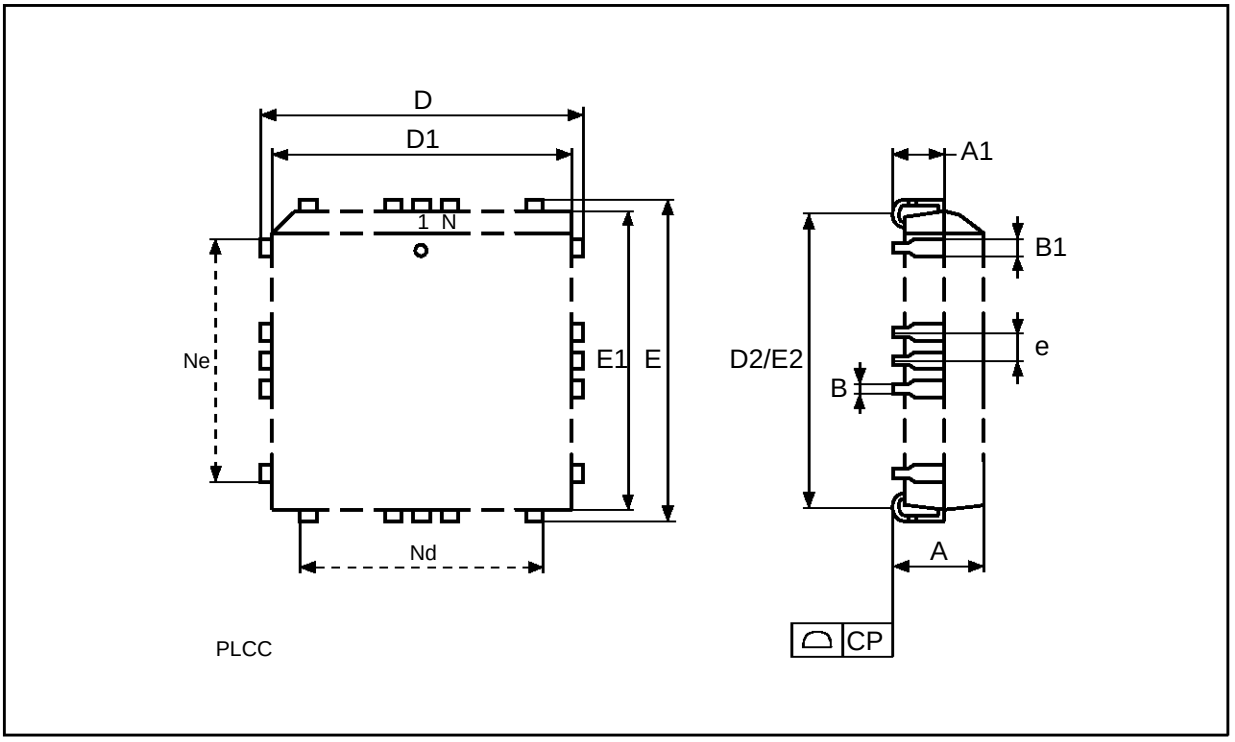
PDIP

Drawing is not to scale

PLCC32 - 32 lead Plastic Leaded Chip Carrier, rectangular

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A		2.54	3.56		0.100	0.140
A1		1.52	2.41		0.060	0.095
B		0.33	0.53		0.013	0.021
B1		0.66	0.81		0.026	0.032
D		12.32	12.57		0.485	0.495
D1		11.35	11.56		0.447	0.455
D2		9.91	10.92		0.390	0.430
E		14.86	15.11		0.585	0.595
E1		13.89	14.10		0.547	0.555
E2		12.45	13.46		0.490	0.530
e	1.27	–	–	0.050	–	–
N	32			32		
Nd	7			7		
Ne	9			9		
CP			0.10			0.004

PLCC32



PLCC

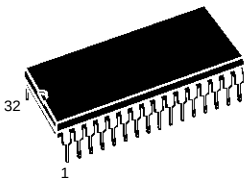
Drawing is not to scale

SGS-THOMSON MICROELECTRONICS

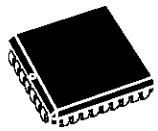
M28F101

1 Megabit (128K x 8, Chip Erase) FLASH MEMORY

- FAST ACCESS TIME: 70ns
- LOW POWER CONSUMPTION
  - Standby Current: 100µA Max
- 10,000 ERASE/PROGRAM CYCLES
- 12V PROGRAMMING VOLTAGE
- TYPICAL BYTE PROGRAMING TIME 10µs (PRESTO F ALGORITHM)
- ELECTRICAL CHIP ERASE in 1s RANGE
- INTEGRATED ERASE/PROGRAM-STOP TIMER
- OTP COMPATIBLE PACKAGES and PINOUTS
- EXTENDED TEMPERATURE RANGES



PDIP32 (P)



PLCC32 (K)

TSOP32 (N)
8 x 20 mm

DESCRIPTION

The M28F101 FLASH Memory is a non-volatile memory which may be erased electrically at the chip level and programmed byte-by-byte. It is organised as 128K bytes of 8 bits. It uses a command register architecture to select the operating modes and thus provides a simple microprocessor interface. The M28F101 FLASH Memory is suitable for applications where the memory has to be reprogrammed in the equipment. The access time of 100ns makes the device suitable for use in high speed microprocessor systems.

Table 1. Signal Names

A0 - A16	Address Inputs
DQ0 - DQ7	Data Inputs / Outputs
$\overline{E}$	Chip Enable
$\overline{G}$	Output Enable
$\overline{W}$	Write Enable
V_{PP}	Program Supply
V_{CC}	Supply Voltage
V_{SS}	Ground

Figure 1. Logic Diagram

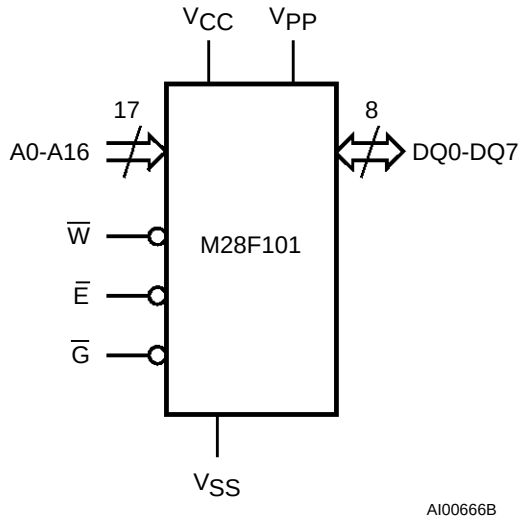
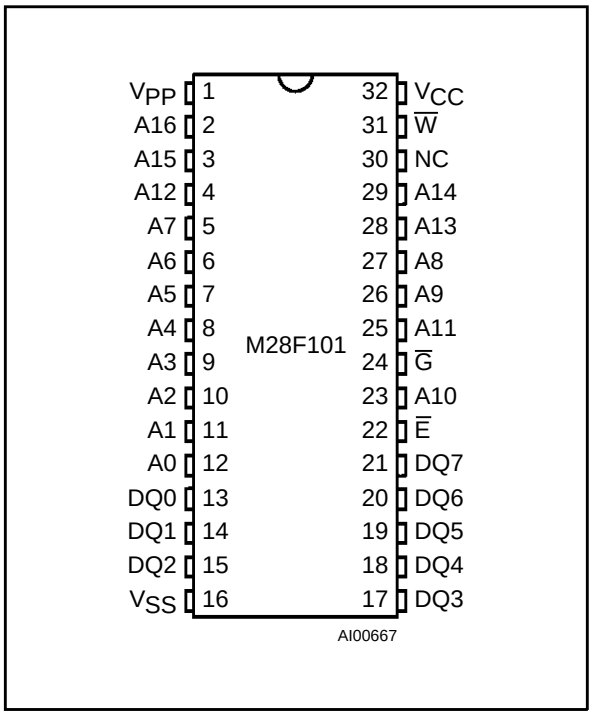
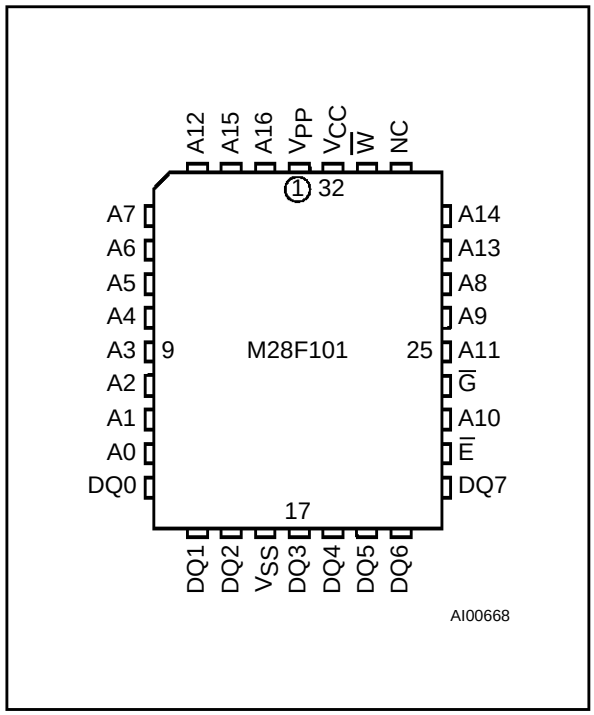


Figure 2A. DIP Pin Connections



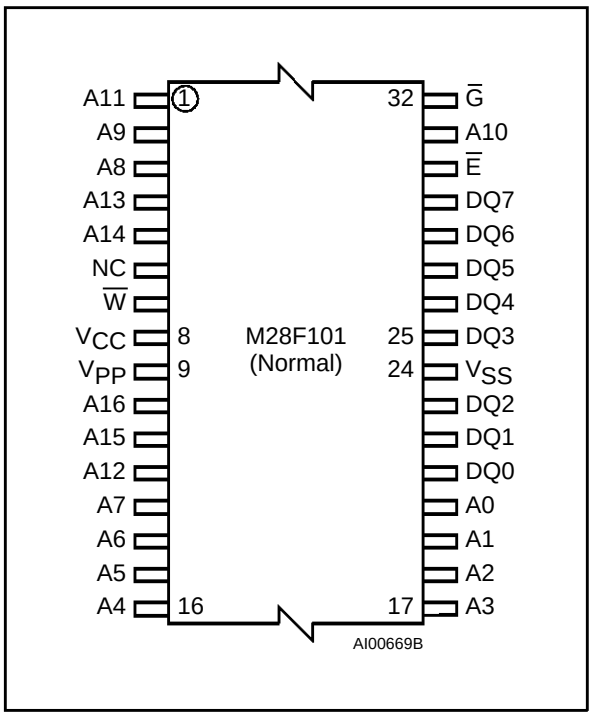
Warning: NC = Not Connected

Figure 2B. LCC Pin Connections



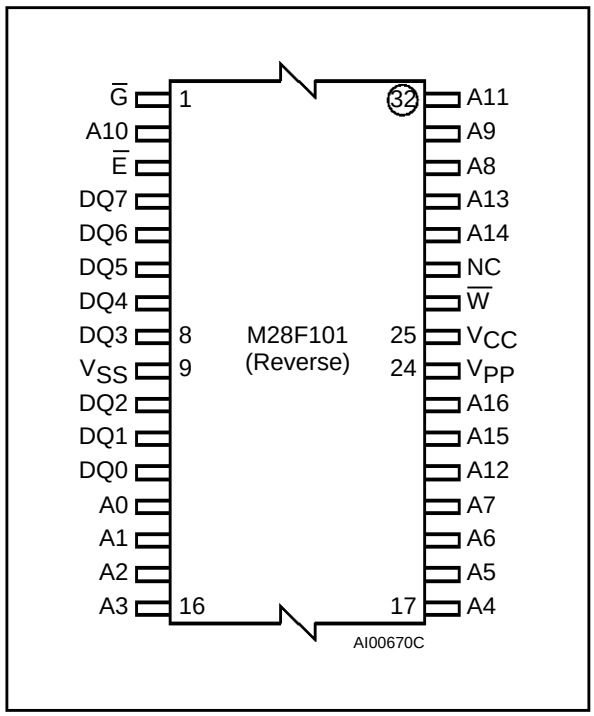
Warning: NC = Not Connected

Figure 2C. TSOP Pin Connections



Warning: NC = Not Connected

Figure 2D. TSOP Reverse Pin Connections



Warning: NC = Not Connected

Table 2. Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
T_A	Ambient Operating Temperature	–40 to 125	°C
T_{STG}	Storage Temperature	–65 to 150	°C
V_{IO}	Input or Output Voltages	–0.6 to 7	V
V_{CC}	Supply Voltage	–0.6 to 7	V
V_{A9}	A9 Voltage	–0.6 to 13.5	V
V_{PP}	Program Supply Voltage, during Erase or Programming	–0.6 to 14	V

Note: Except for the rating "Operating Temperature Range", stresses above those listed in the Table "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the SGS-THOMSON SURE Program and other relevant quality documents.

DEVICE OPERATION

The M28F101 FLASH Memory employs a technology similar to a 1 Megabit EPROM but adds to the device functionality by providing electrical erasure and programming. These functions are managed by a command register. The functions that are addressed via the command register depend on the voltage applied to the V_{PP}, program voltage, input. When V_{PP} is less than or equal to 6.5V, the command register is disabled and M28F101 functions as a read only memory providing operating modes similar to an EPROM (Read, Output Disable, Electronic Signature Read and Standby). When V_{PP} is raised to 12V the command regsiter is enabled and this provides, in addition, Erase and Program operations.

READ ONLY MODES, $V_{PP} \leq 6.5V$

For all Read Only Modes, except Standby Mode, the Write Enable input $\overline{W}$ should be High. In the Standby Mode this input is don't care.

Read Mode. The M28F101 has two enable inputs, $\overline{E}$ and $\overline{G}$, both of which must be Low in order to output data from the memory. The Chip Enable ($\overline{E}$) is the power control and should be used for device selection. Output Enable ($\overline{G}$) is the output control and should be used to gate data on to the output, independant of the device selection.

Standby Mode. In the Standby Mode the maximum supply current is reduced. The device is placed in the Standby Mode by applying a High to the Chip Enable ($\overline{E}$) input. When in the Standby Mode the outputs are in a high impedance state, independant of the Output Enable ($\overline{G}$) input.

Output Disable Mode. When the Output Enable ($\overline{G}$) is High the outputs are in a high impedance state.

Electronic Signature Mode. This mode allows the read out of two binary codes from the device which identify the manufacturer and device type. This mode is intended for use by programming equipment to automatically select the correct erase and programming algorithms. The Electronic Signature Mode is active when a high voltage (11.5V to 13V) is applied to address line A9 with $\overline{E}$ and $\overline{G}$ Low. With A0 Low the output data is the manufacturer code, when A0 is High the output is the device type code. All other address lines should be maintained Low while reading the codes. The electronic signature may also be accessed in Read/Write modes.

READ/WRITE MODES, $11.4V \leq V_{PP} \leq 12.6V$

When V_{PP} is High both read and write operations may be performed. These are defined by the contents of an internal command register. Commands may be written to this register to set-up and execute, Erase, Erase Verify, Program, Program Verify and Reset modes. Each of these modes needs 2 cycles. Every mode starts with a write operation to set-up the command, this is followed by either read or write operations. The device expects the first cycle to be a write operation and does not corrupt data at any location in memory. Read mode is set-up with one cycle only and may be followed by any number of read operations to output data. Electronic Signature Read mode is set-up with one cycle and followed by a read cycle to output the manufacturer or device codes.

Table 3. Operations (1)

	V_{PP}	Operation	$\overline{E}$	$\overline{G}$	$\overline{W}$	A9	DQ0 - DQ7
Read Only	V_{PPL}	Read	V_{IL}	V_{IL}	V_{IH}	A9	Data Output
		Output Disable	V_{IL}	V_{IH}	V_{IH}	X	Hi-Z
		Standby	V_{IH}	X	X	X	Hi-Z
		Electronic Signature	V_{IL}	V_{IL}	V_{IH}	V_{ID}	Codes
Read/Write (2)	V_{PPH}	Read	V_{IL}	V_{IL}	V_{IH}	A9	Data Output
		Write	V_{IL}	V_{IH}	V_{IL} Pulse	A9	Data Input
		Output Disable	V_{IL}	V_{IH}	V_{IH}	X	Hi-Z
		Standby	V_{IH}	X	X	X	Hi-Z

Notes: 1. X = V_{IL} or V_{IH}
2. Refer also to the Command Table

Table 4. Electronic Signature

Identifier	A0	DQ7	DQ6	DQ5	DQ4	DQ3	DQ2	DQ1	DQ0	Hex Data
Manufacturer's Code	V_{IL}	0	0	1	0	0	0	0	0	20h
Device Code	V_{IH}	0	0	0	0	0	1	1	1	07h

Table 5. Commands (1)

Command	Cycles	1st Cycle			2nd Cycle		
		Operation	A0-A16	DQ0-DQ7	Operation	A0-A16	DQ0-DQ7
Read	1	Write	X	00h			
Electronic Signature	2	Write	X	90h	Read	00000h	20h
					Read	00001h	07h
Setup Erase/ Erase	2	Write	X	20h			
					Write	X	20h
Erase Verify	2	Write	A0-A16	0A0h	Read	X	Data Output
Setup Program/ Program	2	Write	X	40h			
					Write	A0-A16	Data Input
Program Verify	2	Write	X	0C0h	Read	X	Data Output
Reset	2	Write	X	0FFh	Write	X	0FFh

Note: 1. X = V_{IL} or V_{IH}

READ/WRITE MODES (cont'd)

A write to the command register is made by bringing $\overline{W}$ Low while $\overline{E}$ is Low. The falling edge of $\overline{W}$ latches Addresses, while the rising edge latches Data, which are used for those commands that require address inputs, command input or provide data output.

The supply voltage V_{CC} and the program voltage V_{PP} can be applied in any order. When the device is powered up or when V_{PP} is ≤ 6.5V the contents of the command register default to 00h, thus automatically setting-up Read operations. In addition a specific command may be used to set the command register to 00h for reading the memory.

The system designer may chose to provide a constant high V_{PP} and use the register commands for all operations, or to switch the V_{PP} from low to high only when needing to erase or program the memory. All command register access is inhibited when V_{CC} falls below the Erase/Write Lockout Voltage (V_{LKO}) of 2.5V.

If the device is deselected during Erasure, Programming or Verification it will draw active supply currents until the operations are terminated.

The device is protected against stress caused by long erase or program times. If the end of Erase or Programming operations are not terminated by a Verify cycle within a maximum time permitted, an internal stop timer automatically stops the operation. The device remains in an inactive state, ready to start a Verify or Reset Mode operation.

Table 6. AC Measurement Conditions

	SRAM Interface Levels	EPROM Interface Levels
Input Rise and Fall Times	≤ 10ns	≤ 10ns
Input Pulse Voltages	0 to 3V	0.45V to 2.4V
Input and Output Timing Ref. Voltages	1.5V	0.8V and 2V

Figure 3. AC Testing Input Output Waveform

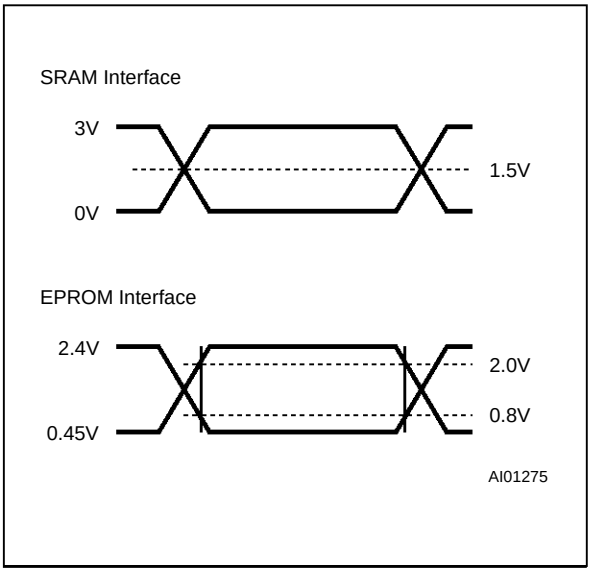


Figure 4. AC Testing Load Circuit

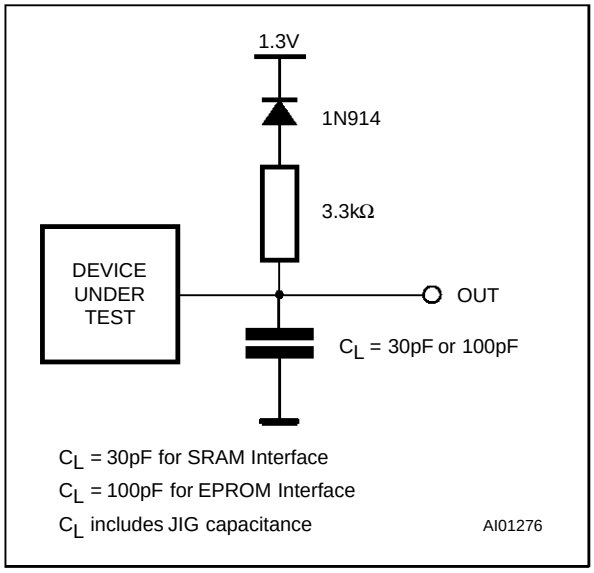


Table 7. Capacitance (1) (T_A = 25 °C, f = 1 MHz)

Symbol	Parameter	Test Condition	Min	Max	Unit
C_{IN}	Input Capacitance	V_{IN} = 0V		6	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V		12	pF

Note: 1. Sampled only, not 100% test.ed

Table 8. DC Characteristics
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; V_{CC} = 5V ± 10%)

Symbol	Parameter	Test Condition	Min	Max	Unit
I_{LI}	Input Leakage Current	$0V \le V_{IN} \le V_{CC}$		±1	µA
I_{LO}	Output Leakage Current	$0V \le V_{OUT} \le V_{CC}$		±10	µA
I_{CC}	Supply Current (Read)	$\overline{E} = V_{IL}$, f = 6MHz		30	mA
I_{CC1}	Supply Current (Standby) TTL	$\overline{E} = V_{IH}$		1	mA
	Supply Current (Standby) CMOS	$\overline{E} = V_{CC} \pm 0.2V$		50	µA
I_{CC2} (1)	Supply Current (Programming)	During Programming		10	mA
I_{CC3} (1)	Supply Current (Program Verify)	During Verify		15	mA
I_{CC4} (1)	Supply Current (Erase)	During Erasure		15	mA
I_{CC5} (1)	Supply Current (Erase Verify)	During Erase Verify		15	mA
I_{LPP}	Program Leakage Current	$V_{PP} \le V_{CC}$		±10	µA
I_{PP}	Program Current (Read or Standby)	$V_{PP} > V_{CC}$		120	µA
		$V_{PP} \le V_{CC}$		±10	µA
I_{PP1}(1)	Program Current (Programming)	$V_{PP} = V_{PPH}$, During Programming		30	mA
I_{PP2}(1)	Program Current (Program Verify)	$V_{PP} = V_{PPH}$, During Verify		5	mA
I_{PP3}(1)	Program Current (Erase)	$V_{PP} = V_{PPH}$, During Erase		30	mA
I_{PP4}(1)	Program Current (Erase Verify)	$V_{PP} = V_{PPH}$, During Erase Verify		5	mA
V_{IL}	Input Low Voltage		–0.5	0.8	V
V_{IH}	Input High Voltage TTL		2	V_{CC} + 0.5	V
	Input High Voltage CMOS		0.7 V_{CC}	V_{CC} + 0.5	V
V_{OL}	Output Low Voltage	I_{OL} = 5.8mA (grade 1)		0.45	V
		I_{OL} = 2.1mA (grade 6)		0.45	V
V_{OH}	Output High Voltage CMOS	I_{OH} = –100µA	4.1		V
		I_{OH} = –2.5mA	0.85 V_{CC}		V
	Output High Voltage TTL	I_{OH} = –2.5mA	2.4		V
V_{PPL}	Program Voltage (Read Operations)		0	6.5	V
V_{PPH}	Program Voltage (Read/Write Operations)		11.4	12.6	V
V_{ID}	A9 Voltage (Electronic Signature)		11.5	13	V
I_{ID} (1)	A9 Current (Electronic Signature)	A9 = V_{ID}		200	µA
V_{LKO}	Supply Voltage, Erase/Program Lock-out		2.5		V

Note: 1. Not 100% tested. Characterisation Data available.

Table 9A. Read Only Mode AC Characteristics
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; 0V ≤ V_{PP} ≤ 6.5V)

Symbol	Alt	Parameter	Test Condition	M28F101						Unit
				-70		-90		-100		
				V_{CC}=5V±5%		V_{CC}=5V±10%		V_{CC}=5V±10%		
				SRAM Interface		EPROM Interface		EPROM Interface		
				Min	Max	Min	Max	Min	Max	
t_{WHGL}		Write Enable High to Output Enable Low		6		6		6		µs
t_{AVAV}	t_{RC}	Read Cycle Time	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	70		90		100		ns
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		70		90		100	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	$\overline{G}$ = V_{IL}	0		0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		70		90		100	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	$\overline{E}$ = V_{IL}	0		0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		30		35		45	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}	0	30	0	45	0	45	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}	0	30	0	30	0	30	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		0		0		ns

Note: 1. Sampled only, not 100% tested

Read Mode. The Read Mode is the default at power up or may be set-up by writing 00h to the command register. Subsequent read operations output data from the memory. The memory remains in the Read Mode until a new command is written to the command register.

Electronic Signature Mode. In order to select the correct erase and programming algorithms for on-board programming, the manufacturer and devices code may be read directly. It is not neccessary to apply a high voltage to A9 when using the command register. The Electronic Signature Mode is set-up by writing 90h to the command register. The following read cycle, with address inputs 00000h or 00001h, output the manufacturer or device type codes. The command is terminated by writing another valid command to the command register (for example Reset).

Table 9B. Read Only Mode AC Characteristics
($(T_A$ = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C; 0V ≤ V_{PP} ≤ 6.5V)

Symbol	Alt	Parameter	Test Condition	M28F101						Unit
				-120		-150		-200		
				V_{CC}=5V±10%		V_{CC}=5V±10%		V_{CC}=5V±10%		
				EPROM Interface		EPROM Interface		EPROM Interface		
				Min	Max	Min	Max	Min	Max	
t_{WHGL}		Write Enable High to Output Enable Low		6		6		6		µs
t_{AVAV}	t_{RC}	Read Cycle Time	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	120		150		200		ns
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		120		150		200	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	$\overline{G}$ = V_{IL}	0		0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		120		150		200	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	$\overline{E}$ = V_{IL}	0		0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		50		55		60	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}	0	55	0	55	0	60	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}	0	30	0	35	0	40	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		0		0		ns

Note: 1. Sampled only, not 100% tested

Erase and Erase Verify Modes. The memory is erased by first Programming all bytes to 00h, the Erase command then erases them to 0FFh. The Erase Verify command is then used to read the memory byte-by-byte for a content of 0FFh. The Erase Mode is set-up by writing 20h to the command register. The write cycle is then repeated to start the erase operation. Erasure starts on the rising edge of $\overline{W}$ during this second cycle. Erase is followed by an Erase Verify which reads an addressed byte.

Erase Verify Mode is set-up by writing 0A0h to the command register and at the same time supplying the address of the byte to be verified. The rising edge of $\overline{W}$ during the set-up of the first Erase Verify Mode stops the Erase operation. The following read cycle is made with an internally generated margin voltage applied; reading 0FFh indicates that all bits of the addressed byte are fully erased. The whole contents of the memory are verified by repeating the Erase Verify Operation, first writing the set-up code 0A0h with the address of the byte to be verified and then reading the byte contents in a second read cycle.

Figure 5. Read Mode AC Waveforms

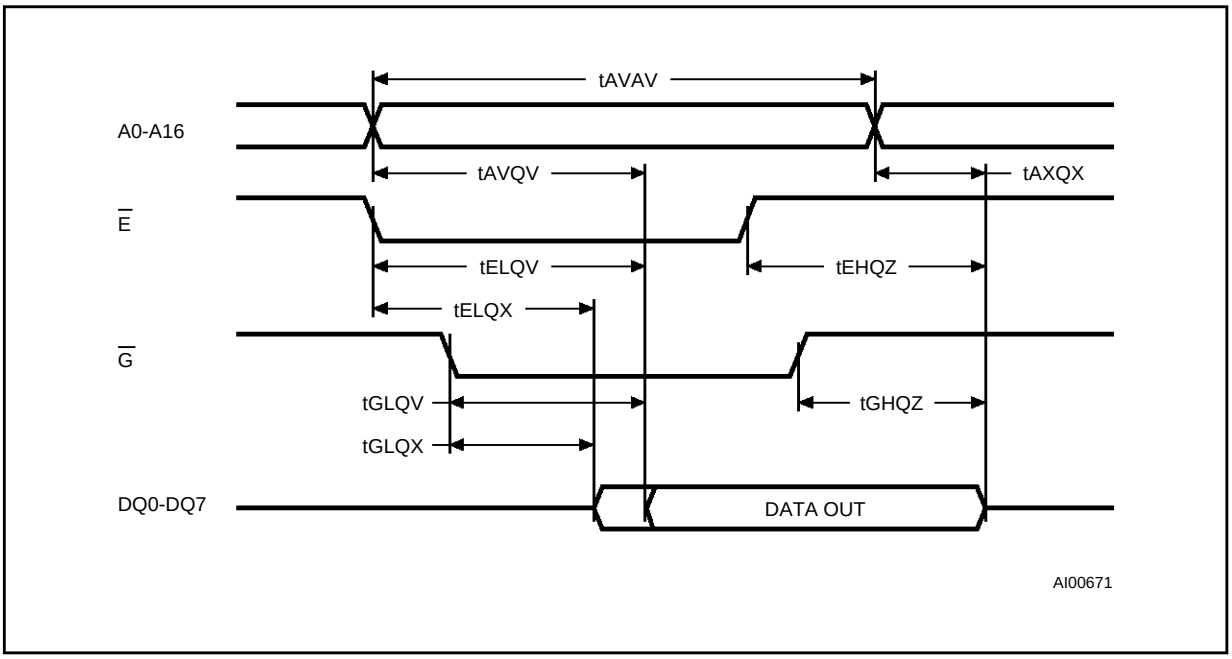


Figure 6. Read Command Waveforms

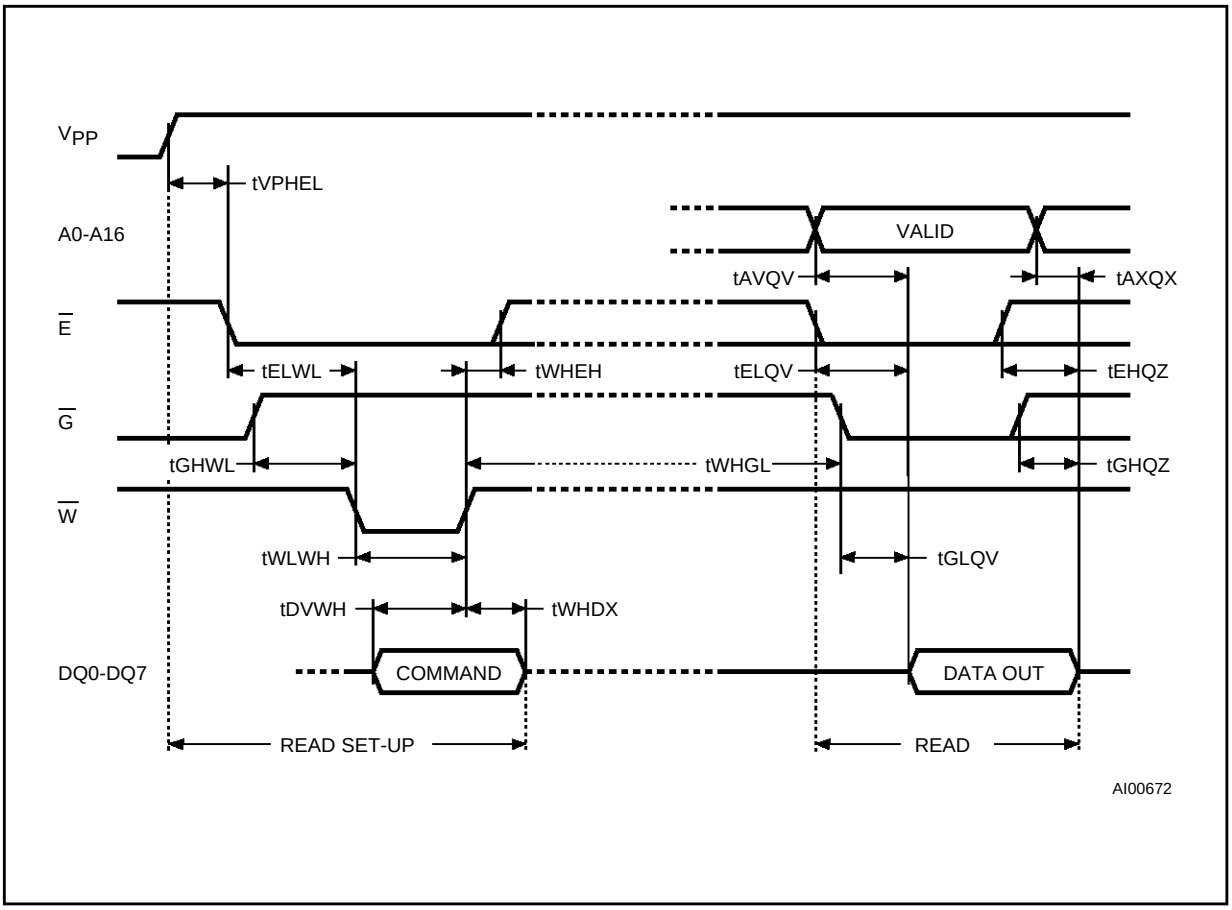
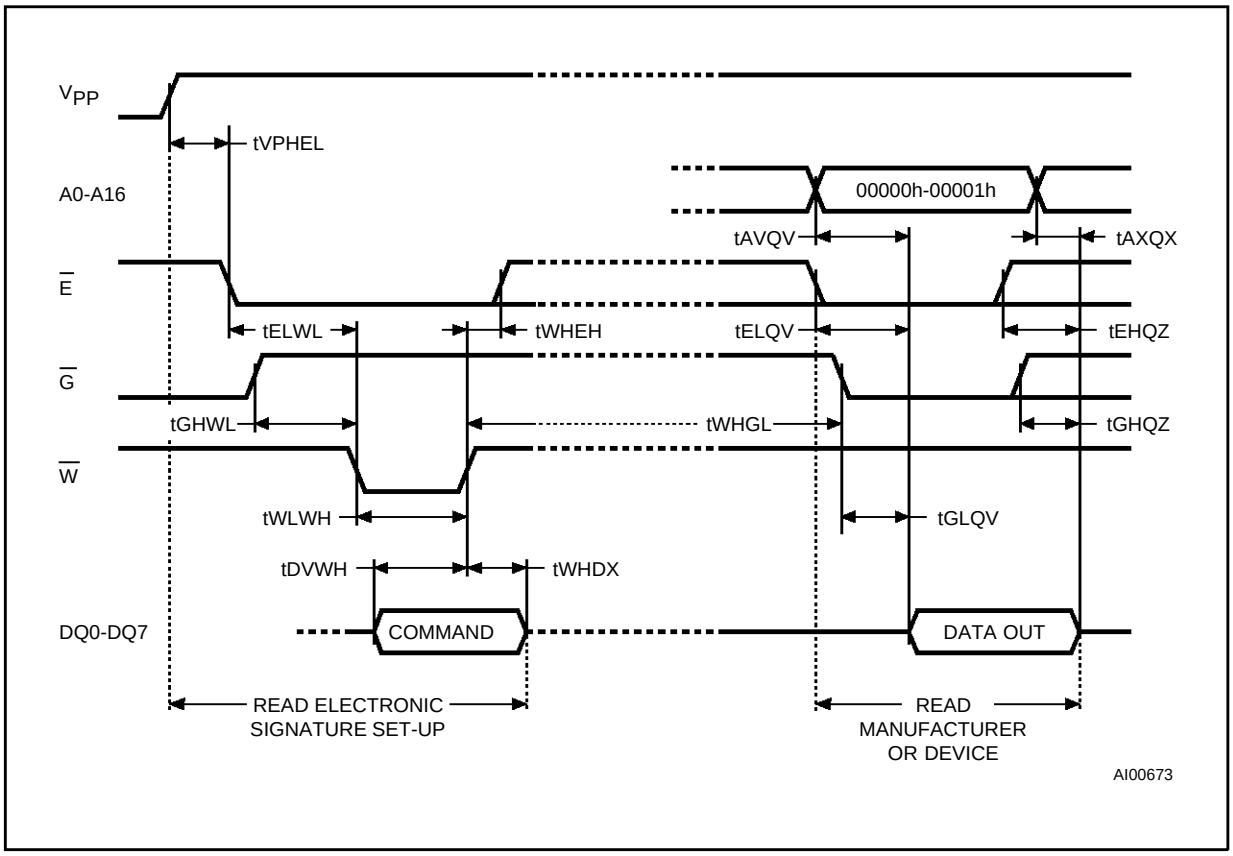


Figure 7. Electronic Signature Command Waveforms



READ/WRITE MODES (cont'd)

As the Erase algorithm flow chart shows, when the data read during Erase Verify is not 0FFh, another Erase operation is performed and verification continues from the address of the last verified byte. The command is terminated by writing another valid command to the command register (for example Program or Reset).

Program and Program Verify Modes. The Program Mode is set-up by writing 40h to the command register. This is followed by a second write cycle which latches the address and data of the byte to be programmed. The rising edge of $\overline{W}$ during this secind cycle starts the programming operation. Programming is followed by a Program Verify of the data written.

Program Verify Mode is set-up by writing 0C0h to the command register. The rising edge of $\overline{W}$ during the set-up of the Program Verify Mode stops the Programming operation. The following read cycle, of the address already latched during programming, is made with an internally generated margin voltage applied, reading valid data indicates that all bits have been programmed.

Reset Mode. This command is used to safely abort Erase or Program Modes. The Reset Mode is set-up and performed by writing 0FFh two times to the command register. The command should be followed by writing a valid command to the the command register (for example Read).

Table 10A. Read/Write Mode AC Characteristics, $\overline{W}$ and $\overline{E}$ Controlled
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C)

Symbol	Alt	Parameter	M28F101						Unit
			-70		-90		-100		
			V_{CC}=5V±5%		V_{CC}=5V±10%		V_{CC}=5V±10%		
			SRAM Interface		EPROM Interface		EPROM Interface		
			Min	Max	Min	Max	Min	Max	
t_{VPHEL}		V_{PP} High to Chip Enable Low	1		1		1		µs
t_{VPHWL}		V_{PP} High to Write Enable Low	1		1		1		µs
t_{WHWH3}	t_{WC}	Write Cycle Time	70		90		100		ns
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	0		0		0		ns
t_{AVEL}		Address Valid to Chip Enable Low	0		0		0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition	40		40		40		ns
t_{ELAX}		Chip Enable Low to Address Transition	50		60		60		ns
t_{ELWL}	t_{CS}	Chip Enable Low to Write Enable Low	10		15		15		ns
t_{WLEL}		Write Enable Low to Chip Enable Low	0		0		0		ns
t_{GHWL}		Output Enable High to Write Enable Low	0		0		0		µs
t_{GHEL}		Output Enable High to Chip Enable Low	0		0		0		µs
t_{DVWH}	t_{DS}	Input Valid to Write Enable High	30		40		40		ns
t_{DVEH}		Input Valid to Chip Enable High	30		35		40		ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High (Write Pulse)	35		40		40		ns
t_{ELEH}		Chip Enable Low to Chip Enable High (Write Pulse)	35		45		45		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition	10		10		10		ns
t_{EHDX}		Chip Enable High to Input Transition	10		10		10		ns
t_{WHWH1}		Duration of Program Operation	9.5		9.5		9.5		µs
t_{EHEH1}		Duration of Program Operation	9.5		9.5		9.5		µs
t_{WHWH2}		Duration of Erase Operation	9.5		9.5		9.5		ms
t_{WHEH}	t_{CH}	Write Enable High to Chip Enable High	0		0		0		ns
t_{EHWH}		Chip Enable High to Write Enable High	0		0		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low	20		20		20		ns
t_{EHEL}		Chip Enable High to Chip Enable Low	20		20		20		ns
t_{WHGL}		Write Enable High to Output Enable Low	6		6		6		µs
t_{EHGL}		Chip Enable High to Output Enable Low	6		6		6		µs
t_{AVQV}	t_{ACC}	Addess Valid to data Output		70		90		100	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	0		0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid		70		90		100	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	0		0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid		30		35		45	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z		30		40		40	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z		30		30		30	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	0		0		0		ns

Note: 1. Sampled only, not 100% tested

Table 10B. Read/Write Mode AC Characteristics, $\overline{W}$ and $\overline{E}$ Controlled
(T_A = 0 to 70 °C, –40 to 85 °C or –40 to 125 °C)

Symbol	Alt	Parameter	M28F101						Unit
			-120		-150		-200		
			V_{CC}=5V±10%		V_{CC}=5V±10%		V_{CC}=5V±10%		
			EPROM Interface		EPROM Interface		EPROM Interface		
			Min	Max	Min	Max	Min	Max	
t_{VPHEL}		V_{PP} High to Chip Enable Low	1		1		1		µs
t_{VPHWL}		V_{PP} High to Write Enable Low	1		1		1		µs
t_{WHWH3}	t_{WC}	Write Cycle Time	120		150		200		ns
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	0		0		0		ns
t_{AVEL}		Address Valid to Chip Enable Low	0		0		0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition	60		60		75		ns
t_{ELAX}		Chip Enable Low to Address Transition	80		80		80		ns
t_{ELWL}	t_{CS}	Chip Enable Low to Write Enable Low	20		20		20		ns
t_{WLEL}		Write Enable Low to Chip Enable Low	0		0		0		ns
t_{GHWL}		Output Enable High to Write Enable Low	0		0		0		µs
t_{GHEL}		Output Enable High to Chip Enable Low	0		0		0		µs
t_{DVWH}	t_{DS}	Input Valid to Write Enable High	50		50		50		ns
t_{DVEH}		Input Valid to Chip Enable High	50		50		50		ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High (Write Pulse)	60		60		60		ns
t_{ELEH}		Chip Enable Low to Chip Enable High (Write Pulse)	70		70		70		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition	10		10		10		ns
t_{EHDX}		Chip Enable High to Input Transition	10		10		10		ns
t_{WHWH1}		Duration of Program Operation	9.5		9.5		9.5		µs
t_{EHEH1}		Duration of Program Operation	9.5		9.5		9.5		µs
t_{WHWH2}		Duration of Erase Operation	9.5		9.5		9.5		ms
t_{WHEH}	t_{CH}	Write Enable High to Chip Enable High	0		0		0		ns
t_{EHWH}		Chip Enable High to Write Enable High	0		0		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low	20		20		20		ns
t_{EHEL}		Chip Enable High to Chip Enable Low	20		20		20		ns
t_{WHGL}		Write Enable High to Output Enable Low	6		6		6		µs
t_{EHGL}		Chip Enable High to Output Enable Low	6		6		6		µs
t_{AVQV}	t_{ACC}	Addess Valid to data Output		120		150		200	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	0		0		0		ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid		120		150		200	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	0		0		0		ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid		50		55		60	ns
t_{EHQZ} (1)		Chip Enable High to Output Hi-Z		50		55		60	ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z		30		35		40	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	0		0		0		ns

Note: 1. Sampled only, not 100% tested

Figure 8. Erase Set-up and Erase Verify Commands Waveforms, $\overline{W}$ Controlled

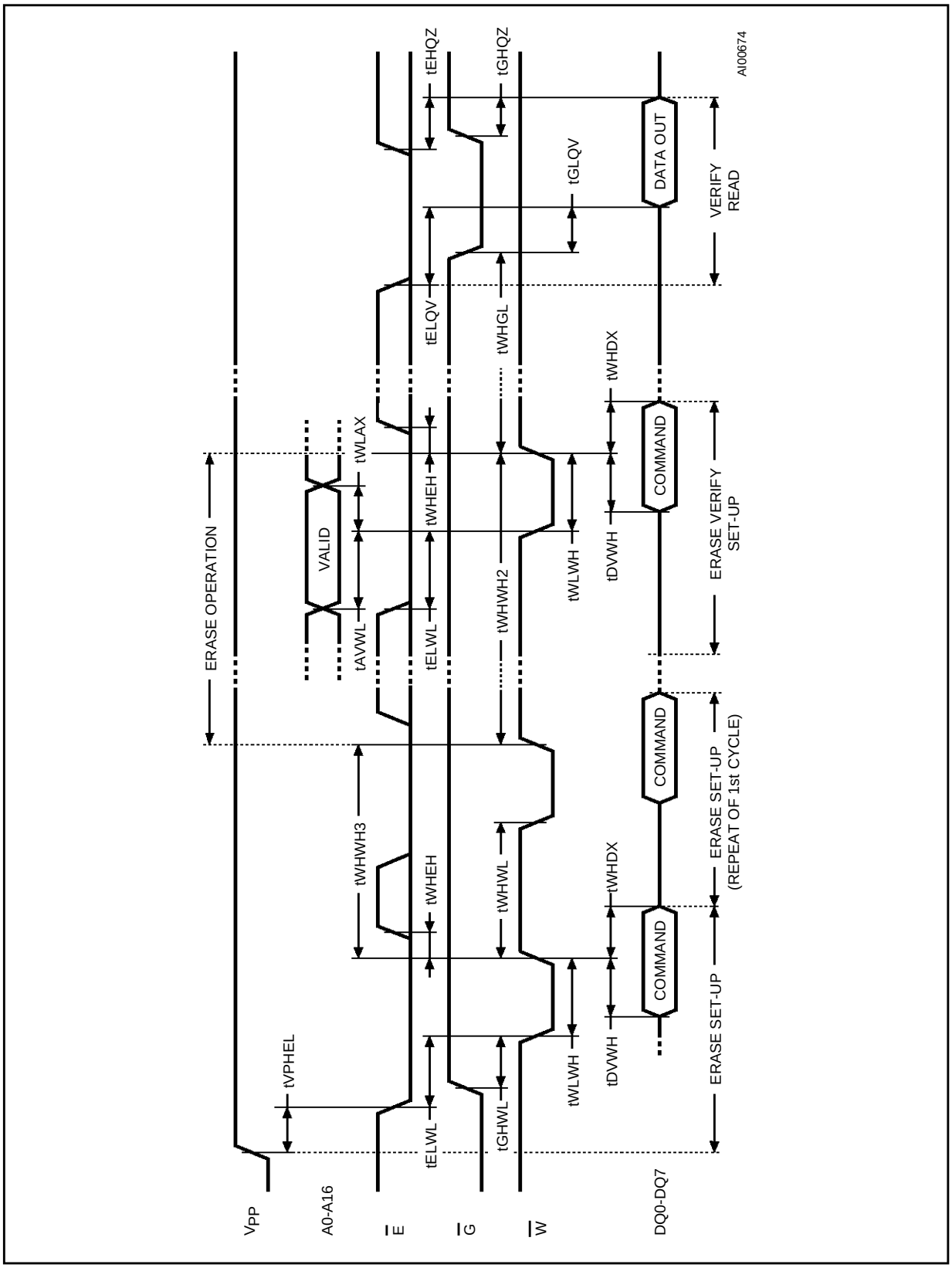


Figure 9. Erase Set-up and Erase Verify Commands Waveforms, $\overline{E}$ Controlled

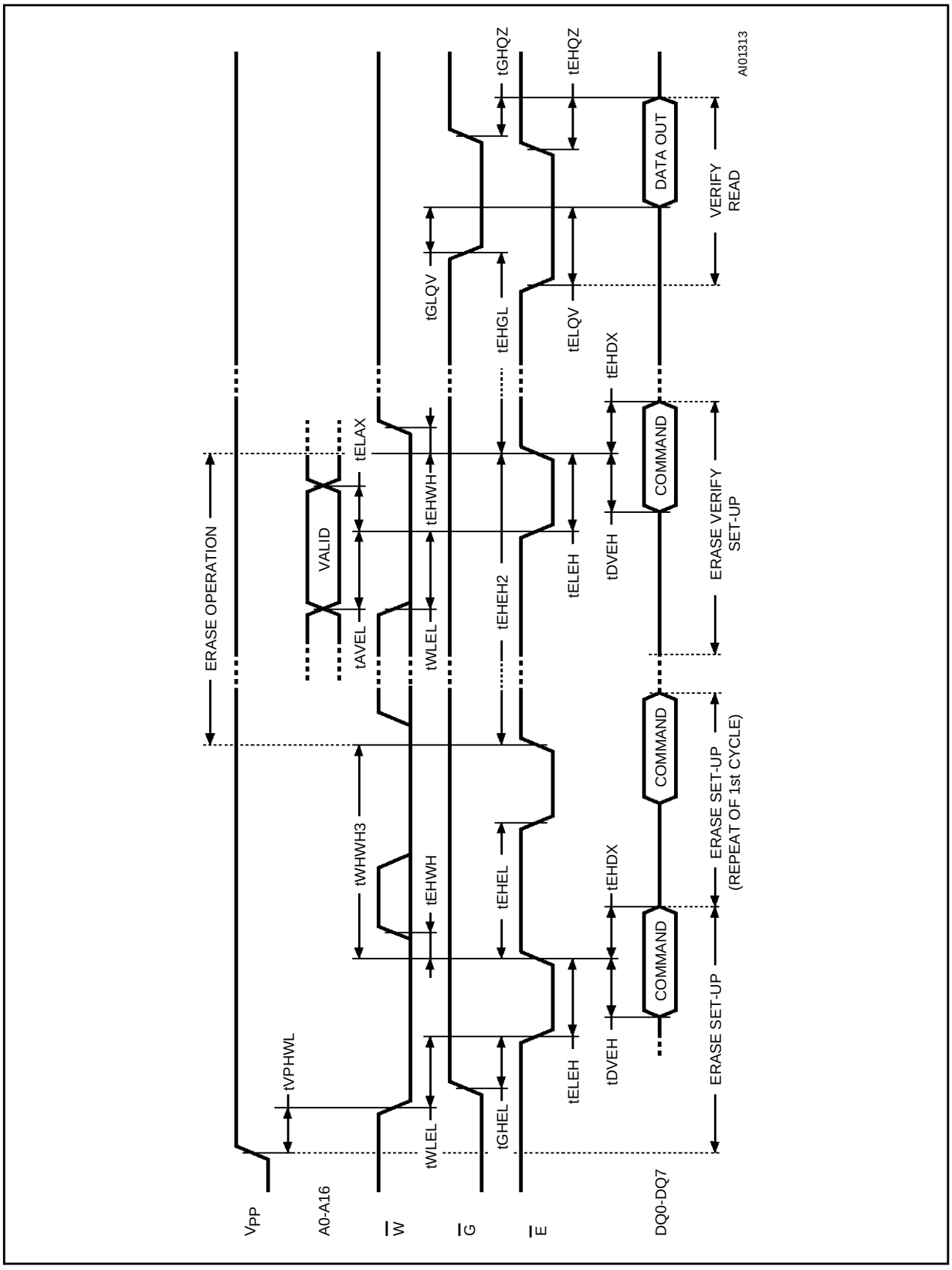


Figure 10. Program Set-up and Program Verify Commands Waveforms, $\overline{W}$ Controlled

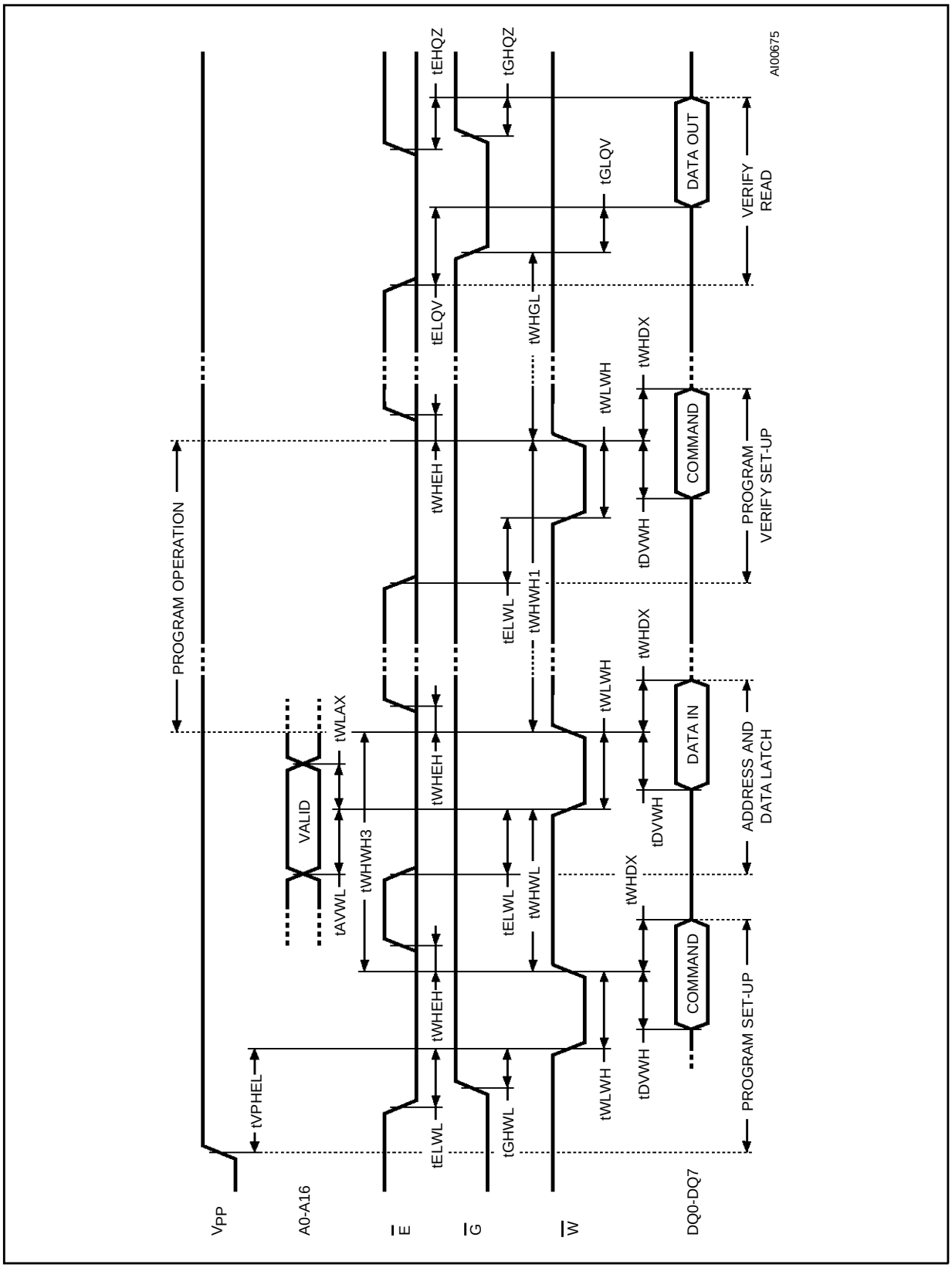


Figure 11. Program Set-up and Program Verify Commands Waveforms, $\overline{E}$ Controlled

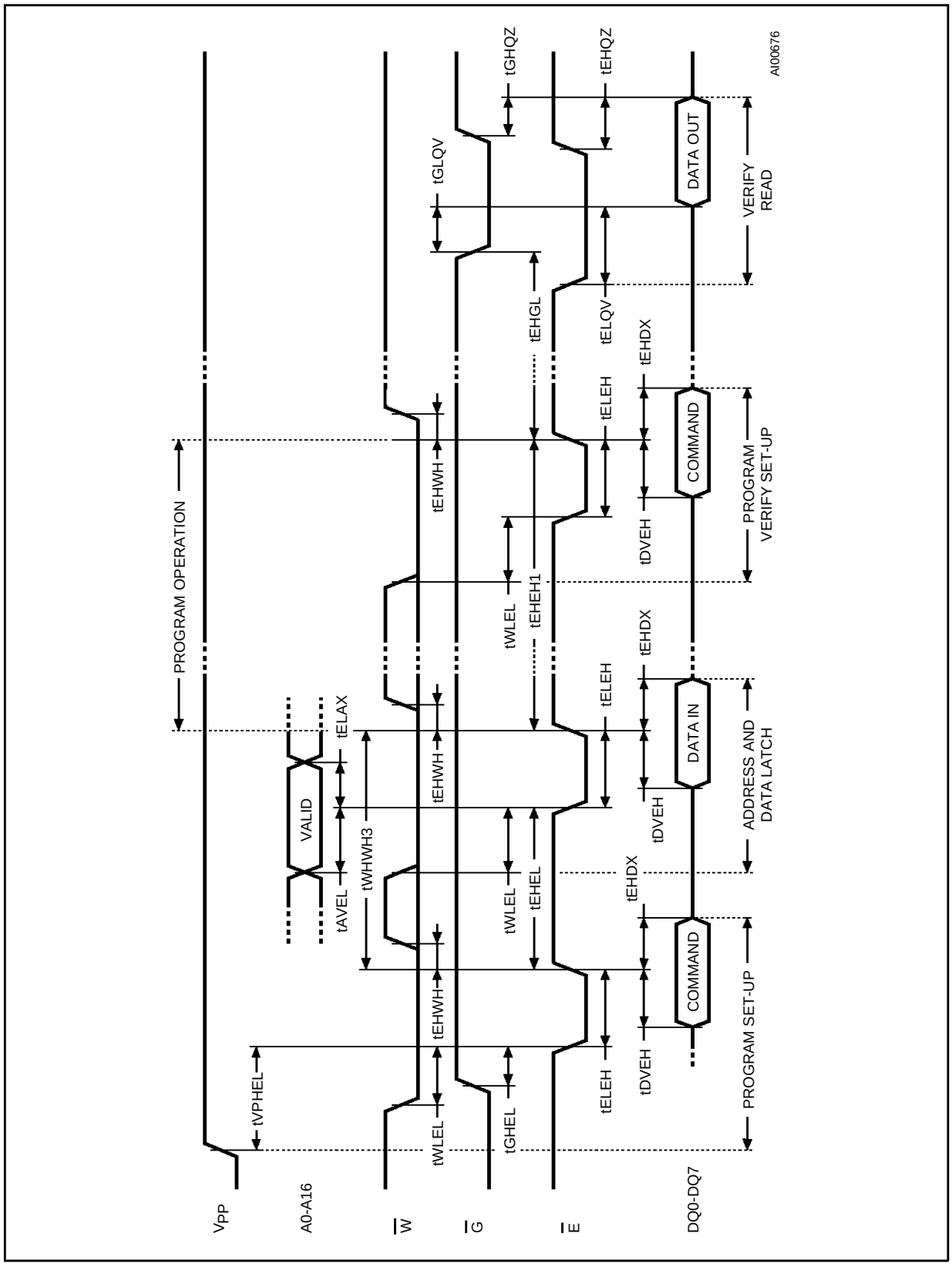


Figure 12. Erasing Flowchart

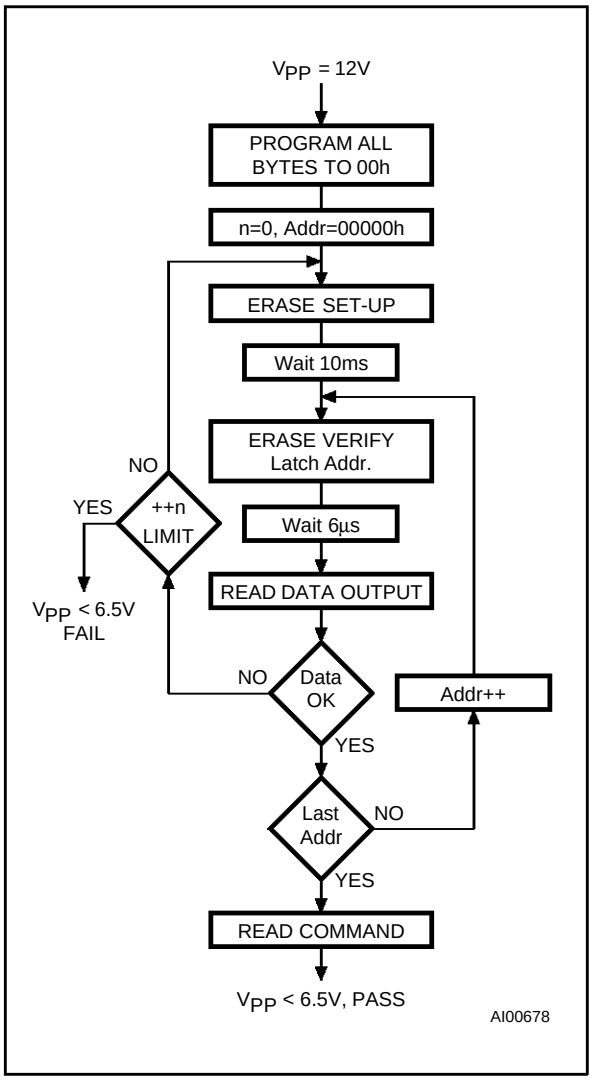
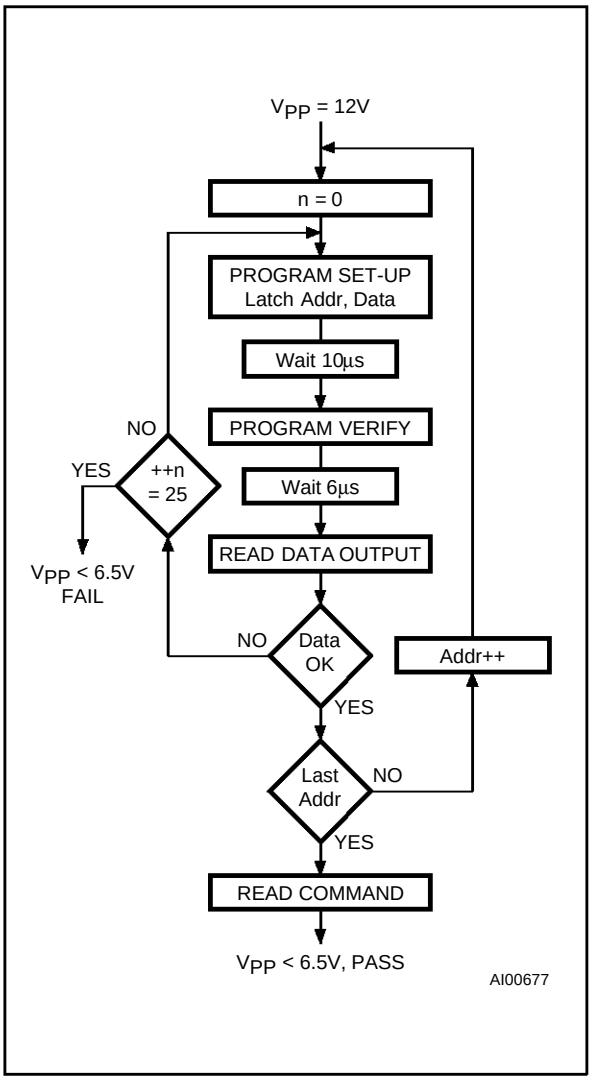


Figure 13. Programming Flowchart



Limit: 1000 at grade 1; 6000 at grades 3 & 6.

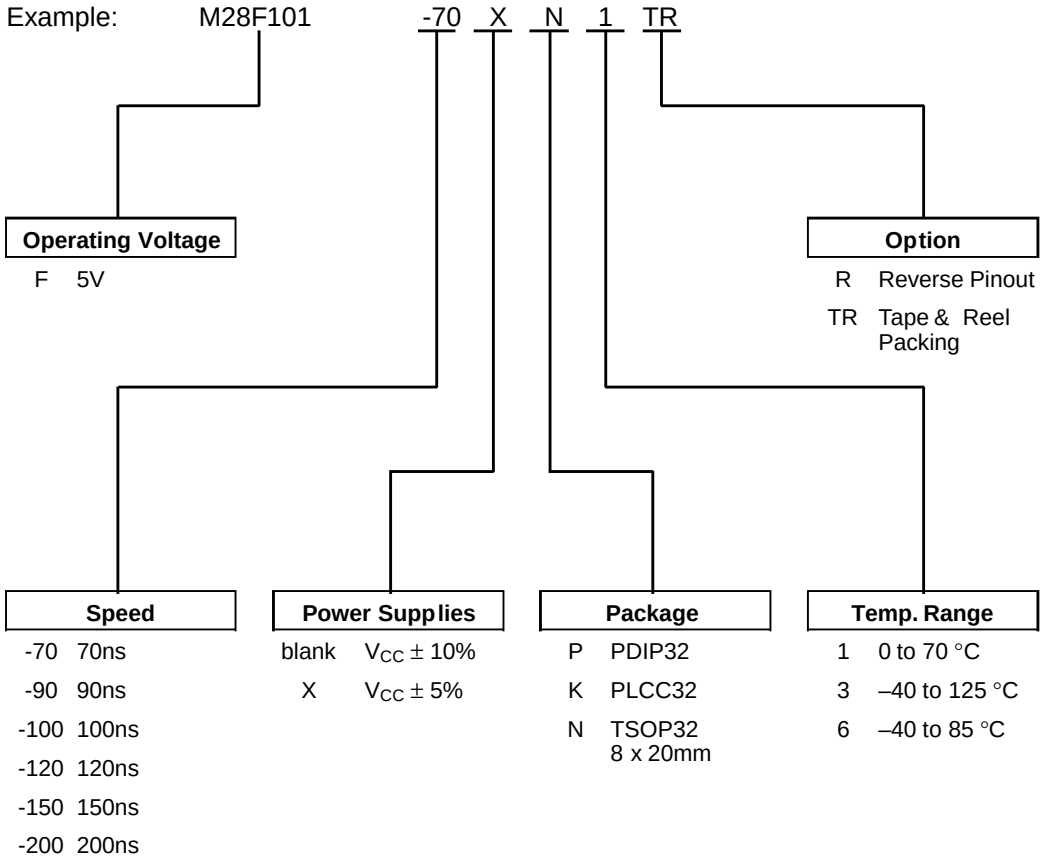
PRESTO F ERASE ALGORITHM

The PRESTO F Erase Algorithm guarantees that the device will be erased in a reliable way. The algorithm first programms all bytes to 00h in order to ensure uniform erasure. The programming follows the Presto F Programming Algorithm (see below). Erase is set-up by writing 20h to the command register, the erasure is started by repeating this write cycle. Erase Verify is set-up by writing 0A0h to the command register together with the address of the byte to be verified. The subsequent read cycle reads the data which is compared to 0FFh. Erase Verify begins at address 0000h and continues to the last address or until the comparison of the data to 0FFh fails. If this occurs, the address of the last byte checked is stored and a new Erase operation performed. Erase Verify then continues from the address of the stored location.

PRESTO F PROGRAM ALGORITHM

The PRESTO F Programming Algorithm applies a series of 10µs programming pulses to a byte until a correct verify occurs. Up to 25 programming operations are allowed for one byte. Program is set-up by writing 40h to the command register, the programming is started after the next write cycle which also latches the address and data to be programmed. Program Verify is set-up by writing 0C0h to the command register, followed by a read cycle and a compare of the data read to the data expected. During Program and Program Verify operations a MARGIN MODE circuit is activated to guarantee that the cell is programmed with a safety margin.

ORDERING INFORMATION SCHEME

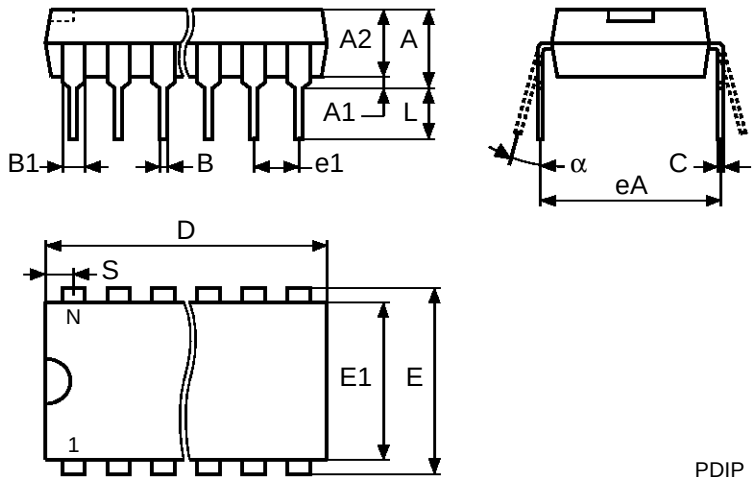


For a list of available options (V_{CC} Range, Speed, etc...) refer to the current Memory Shortform catalogue. For further information on any aspect of this device, please contact the SGS-THOMSON Sales Office nearest to you.

PDIP32 - 32 pin Plastic DIP, 600 mils width

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A			4.83			0.190
A1		0.38	–		0.015	–
A2	–	–	–	–	–	–
B		0.41	0.51		0.016	0.020
B1		1.14	1.40		0.045	0.055
C		0.20	0.30		0.008	0.012
D		41.78	42.04		1.645	1.655
E		15.24	15.88		0.600	0.625
E1		13.46	13.97		0.530	0.550
e1	2.54	–	–	0.100	–	–
eA	15.24	–	–	0.600	–	–
L		3.18	3.43		0.125	0.135
S		1.78	2.03		0.070	0.080
α		0°	15°		0°	15°
N	32			32		

PDIP32



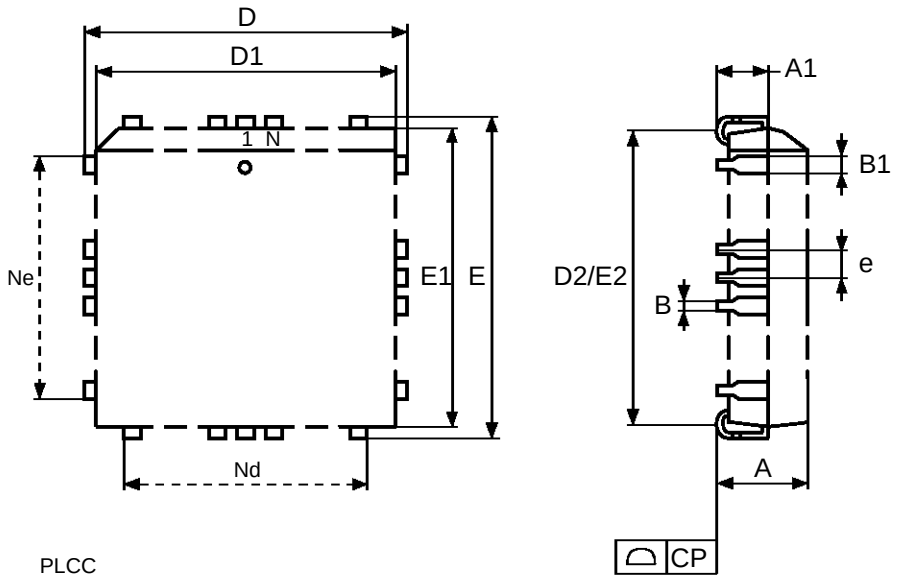
PDIP

Drawing is not to scale

PLCC32 - 32 lead Plastic Leaded Chip Carrier, rectangular

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A		2.54	3.56		0.100	0.140
A1		1.52	2.41		0.060	0.095
B		0.33	0.53		0.013	0.021
B1		0.66	0.81		0.026	0.032
D		12.32	12.57		0.485	0.495
D1		11.35	11.56		0.447	0.455
D2		9.91	10.92		0.390	0.430
E		14.86	15.11		0.585	0.595
E1		13.89	14.10		0.547	0.555
E2		12.45	13.46		0.490	0.530
e	1.27	–	–	0.050	–	–
N	32			32		
Nd	7			7		
Ne	9			9		
CP			0.10			0.004

PLCC32



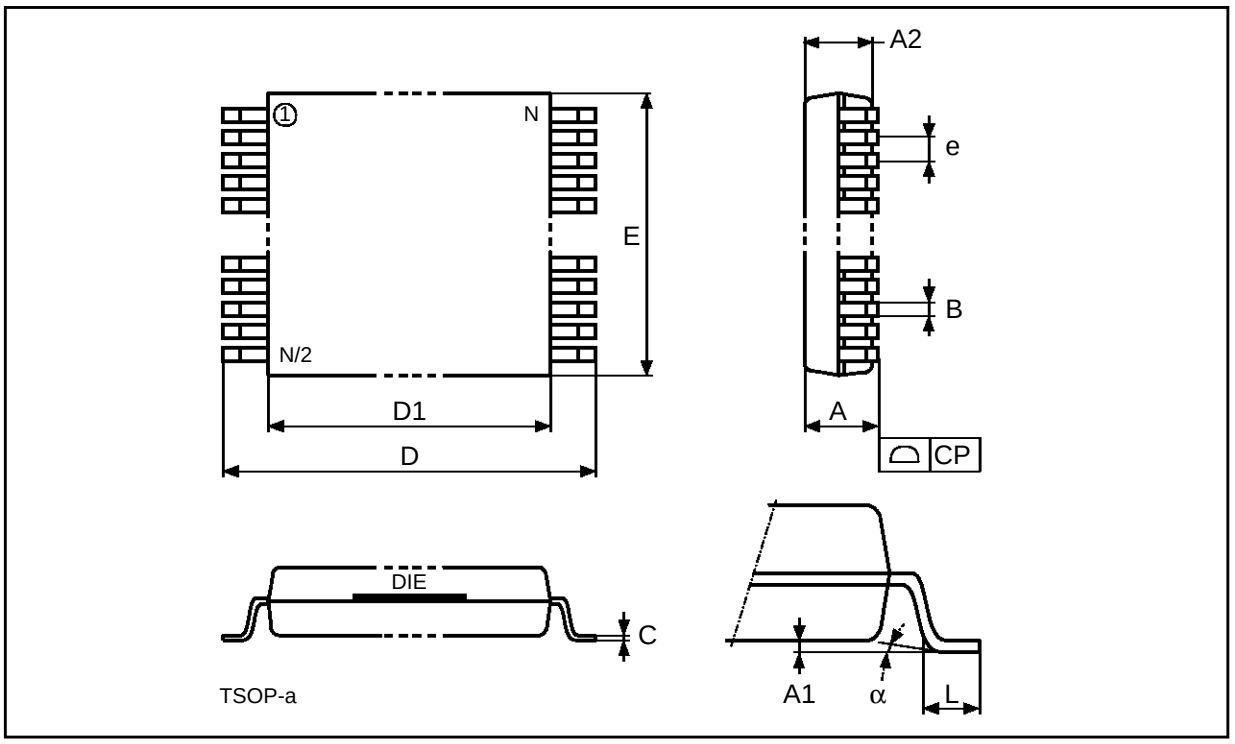
PLCC

Drawing is not to scale

TSOP32 Normal Pinout - 32 lead Plastic Thin Small Outline, 8 x 20mm

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A		1.04	1.24		0.041	0.049
A1		0.05	0.20		0.002	0.008
A2		0.95	1.06		0.037	0.042
B		0.15	0.27		0.006	0.011
C		0.10	0.21		0.004	0.008
D		19.90	20.12		0.783	0.792
D1		18.24	18.49		0.718	0.728
E		7.90	8.10		0.311	0.319
e	0.50	–	–	0.020	–	–
L		0.30	0.70		0.012	0.028
α		0°	5°		0°	5°
N	32			32		
CP			0.10			0.004

TSOP32



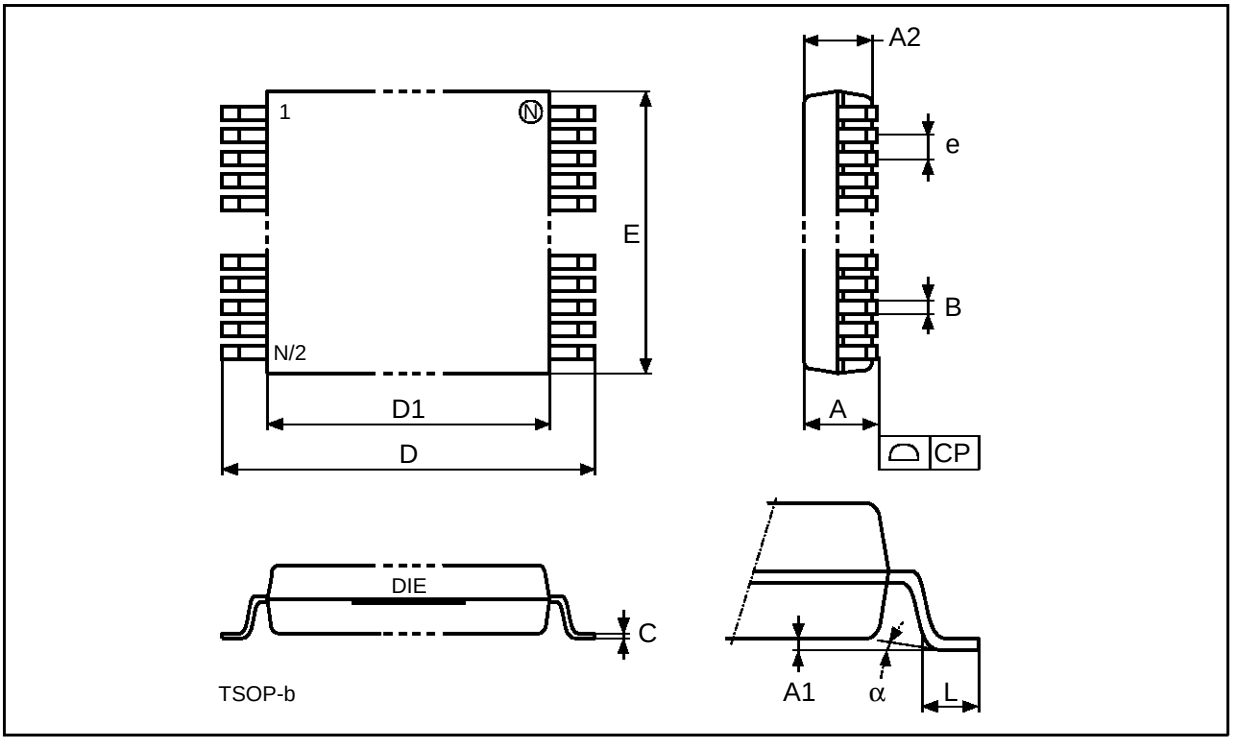
TSOP-a

Drawing is not to scale

TSOP32 Reverse Pinout - 32 lead Plastic Thin Small Outline, 8 x 20mm

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A		1.04	1.24		0.041	0.049
A1		0.05	0.20		0.002	0.008
A2		0.95	1.06		0.037	0.042
B		0.15	0.27		0.006	0.011
C		0.10	0.21		0.004	0.008
D		19.90	20.12		0.783	0.792
D1		18.24	18.49		0.718	0.728
E		7.90	8.10		0.311	0.319
e	0.50	–	–	0.020	–	–
L		0.30	0.70		0.012	0.028
α		0°	5°		0°	5°
N	32			32		
CP			0.10			0.004

TSOP32



TSOP-b

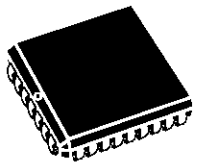
Drawing is not to scale

SGS-THOMSON MICROELECTRONICS

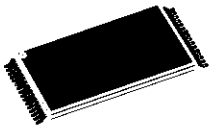
M29F040

SINGLE SUPPLY
4 Megabit (512K x 8, Sector Erase) FLASH MEMORY

- FAST ACCESS TIME: 70ns
- 5V ± 10% SUPPLY VOLTAGE for PROGRAM and ERASE OPERATIONS
- 5V ± 10% SUPPLY VOLTAGE in READ OPERATIONS
- BYTE PROGRAMMING TIME: 10µs typical
- ERASE TIME
  - Sector: 1.0 sec typical
  - Bulk: 2.5 sec typical
- PROGRAM/ERASE CONTROLLER (P/E.C.)
  - Program Byte-by-Byte
  - Data Polling and Toggle Protocol for P/E.C. Status
- MEMORY ERASE in SECTORS
  - 8 Sectors of 64K Bytes each
  - Sector Protection
  - Multisector Erase
- ERASE SUSPEND and RESUME MODES
- 100,000 PROGRAM/ERASE CYCLES per SECTOR
- LOW POWER CONSUMPTION
  - 25µA typical in Standby current
  - 8mA typical Read Current
  - Automatic CMOS Standby Mode



PLCC32 (K)



TSOP32 (N)
8 x 20 mm

Figure 1. Logic Diagram

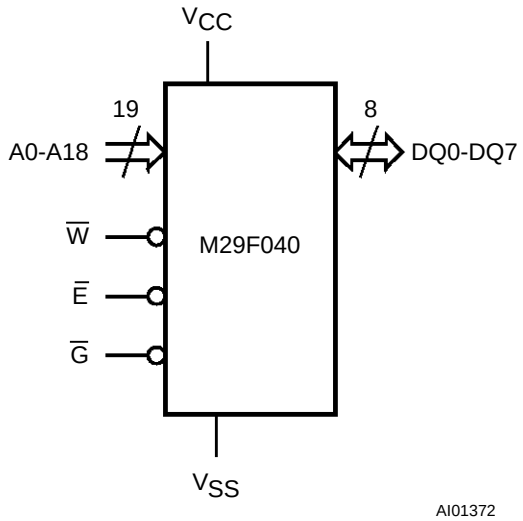


Table 1. Signal Names

A0-A18	Address Inputs
DQ0-DQ7	Data Input / Outputs
$\overline{E}$	Chip Enable
$\overline{G}$	Output Enable
$\overline{W}$	Write Enable
V_{CC}	Supply Voltage
V_{SS}	Ground

Figure 2A. LCC Pin Connections

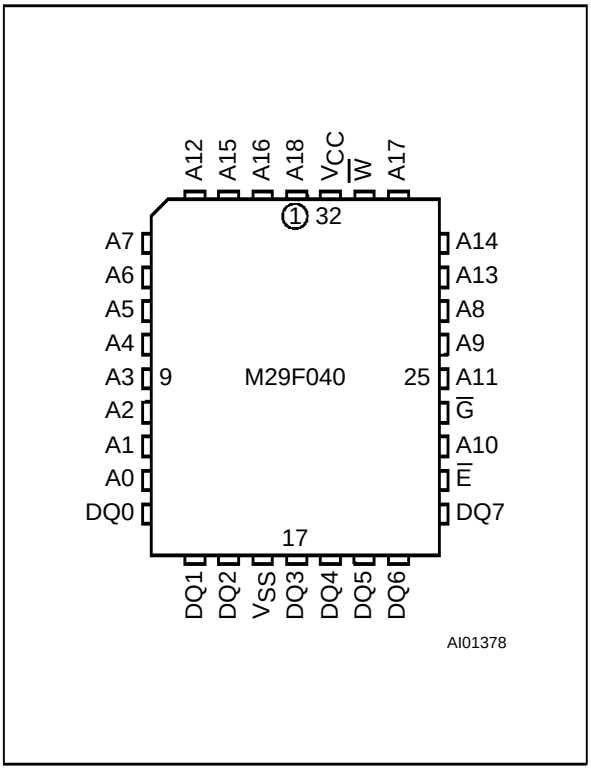


Figure 2B. TSOP Pin Connections

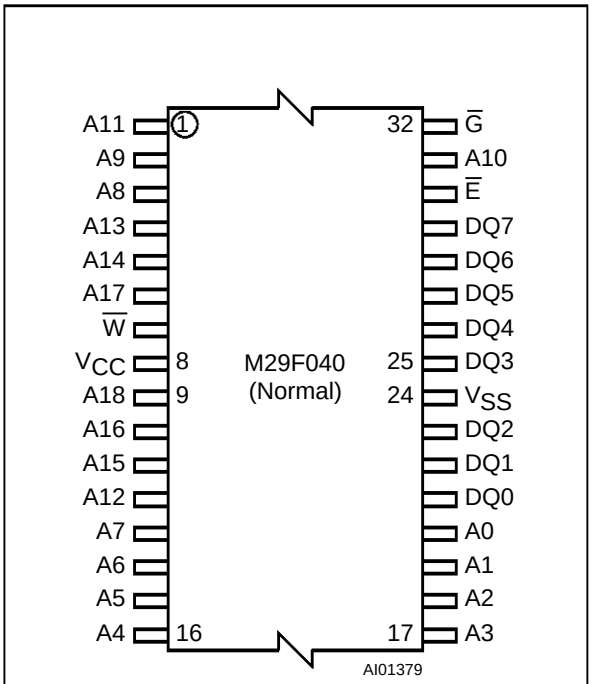
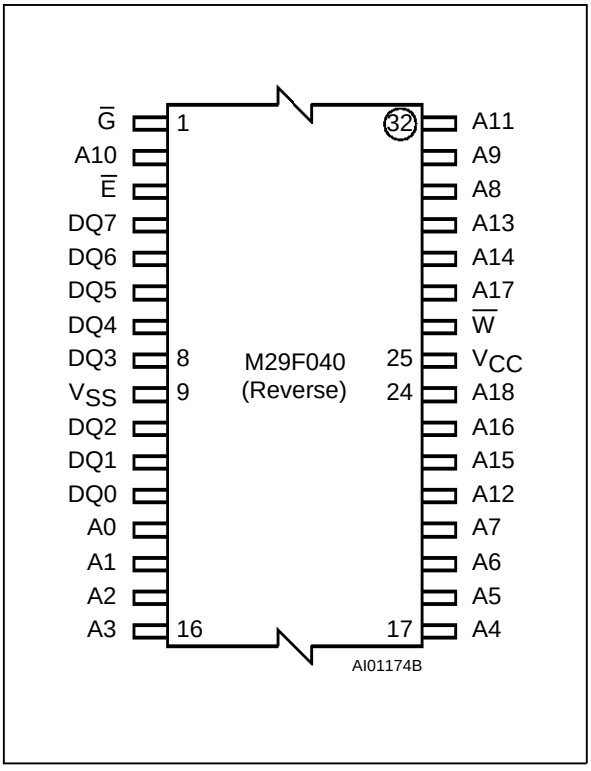


Figure 2C. TSOP Reverse Pin Connections



DESCRIPTION

The M29F040 is a non-volatile memory that may be erased electrically at the sector level, and programmed Byte-by-Byte.

The interface is directly compatible with most microprocessors. PLCC32 and TSOP32 (8 x 20mm) packages are available. Both normal and reverse pin outs are available for the TSOP32 package.

Organisation

The FLASH Memory organisation is 512K x 8 bits with Address lines A0-A18 and Data Inputs/Outputs DQ0-DQ7. Memory control is provided by Chip Enable, Output Enable and Write Enable Inputs.

Erase and Program are performed through the internal Program/Erase Controller (P/E.C.).

Data Outputs bits DQ7 and DQ6 provide polling or toggle signals during Automatic Program or Erase to indicate the Ready/Busy state of the internal Program/Erase Controller.

Sectors

Erasure of the memory is in sectors. There are 8 sectors of 64K bytes each in the memory address space. Erasure of each sector takes typically 1.5 seconds and each sector can be programmed and erased over 100,000 cycles. Each sector may

Table 2. Absolute Maximum Ratings (1)

Symbol	Parameter	Value	Unit
T_A	Ambient Operating Temperature	–40 to 125	°C
T_{BIAS}	Temperature Under Bias	–50 to 125	°C
T_{STG}	Storage Temperature	–65 to 150	°C
V_{IO} (2)	Input or Output Voltages	–0.6 to 7	V
V_{CC}	Supply Voltage	–0.6 to 7	V
V_{A9} (2)	A9 Voltage	–0.6 to 13.5	V

Notes: 1. Except for the rating "Operating Temperature Range", stresses above those listed in the Table "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the SGS-THOMSON SURE Program and other relevant quality documents.
2. Minimum Voltage may undershoot to –2V during transition and for less than 20ns.

separately be protected and unprotected against program and erase. Sector erasure may be suspended, while data is read from other blocks of the memory, and then resumed.

Bus Operations

Seven operations can be performed by the appropriate bus cycles, Read Array, Read Electronic Signature, Output Disable, Standby, Protect Sector, Unprotect Sector, and Write the Command of an Instruction.

Command Interface

Command Bytes can be written to a Command Interface (C.I.) latch to perform Reading (from the Array or Electronic Signature), Erasure or Programming. For added data protection, command execution starts after 4 or 6 command cycles. The first, second, fourth and fifth cycles are used to input a code sequence to the Command Interface (C.I.). This sequence is equal for all P/E.C. instructions. Command itself and its confirmation - if it applies - are given on the third and fourth or sixth cycles.

Instructions

Seven instructions are defined to perform Reset, Read Electronic Signature, Auto Program, Sector Auto Erase, Auto Bulk Erase, Sector Erase Suspend and Sector Erase Resume. The internal Program/Erase Controller (P/E.C.) handles all timing and verification of the Program and Erase instructions and provides Data Polling, Toggle, and Status data to indicate completion of Program and Erase Operations.

Instructions are composed of up to six cycles. The first two cycles input a code sequence to the Command Interface which is common to all P/E.C. instructions (see Table 7 for Command Descriptions). The third cycle inputs the instruction set up command instruction to the Command Interface. Subsequent cycles output Signature, Sector protection or the addressed data for Read operations. For added data protection, the instructions for program and sector or bulk erase require further command inputs. For a Program instruction, the fourth command cycle inputs the address and data to be programmed. For an Erase instruction (sector or bulk), the fourth and fifth cycles input a further code sequence before the Erase confirm command on the sixth cycle. Byte programming takes typically 10µs while erase is performed in typically 1.5 seconds.

Erasure of a memory sector may be suspended, in order to read data from another sector, and then resumed. Data Polling, Toggle and Error data may be read at any time, including during the programming or erase cycles, to monitor the progress of the operation. When power is first applied or if V_{CC} falls below V_{LKO}, the command interface is reset to Read Array.

Table 3. Operations

Operation	$\overline{E}$	$\overline{G}$	$\overline{W}$	DQ0 - DQ7
Read	V_{IL}	V_{IL}	V_{IH}	Data Output
Write	V_{IL}	V_{IH}	V_{IL}	Data Input
Output Disable	V_{IL}	V_{IH}	V_{IH}	Hi-Z
Standby	V_{IH}	X	X	Hi-Z

Note: X = V_{IL} or V_{IH}

Table 4. Electronic Signature

Code	$\overline{E}$	$\overline{G}$	$\overline{W}$	A0	A1	A6	A9	Other Addresses	DQ0 - DQ7
Manufact. Code	V_{IL}	V_{IL}	V_{IH}	V_{IL}	V_{IL}	V_{IL}	V_{ID}	Don't Care	20h
Device Code	V_{IL}	V_{IL}	V_{IH}	V_{IH}	V_{IL}	V_{IL}	V_{ID}	Don't Care	0E2h

Table 5. Sector Protection Status

Code	$\overline{E}$	$\overline{G}$	$\overline{W}$	A0	A1	A6	A16	A17	A18	Other Addresses	DQ0 - DQ7
Protected Sector	V_{IL}	V_{IL}	V_{IH}	V_{IL}	V_{IH}	V_{IL}	SA	SA	SA	Don't Care	01h
Unprotected Sector	V_{IL}	V_{IL}	V_{IH}	V_{IL}	V_{IH}	V_{IL}	SA	SA	SA	Don't Care	00h

Note: SA = Address of sector being checked

DEVICE OPERATION

Signal Descriptions

A0-A18 Address Inputs. The address inputs for the memory array are latched during a write operation. The A9 address input is used also for the Electronic Signature read and Sector Protect verification. When A9 is raised to V_{ID}, either a Read Manufacturer Code, Read Device Code or Verify Sector Protection is enabled depending on the combination of levels on A0, A1 and A6. When A0, A1 and A6 are Low, the Electronic Signature Manufacturer code is read, when A0 is High and A1 and A6 are Low, the Device code is read, and when A1 is High and A0 and A6 are low, the Sector Protection Status is read for the sector addressed by A16, A17, A18.

DQ0-DQ7 Data Input/Outputs. The data input is a byte to be programmed or a command written to the C.I. Both are latched when Chip Enable $\overline{E}$ and Write Enable $\overline{W}$ are active. The data output is from the memory Array, the Electronic Signature, the Data Polling bit (DQ7), the Toggle Bit (DQ6), the Error bit (DQ5) or the Erase Timer bit (DQ3). Ouputs are valid when Chip Enable $\overline{E}$ and Output Enable $\overline{G}$ are active. The output is high impedance when the chip is deselected or the outputs are disabled.

$\overline{E}$ Chip Enable. The Chip Enable activates the memory control logic, input buffers, decoders and sense amplifiers. $\overline{E}$ High deselects the memory and reduces the power consumption to the standby level. $\overline{E}$ can also be used to control writing to the command register and to the memory array, while $\overline{W}$ remains at a low level. Addresses are then latched on the falling edge of $\overline{E}$ while data is latched on the rising edge of $\overline{E}$. The Chip Enable must be forced to V_{ID} during Sector Unprotect operations.

Table 6. Instructions (1)

Mne.	Instr.	Cyc.		1st Cyc.	2nd Cyc.	3rd Cyc.	4th Cyc.	5th Cyc.	6th Cyc.	7th Cyc.
RST (3,9)	Reset	1+	**Addr.** (2,6)	X	Read Memory Array until a new write cycle is initiated.					
			Data	0F0h						
RSIG (3)	Read Electronic Signature	3+	**Addr.** (2,6)	x5555h	x2AAAh	x5555h	Read Electronic Signature until a new write cycle is initiated. See Note 4.			
			Data	0AAh	55h	90h				
RSP (3)	Read Sector Protection	3+	**Addr.** (2,6)	x5555h	x2AAAh	x5555h	Read Sector Protection until a new write cycle is initiated. See Note 5.			
			Data	0AAh	55h	90h				
PG	Program	4	**Addr.** (2,6)	x5555h	x2AAAh	x5555h	Program Address	Read Data Polling or Toggle Bit until Program completes.		
			Data	0AAh	55h	0A0h	Program Data			
SE	Sector Erase	6	**Addr.** (2,6)	x5555h	x2AAAh	x5555h	x5555h	x2AAAh	Sector Address	Additional Sector (7)
			Data	0AAh	55h	80h	0AAh	55h	30h	30h
BE	Bulk Erase	6	**Addr.** (2,6)	x5555h	x2AAAh	x5555h	x5555h	x2AAAh	x5555h	Note 8
			Data	0AAh	55h	80h	0AAh	55h	10h	
ES	Erase Suspend	1	**Addr.** (2,6)	X	Read until Toggle stops, then read all the data needed from any sector(s) not being erased then Resume Erase.					
			Data	0B0h						
ER	Erase Resume	1	**Addr.** (2,6)	X	Read Data Polling or Toggle Bit until Erase completes or Erase is suspended another time					
			Data	30h						

Notes: 1. Command not interpreted in this table will default to read array mode.
2. X = Don't Care.
3. The first cycle of the RST, RSP or RSIG instruction is followed by read operations to read memory array, Status Register or Electronic Signature codes. Any number of read cycles can occur after one command cycle.
4. Signature Address bits A0, A1, A6 at V_{IL} will output Manufacturer code (20h). Address bits A0 at V_{IH} and A1, A6 at V_{IL} will output Device code (0E2h).
5. Protection Address: A0, A6 at V_{IL}, A1 at V_{IH} and A16, A17, A18 within the sector to be checked, will output the Sector Protection status.
6. Address bits A16, A17, A18 are don't care for coded address inputs.
7. Optional, additional sectors addresses must be entered within a 80µs delay after last write entry, timeout status can be verified through DQ3 value. When full command is entered, read Data Polling or Toggle bit until Erase is completed or suspended.
8. Read Data Polling or Toggle bit until Erase completes.
9. A wait time of 5µs is necessary after a Reset command, before starting any operation.

DEVICE OPERATION (cont'd)

$\overline{G}$ Output Enable. The Output Enable gates the outputs through the data buffers during a read operation. $\overline{G}$ must be forced to V_{ID} level during Sector Protect and Sector Unprotect operations.

$\overline{W}$ Write Enable. This input controls writing to the Command Register and Address and Data latches. Addresses are latched on the falling edge of $\overline{W}$, and Data Inputs are latched on the rising edge of $\overline{W}$.

V_{CC} Supply Voltage. The power supply for all operations (Read, Program and Erase).

V_{SS} Ground. V_{SS} is the reference for all voltage measurements.

Table 7. Commands

Hex Code	Command
00h	Invalid/Reserved
10h	Bulk Erase Confirm
30h	Sector Erase Resume/Confirm
80h	Set-up Erase
90h	Read Electronic Signature/ Sector protection Status
0A0h	Program
0B0h	Erase Suspend
0F0h	Reset

Table 8. Status Register

DQ	Name	Logic Level	Definition	Note
7	Data Polling	'1'	Erase Complete	Indicates the P/E.C. status, check during Program or Erase, and on completion before checking bits DQ5 for Program or Erase Success.
		'0'	Erase on Going	
		DQ	Program Complete	
		$\overline{DQ}$	Program on Going	
6	Toggle Bit	'-1-0-1-0-1-0-1-'	Erase or Program on Going	Successive read output complementary data on DQ6 while Programming or Erase operations are going on. DQ6 remain at constant level when P/E.C. operations are completed or Erase Suspend is acknowledged.
		'-0-0-0-0-0-0-0-'	Program ('0' on DQ6) Complete	
		'-1-1-1-1-1-1-1-'	Erase or Program ('1' on DQ6) Complete	
5	Error Bit	'1'	Program or Erase Error	This bit is set to '1' if P/E.C. has exceded the specified time limits.
		'0'	Program or Erase on Going	
4		'1'		
		'0'		
3	Erase Time Bit	'1'	Erase Timeout Period Expired	P/E.C. Erase operation has started. Only possible command entry is Erase Suspend (ES). An additional sector to be erased in parallel can be entered to the P/E.C.
		'0'	Erase Timeout Period on Going	
2	Reserved			
1	Reserved			
0	Reserved			

Notes: Logic level '1' is High, '0' is Low. -0-1-0-0-0-1-1-1-0- represent bit value in successive Read operations.

Memory Sectors

The memory sectors of the M29F040 are shown in Figure 5. The memory array is divided in 8 sectors of 64K bytes. Each sector can be erased separately or any combination of sectors can be erased simultaneously. The Sector Erase operation is managed automatically by the P/E.C. The operation can be suspended in order to read from any another sector, and then resumed.

Sector Protection provides additional data security. Each sector can be separately protected or unprotected against Program or Erase. Bringing A9 and $\overline{G}$ to V_{ID} initiates protection, while bringing A9, $\overline{G}$ and $\overline{E}$ to V_{ID} cancels the protection. The sector affected during protection is addressed by the inputs on A16, A17, and A18. Unprotect operation affects all sectors.

Operations

Operations are defined as specific bus cycles and signals which allow Memory Read, Command Write, Output Disable, Standby, Read Status Bits, Sector Protect/Unprotect, Sector Protection Check and Electronic Signature Read. They are shown in Tables 3, 4, 5.

Read. Read operations are used to output the contents of the Memory Array, the Status Register or the Electronic Signature. Both Chip Enable $\overline{E}$ and Output Enable $\overline{G}$ must be low in order to read the output of the memory. The Chip Enable input also provides power control and should be used for device selection. Output Enable should be used to gate data onto the output independent of the device selection. The data read depends on the previous command written to the memory (see instructions RST and RSIG, and Status Bits).

Write. Write operations are used to give Instruction Commands to the memory or to latch input data to be programmed. A write operation is initiated when Chip Enable $\overline{E}$ is Low and Write Enable $\overline{W}$ is Low with Output Enable $\overline{G}$ High. Addresses are latched on the falling edge of $\overline{W}$ or $\overline{E}$ whichever occurs last. Commands and Input Data are latched on the rising edge of $\overline{W}$ or $\overline{E}$ whichever occurs first.

Output Disable. The data outputs are high impedance when the Output Enable $\overline{G}$ is High with Write Enable $\overline{W}$ High.

Standby. The memory is in standby when Chip Enable $\overline{E}$ is High and Program/Erase Controller P./E.C. is Idle. The power consumption is reduced to the standby level and the outputs are high impedance, independent of the Output Enable $\overline{G}$ or Write Enable $\overline{W}$ inputs.

Automatic Standby. After 150ns of inactivity and when CMOS levels are driving the addresses, the chip automatically enters a pseudo standby mode where consumption is reduced to the CMOS standby value, while outputs are still driving the bus.

Electronic Signature. Two codes identifying the manufacturer and the device can be read from the memory, the manufacturer's code for SGS-THOMSON is 20h, and the device code is E2h for the M29F040. These codes allow programming equipment or applications to automatically match their interface to the characteristics of the particular manufacturer's product. The Electronic Signature is output by a Read operation when the voltage applied to A9 is at V_{ID} and address inputs A1 and A6 are at Low. The manufacturer code is output when the Address input A0 is Low and the device code when this input is High. Other Address inputs are ignored. The codes are output on DQ0-DQ7. This is shown in Table 4.

The Electronic Signature can also be read, without raising A9 to V_{ID} by giving the memory the instruction RSIG (see below).

Sector Protection. Each sector can be separately protected against Program or Erase. Sector Protection provides additional data security, as it disables all program or erase operations. This mode is activated when both A9 and $\overline{G}$ are set to V_{ID} and the sector address is applied on A16, A17 and A18. Sector protection is programmed using a Presto F program like algorithm. Protection is initiated on the edge of $\overline{W}$ falling to V_{IL}. Then after a delay of 100µs, the edge of $\overline{W}$ rising to V_{IH} ends the protection operation. Protection verify is achieved by bringing $\overline{G}$, $\overline{E}$ and A6 to V_{IL} while $\overline{W}$ is at V_{IH} and A9 at V_{ID}. Under these conditions, reading the data output will yield 01h if the sector defined by the inputs on A16, A17 and A18 is protected. Any attempt to program or erase a protected sector will be ignored by the device.

Any protected sector can be unprotected to allow updating of bit contents. All sectors must be protected before an unprotect operation. Sector unprotect is activated when A9, $\overline{G}$ and $\overline{E}$ are at V_{ID}. The addresses inputs A6, A16, A12 must be maintained at V_{IH}. Sector unprotect is performed through a Presto F Erase like algorithm. Unprotect is initiated by the edge of W falling to V_{IL}. After a delay of 10ms, the edge of $\overline{W}$ rising to V_{IH} will end the unprotection operation. Unprotect verify is achieved by bringing $\overline{G}$ and $\overline{E}$ to V_{IL} while A6 and $\overline{W}$ are at V_{IH} and A9 at V_{ID}. In these conditions, reading the output data will yield 00h if the sector defined by the inputs on A16, A17 and A18 has been successfully unprotected. All combinations of A16, A17 and A18 must be addressed in order to ensure that all of the 8 sectors have been unprotected. Sector Protection Status is shown in Table 5.

Table 9. AC Measurement Conditions

	SRAM Interface Levels	EPROM Interface Levels
Input Rise and Fall Times	≤ 10ns	≤ 10ns
Input Pulse Voltages	0 to 3V	0.45V to 2.4V
Input and Output Timing Ref. Voltages	1.5V	0.8V and 2V

Figure 3. AC Testing Input Output Waveform

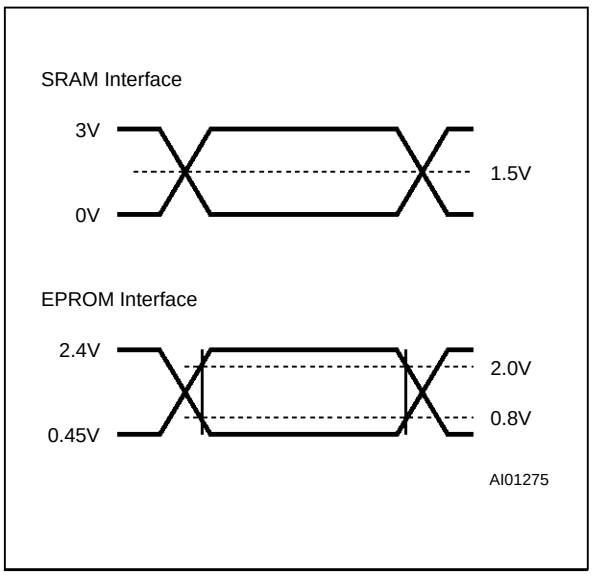


Figure 4. AC Testing Load Circuit

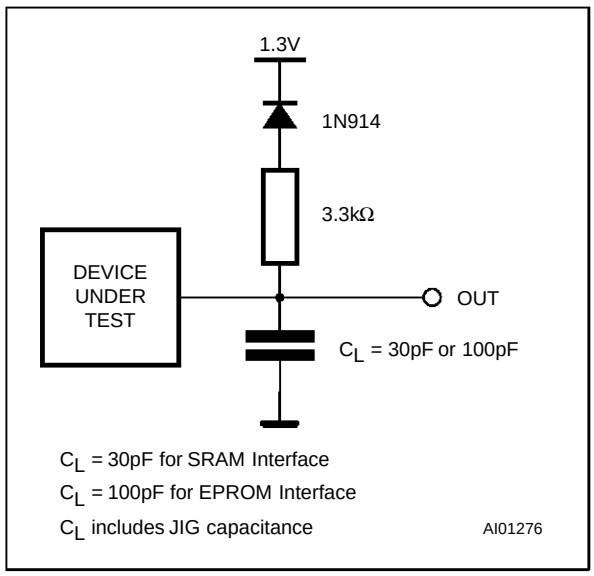


Table 10. Capacitance (1) (T_A = 25 °C, f = 1 MHz)

Symbol	Parameter	Test Condition	Min	Max	Unit
C_{IN}	Input Capacitance	V_{IN} = 0V		6	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V		12	pF

Note: 1. Sampled only, not 100% tested.

Instructions and Commands

The Command Interface (C.I.) latches commands written to the memory. Instructions are made up from one or more commands to perform Reset, Read Electronic Signature, Sector Erase, Bulk Erase, Program, Sector Erase Suspend and Erase Resume. Commands are made of address and data sequences. Addresses are latched on the falling edge of $\overline{W}$ or $\overline{E}$ and data is latched on the rising of $\overline{W}$ or $\overline{E}$. The instructions require from 1 to 6 cycles, the first or first three of which are always write operations used to initiate the command. They are followed by either further write cycles to confirm the first command or execute the command immediately. Command sequencing must be followed exactly. Any invalid combination of commands will reset the device to Read Array. The increased number of cycles has been chosen to assure maximum data security. Commands are initialised by two preceding coded cycles which unlock the Command Interface. In addition, for Erase, command confirmation is again preceeded by the two coded cycles.

P/E.C. status is indicated during command execution by Data Polling on DQ7, detection of Toggle on DQ6, or Error on DQ5 and Erase Timer DQ3 bits. Any read attempt during Program or Erase command execution will automatically output those four bits. The P/E.C. automatically sets bits DQ3, DQ5, DQ6 and DQ7. Other bits (DQ0, DQ1, DQ2 and DQ4) are reserved for future use and should be masked.

Figure 5. Memory Map and Sector Address Table

A18	A17	A16		TOP ADDRESS	BOTTOM ADDRESS
1	1	1	64K Bytes Sector	7FFFFh	70000h
1	1	0	64K Bytes Sector	6FFFFh	60000h
1	0	1	64K Bytes Sector	5FFFFh	50000h
1	0	0	—	4FFFFh	40000h
0	1	1	—	3FFFFh	30000h
0	1	0	—	2FFFFh	20000h
0	0	1	64K Bytes Sector	1FFFFh	10000h
0	0	0	64K Bytes Sector	0FFFFh	00000h

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Table 11. DC Characteristics
(T_A = 0 to 70°C, -20 to 85°C, -40 to 85°C or -40 to 125°C; V_{CC} = 5V ± 10%)

Symbol	Parameter	Test Condition	Min	Max	Unit
I_{LI}	Input Leakage Current	$0V \le V_{IN} \le V_{CC}$		±1	µA
I_{LO}	Output Leakage Current	$0V \le V_{OUT} \le V_{CC}$		±1	µA
I_{CC1}	Supply Current (Read) TTL	$\overline{E} = V_{IL}$, $\overline{G} = V_{IH}$, f = 6MHz		40	mA
I_{CC2}	Supply Current (Standby) TTL	$\overline{E} = V_{IH}$		1	mA
I_{CC3}	Supply Current (Standby) CMOS	$\overline{E} = V_{CC} \pm 0.2V$		100	µA
I_{CC4}	Supply Current (Program or Erase)	Byte program, Sector or Bulk Erase in progress		60	mA
V_{IL}	Input Low Voltage		–0.5	0.8	V
V_{IH}	Input High Voltage		2	V_{CC} + 0.5	V
V_{OL}	Output Low Voltage	I_{OL} = 10mA		0.45	V
V_{OH}	Output High Voltage TTL	I_{OH} = –2.5mA	2.4		V
	Output High Voltage CMOS	I_{OH} = –100µA	V_{CC} –0.4		V
		I_{OH} = –2.5mA	0.85 x V_{CC}		V
V_{ID}	A9 Voltage (Electronic Signature)		11.5	12.5	V
I_{ID}	A9 Current (Electronic Signature)	A9 = V_{ID}		50	µA
V_{LKO}	Supply Voltage (Erase and Program lock-out)		3.2	4.2	V

Table 12A. Read AC Characteristics
(T_A = 0 to 70°C, -20 to 85°C, -40 to 85°C or -40 to 125°C)

Symbol	Alt	Parameter	Test Condition	M29F040				Unit
				-70 (3)		-90		
				V_{CC} = 5V ± 5%		V_{CC} = 5V ± 10%		
				SRAM Interface		EPROM Interface		
				Min	Max	Min	Max	
t_{AVAV}	t_{RC}	Address Valid to Next Address Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	70		90		ns
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		70		90	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	$\overline{G}$ = V_{IL}	0		0		ns
t_{ELQV} (2)	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		70		90	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	$\overline{E}$ = V_{IL}	0		0		ns
t_{GLQV} (2)	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		30		35	ns
t_{EHQX}	t_{OH}	Chip Enable High to Output Transition	$\overline{G}$ = V_{IL}	0		0		ns
t_{EHQZ} (1)	t_{HZ}	Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}		20		20	ns
t_{GHQX}	t_{OH}	Output Enable High to Output Transition	$\overline{E}$ = V_{IL}	0		0		ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}		20		20	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		0		ns

Notes: 1. Sampled only, not 100% tested.
2. $\overline{G}$ may be delayed by up to t_{ELQV} - t_{GLQV} after the falling edge of $\overline{E}$ without increasing t_{ELQV}.
3. At grade 1 (0 to 70°C) temperature range.

Data Polling Bit DQ7. When Programming operations are in progress, this bit outputs the complement of the bit being programmed on DQ7. During Erase operation, it outputs a '0'. After completion of the operation, DQ7 will output the bit last programmed or a '1' after erasing. Data Polling is valid only effective during P/E.C. operation, that is after the fourth $\overline{W}$ pulse for programming or after the sixth $\overline{W}$ pulse for Erase. It must be performed at the address being programmed or at an address within the sector being erased. If the byte to be programmed belongs to a protected sector the command is ignored. If all the sectors selected for erasure are protected, DQ7 will set to '0' for about 100µs, and then return to previous addressed memory data. See Figure 9 for the Data Polling flowchart and Figure 10 for the Data Polling waveforms.

Toggle Bit DQ6. When Programming operations are in progress, successive attempts to read DQ6 will output complementary data. DQ6 will toggle following toggling of either $\overline{G}$ or $\overline{E}$ when $\overline{G}$ is low. The operation is completed when two successive reads yield the same output data. The next read will output the bit last programmed or a '1' after erasing. The toggle bit is valid only effective during P/E.C. operations, that is after the fourth $\overline{W}$ pulse for programming or after the sixth $\overline{W}$ pulse for Erase. If the byte to be programmed belongs to a protected sector the command will be ignored. If the sectors selected for erasure are protected, DQ6 will toggle for about 100µs and then return back to Read. See Figure 11 for Toggle Bit flowchart and Figure 12 for Toggle Bit waveforms.

Table 12B. Read AC Characteristics
(T_A = 0 to 70°C, -20 to 85°C, -40 to 85°C or -40 to 125°C)

Symbol	Alt	Parameter	Test Condition	M29F040				Unit
				-120		-150		
				V_{CC} = 5V ± 10%		V_{CC} = 5V ± 10%		
				EPROM Interface		EPROM Interface		
				Min	Max	Min	Max	
t_{AVAV}	t_{RC}	Address Valid to Next Address Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	120		150		ns
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		120		150	ns
t_{ELQX} (1)	t_{LZ}	Chip Enable Low to Output Transition	$\overline{G}$ = V_{IL}	0		0		ns
t_{ELQV} (2)	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		120		150	ns
t_{GLQX} (1)	t_{OLZ}	Output Enable Low to Output Transition	$\overline{E}$ = V_{IL}	0		0		ns
t_{GLQV} (2)	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		50		55	ns
t_{EHQX}	t_{OH}	Chip Enable High to Output Transition	$\overline{G}$ = V_{IL}	0		0		ns
t_{EHQZ} (1)	t_{HZ}	Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}		30		35	ns
t_{GHQX}	t_{OH}	Output Enable High to Output Transition	$\overline{E}$ = V_{IL}	0		0		ns
t_{GHQZ} (1)	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}		30		35	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		0		ns

Notes: 1. Sampled only, not 100% tested.
2. $\overline{G}$ may be delayed by up to t_{ELQV} - t_{GLQV} after the falling edge of $\overline{E}$ without increasing t_{ELQV}.

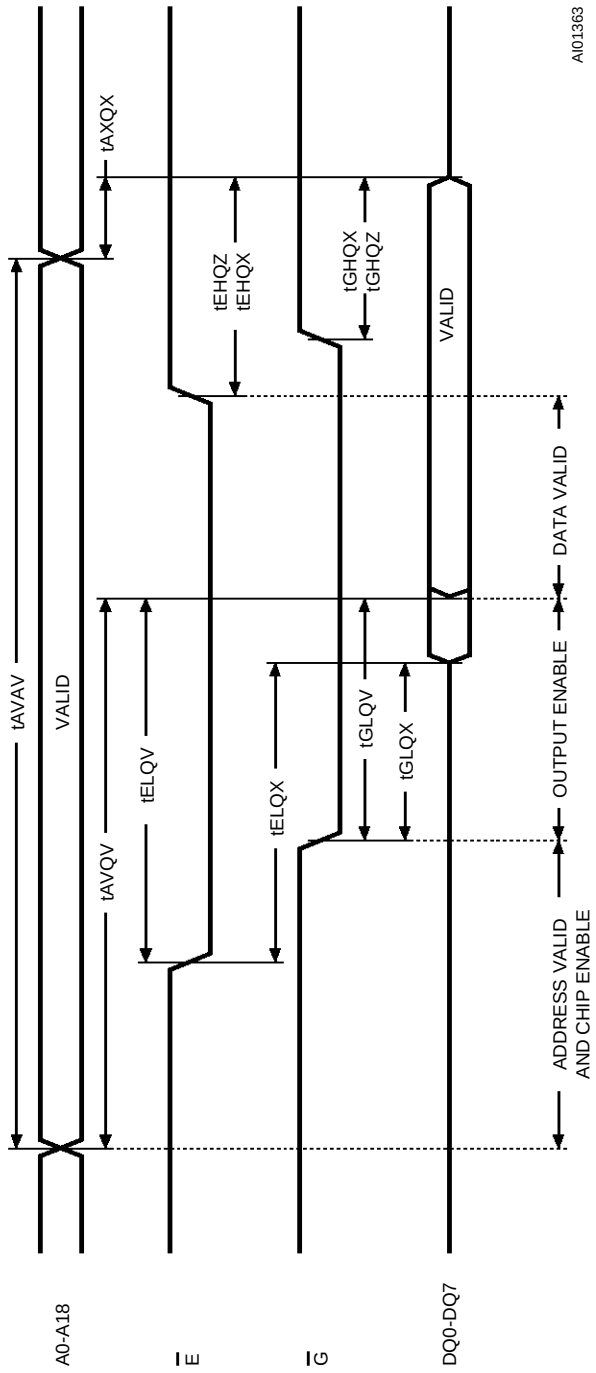
Error bit DQ5. This bit is set to '1' by the P/E.C when there is a failure of byte programming, sector erase, or bulk erase that results in invalid data being programmed in the memory sector. In case of error in sector erase or byte program, the sector in which the error occured or to which the programmed byte belongs, must be discarded. Other sectors may still be used. Error bit resets after Reset (RST) instruction. In case of success, the error bit will set to '0' during Program or Erase and to valid data after write operation is completed.

Erase Timer bit DQ3. This bit is set to '0' by the P/E.C. when the last sector Erase command has been entered to the Command Interface and it is awaiting the Erase start. When the wait period is finished, after 80 to 120µs, DQ3 returns back to '1'.

Coded Cycles. The two coded cycles unlock the Command Interface. They are followed by a command input or a comand confirmation. The coded cycles consist of writing the data 0AAh at address 5555h during the first cycle and data 55h at address 2AAAh during the second cycle. Addresses are latched on the falling edge of $\overline{W}$ or $\overline{E}$ while data is latched on the rising edge of $\overline{W}$ or $\overline{E}$. The coded cycles happen on first and second cycles of the command write or on the fourth and fifth cycles.

Reset (RST) instruction. The Reset instruction consists of one write operation giving the command 0F0h. It can be optionally preceded by the two coded cycles. After wait state of 5µs, subsequent read operations will read the memory array addressed and output the read byte.

Figure 6. Read Mode AC Waveforms



Note: Write Enable ($\overline{W}$) = High

Table 13A. Write AC Characteristics, Write Enable Controlled
(T_A = 0 to 70°C, -20 to 85°C, -40 to 85°C or -40 to 125°C)

Symbol	Alt	Parameter	M29F040				Unit
			-70 (2)		-90		
			V_{CC} = 5V ± 5%		V_{CC} = 5V ± 10%		
			SRAM Interface		EPROM Interface		
			Min	Max	Min	Max	
t_{AVAV}	t_{WC}	Address Valid to Next Address Valid	70		90		ns
t_{ELWL}	t_{CS}	Chip Enable Low to Write Enable Low	0		0		ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High	35		45		ns
t_{DVWH}	t_{DS}	Input Valid to Write Enable High	30		45		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition	0		0		ns
t_{WHEH}	t_{CH}	Write Enable High to Chip Enable High	0		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low	20		20		ns
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	0		0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition	45		45		ns
t_{GHWL}		Output Enable High to Write Enable Low	0		0		ns
t_{VCHEL}	t_{VCS}	V_{CC} High to Chip Enable Low	50		50		µs
t_{WHQV1} (1)		Write Enable High to Output Valid (Program)	10		10		µs
t_{WHQV2} (1)		Write Enable High to Output Valid (Sector Erase)	1.5	30	1.5	30	sec
t_{WHGL}	t_{OEH}	Write Enable High to Output Enable Low	0		0		ns

Notes: 1. Time is measured to Data Polling or Toggle Bit, $t_{WHQV} = t_{WHQ7V} + t_{Q7VQV}$
2. At grade 1 (0 to 70°C) temperature range.

Read Electronic Signature (RSIG) instruction. This instruction uses the two coded cycles followed by one write cycle giving the command 90h to address 5555h for command setup. A subsequent read will output the manufacturer code, the device code or the sector protection status depending on the levels of A0, A1, A6, A16, A17 and A18. The manufacturer code, 20h, is output when the addresses lines A0, A1 and A6 are Low, the device code, 0E2h is output when A0 is High with A1 and A6 Low.

Read Sector Protection. The use of Read Electronic Signature (RSIG) command also allows access to the sector protection status verify. After giving the RSIG command, A0 and A6 are set to V_{IL} with A1 at V_{IH}, while A16, A17 and A18 define the sector of the sector to be verified. A read in these conditions will output a 01h if sector is protected and a 00h if sector is not protected.

Bulk Erase (BE) instruction. This instruction uses six write cycles. The Erase Set-up command 80h is written to address 5555h on third cycle after the two coded cycles. The Bulk Erase Confirm command 10h is written at address 5555h on sixth cycle after another two coded cycles. If the second command given is not an erase confirm or if the coded cycles are wrong, the instruction aborts and the device is reset to Read Array. It is not necessary to program the array with 00h first as the P/E.C. will automatically do this before erasing to 0FFh. Read operations after the sixth rising edge of $\overline{W}$ or $\overline{E}$ output the status register bits. During the execu-

Table 13B. Write AC Characteristics, Write Enable Controlled
(T_A = 0 to 70°C, -20 to 85°C, -40 to 85°C or -40 to 125°C)

Symbol	Alt	Parameter	M29F040				Unit
			-120		-150		
			V_{CC} = 5V ± 10%		V_{CC} = 5V ± 10%		
			EPROM Interface		EPROM Interface		
			Min	Max	Min	Max	
t_{AVAV}	t_{WC}	Address Valid to Next Address Valid	120		150		ns
t_{ELWL}	t_{CS}	Chip Enable Low to Write Enable Low	0		0		ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High	50		50		ns
t_{DVWH}	t_{DS}	Input Valid to Write Enable High	50		50		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition	0		0		ns
t_{WHEH}	t_{CH}	Write Enable High to Chip Enable High	0		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low	20		20		ns
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	0		0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition	50		50		ns
t_{GHWL}		Output Enable High to Write Enable Low	0		0		ns
t_{VCHEL}	t_{VCS}	V_{CC} High to Chip Enable Low	50		50		µs
t_{WHQV1} (1)		Write Enable High to Output Valid (Program)	10		10		µs
t_{WHQV2} (1)		Write Enable High to Output Valid (Sector Erase)	1.5	30	1.5	30	sec
t_{WHGL}	t_{OEH}	Write Enable High to Output Enable Low	0		0		ns

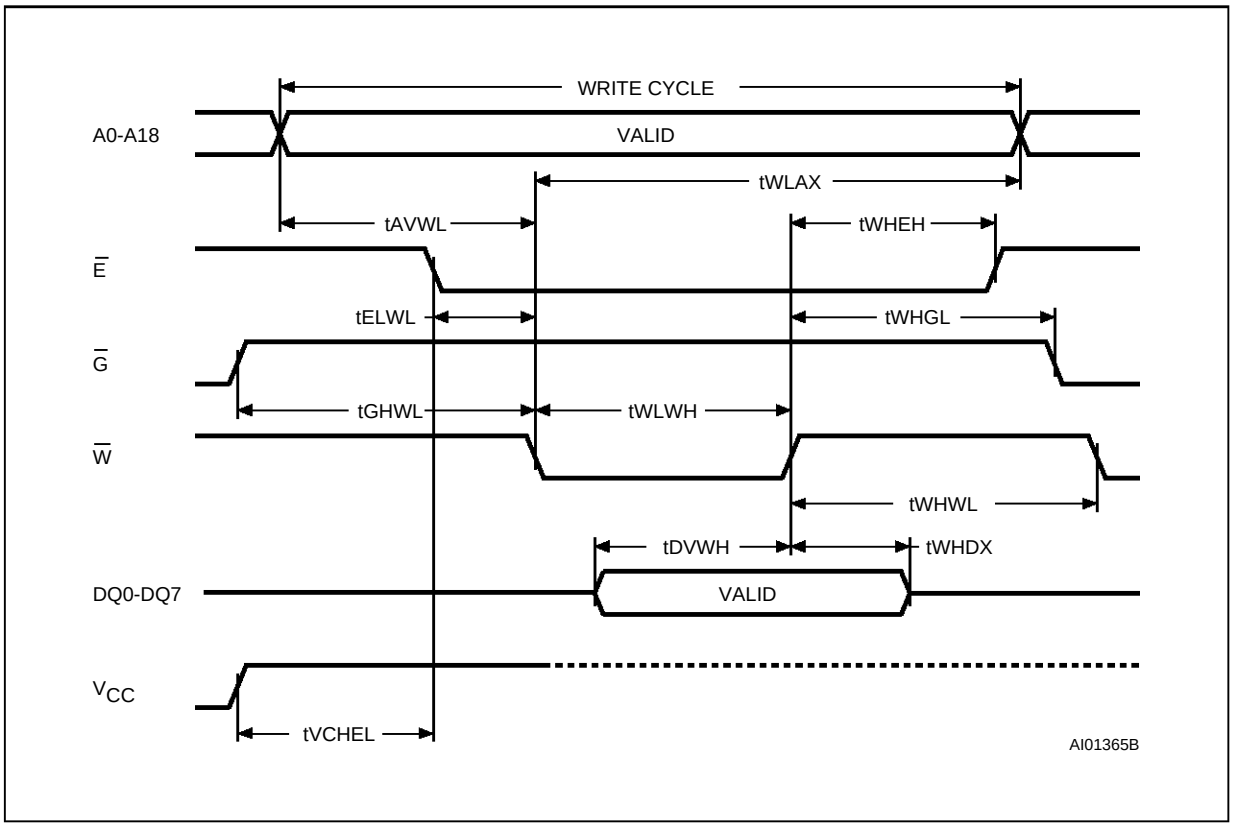
Note: 1. Time is measured to Data Polling or Toggle Bit, $t_{WHQV} = t_{WHQ7V} + t_{Q7VQV}$

DEVICE OPERATION (cont'd)

tion of the erase by the P/E.C. the memory accepts only the Reset (RST) command. Read of Data Polling bit DQ7 returns '0', then '1' on completion. The Toggle Bit DQ6 toggles during erase operation and stops when erase is completed. After completion the Status Register bit DQ5 returns '1' if there has been an Erase Failure because the erasure has not been verified even after the maximum number of erase cycles have been executed.

Sector Erase (SE) instruction. This instruction uses a minimum of six write cycles. The Erase Set-up command 80h is written to address 5555h on third cycle after the two coded cycles. The Sector Erase Confirm command 30h is written on sixth cycle after another two coded cycles. During the input of the second command an address within the sector to be erased is given and latched into the memory. Additional Sector Erase confirm commands and sector addresses can be written subsequently to erase other sectors in parallel, without further coded cycles. The erase will start after an Erase timeout period of about 100µs. Thus, additional Sector Erase commands must be given within this delay. The input of a new Sector Erase command will restart the timeout period. The status of the internal timer can be monitored through the level of DQ3, if DQ3 is '0' the Sector Erase Command has been given and the timeout is running, if DQ3 is '1', the timeout has expired and the P/E.C is erasing the sector(s). Before and during Erase timeout, any command different from 30h will abort the instruction and reset the device to read array mode. It is not necessary to program the sector with 00h as the P/E.C. will do this auto-

Figure 7. Write AC Waveforms, $\overline{W}$ Controlled



Note: Address are latched on the falling edge of $\overline{W}$, Data is latched on the rising edge of $\overline{W}$.

matically before to erasing to 0FFh. Read operations after the sixth rising edge of $\overline{W}$ or $\overline{E}$ output the status register status bits.

During the execution of the erase by the P/E.C., the memory accepts only the ES (Erase Suspend) and RST (Reset) instructions. Data Polling bit DQ7 returns '0' while the erasure is in progress and '1' when it has completed. The Toggle Bit DQ6 toggles during the erase operation. It stops when erase is completed. After completion the Status Register bit DQ5 returns '1' if there has been an Erase Failure because erasure has not completed even after the maximum number of erase cycles have been executed. In this case, it will be necessary to input a Reset (RST) to the command interface in order to reset the P/E.C.

Program (PG) instruction. This instruction uses four write cycles. The Program command A0h is written on the third cycle after two coded cycles. A fourth write operation latches the Address on the falling edge of $\overline{W}$ or $\overline{E}$ and the Data to be written on its rising edge and starts the P/E.C. During the execution of the program by the P/E.C., the memory will not accept any instruction. Read operations output the status bits after the programming has started. Memory programming is made only by writing '0' in place of '1' in a Byte.

Erase Suspend (ES) instruction. The Sector Erase operation may be suspended by this instruction which consists of writing the command 0B0h without any specific address code. No coded cycles are required. It allows reading of data from another sector while erase is in progress. Erase suspend is accepted only during the Sector Erase instruction execution and defaults to read array mode. Writing this command during Erase timeout will, in addition to suspending the erase, terminate the timeout. The Toggle Bit DQ6 stops toggling when the P/E.C. is suspended. Toggle Bit status must be monitored at an address out of the sector being erased.

Table 14A. Write AC Characteristics, Chip Enable Controlled
(T_A = 0 to 70°C, -20 to 85°C, -40 to 85°C or -40 to 125°C)

Symbol	Alt	Parameter	M29F040				Unit
			-70 (2)		-90		
			V_{CC} = 5V ± 5%		V_{CC} = 5V ± 10%		
			SRAM Interface		EPROM Interface		
			Min	Max	Min	Max	
t_{AVAV}	t_{WC}	Address Valid to Next Address Valid	70		90		ns
t_{WLEL}	t_{WS}	Write Enable Low to Chip Enable Low	0		0		ns
t_{ELEH}	t_{CP}	Chip Enable Low to Chip Enable High	35		45		ns
t_{DVEH}	t_{DS}	Input Valid to Chip Enable High	30		45		ns
t_{EHDX}	t_{DH}	Chip Enable High to Input Transition	0		0		ns
t_{EHWH}	t_{WH}	Chip Enable High to Write Enable High	0		0		ns
t_{EHEL}	t_{CPH}	Chip Enable High to Chip Enable Low	20		20		ns
t_{AVEL}	t_{AS}	Address Valid to Chip Enable Low	0		0		ns
t_{ELAX}	t_{AH}	Chip Enable Low to Address Transition	45		45		ns
t_{GHEL}		Output Enable High Chip Enable Low	0		0		ns
t_{VCHWL}	t_{VCS}	V_{CC} High to Write Enable Low	50		50		ns
t_{EHQV1} (1)		Chip Enable High to Output Valid (Program)	10		10		µs
t_{EHQV2} (1)		Chip Enable High to Output Valid (Sector Erase)	1.5	30	1.5	30	sec
t_{EHGL}	t_{OEH}	Chip Enable High to Output Enable Low	0		0		ns

Notes: 1. Time is measured to Data Polling or Toggle Bit, $t_{WHQV} = t_{WHQ7V} + t_{Q7VQV}$
2. At grade 1 (0 to 70°C) temperature range.

DEVICE OPERATION (cont'd)

Toggle Bit will stop toggling between 0.1µs and 15µs after the Erase Suspend (ES) command has been written. The M29F040 will then automatically set to Read Memory Array mode. When erase is suspended, Read from sectors being erased will output invalid data, Read from sector not being erased is valid. During the suspension the memory will respond only to Erase Resume (ER) and Reset (RST) instructions. RST command will definitively abort erasure and result in the invalid data in the sectors being erased.

Erase Resume (ER) instruction. If an Erase Suspend instruction was previously executed, the erase operation may be resumed by giving the command 30h, at any address, and without any coded cycles.

Programing. The memory can be programmed byte-by-byte. The program sequence is started by the two coded cycles, followed by writing the Program command (0A0h) to the Command Interface. This is followed by writing the address and data byte to the memory. The Program/Erase Controller automatically starts and performs the programming after the fourth write operation. During programming the memory status is checked by reading the status bits DQ5, DQ6 and DQ7 which show the status of the P/E.C. DQ6 and DQ7 determine if programming is on going or has completed and DQ5 allows a check to be made for any possible error.

Table 14B. Write AC Characteristics, Chip Enable Controlled
(T_A = 0 to 70°C, -20 to 85°C, -40 to 85°C or -40 to 125°C)

Symbol	Alt	Parameter	M29F040				Unit
			-120		-150		
			V_{CC} = 5V ± 10%		V_{CC} = 5V ± 10%		
			EPROM Interface		EPROM Interface		
			Min	Max	Min	Max	
t_{AVAV}	t_{WC}	Address Valid to Next Address Valid	120		150		ns
t_{WLEL}	t_{WS}	Write Enable Low to Chip Enable Low	0		0		ns
t_{ELEH}	t_{CP}	Chip Enable Low to Chip Enable High	50		50		ns
t_{DVEH}	t_{DS}	Input Valid to Chip Enable High	50		50		ns
t_{EHDX}	t_{DH}	Chip Enable High to Input Transition	0		0		ns
t_{EHWH}	t_{WH}	Chip Enable High to Write Enable High	0		0		ns
t_{EHEL}	t_{CPH}	Chip Enable High to Chip Enable Low	20		20		ns
t_{AVEL}	t_{AS}	Address Valid to Chip Enable Low	0		0		ns
t_{ELAX}	t_{AH}	Chip Enable Low to Address Transition	50		50		ns
t_{GHEL}		Output Enable High Chip Enable Low	0		0		ns
t_{VCHWL}	t_{VCS}	V_{CC} High to Write Enable Low	50		50		ns
t_{EHQV1} (1)		Chip Enable High to Output Valid (Program)	10		10		µs
t_{EHQV2} (1)		Chip Enable High to Output Valid (Sector Erase)	1.5	30	1.5	30	sec
t_{EHGL}	t_{OEH}	Chip Enable High to Output Enable Low	0		0		ns

Note: 1. Time is measured to Data Polling or Toggle Bit, $t_{WHQV} = t_{WHQ7V} + t_{Q7VQV}$

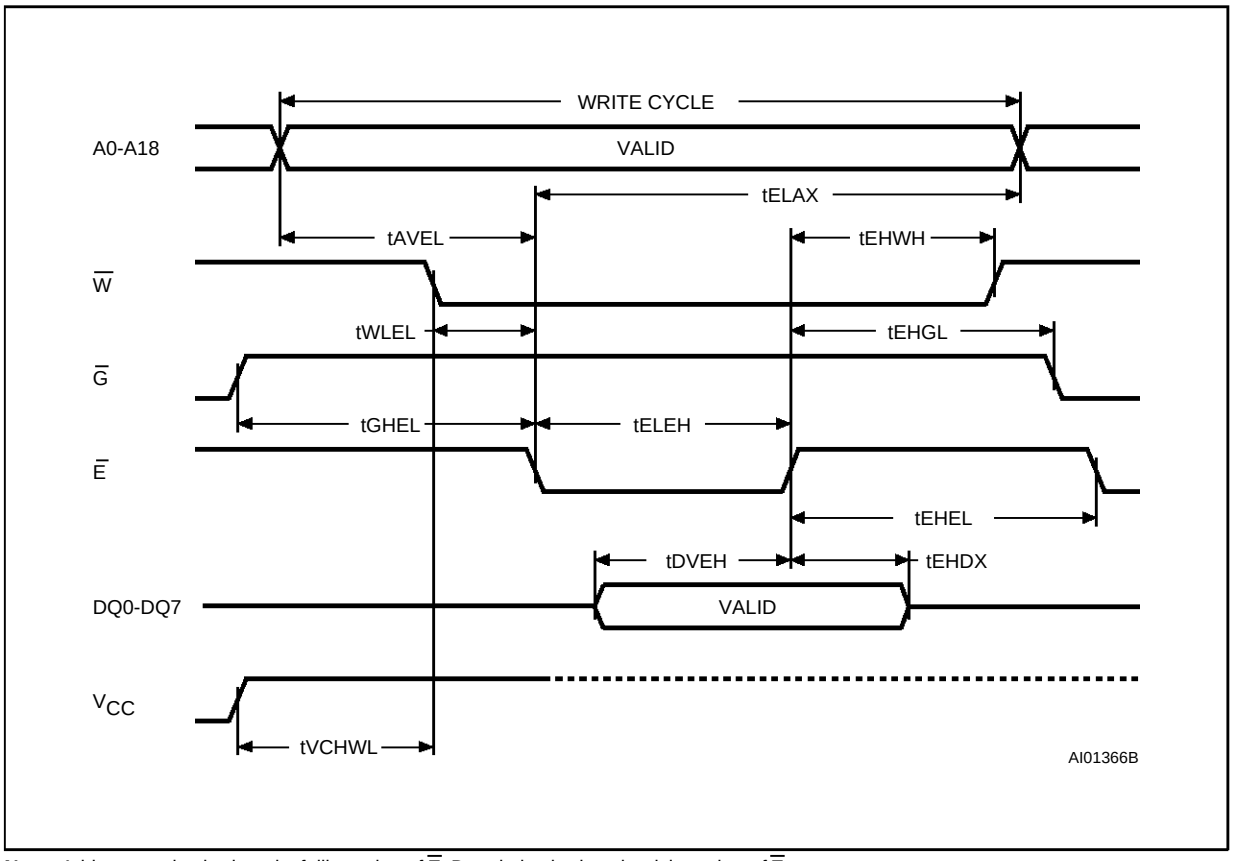
Power Up

The memory Command Interface is reset on power up to Read Array. Either $\overline{E}$ or $\overline{W}$ must be tied to V_{IH} during Power-up to allow maximum security and the possibility to write a command on the first rising adge of $\overline{E}$ or $\overline{W}$. Any write cycle initiation is blocked when V_{CC} is below V_{LKO}.

Supply Rails

Normal precautions must be taken for supply voltage decoupling, each device in a system should have the V_{CC} rail decoupled with a 0.1µF capacitor close to the V_{CC} and V_{SS} pins. The PCB trace widths should be sufficient to carry the V_{CC} program and erase currents required.

Figure 8. Write AC Waveforms, $\overline{E}$ Controlled



Note: Address are latched on the falling edge of $\overline{E}$, Data is latched on the rising edge of $\overline{E}$.

Table 15A. Data Polling and Toggle Bit AC Characteristics (1)
(T_A = 0 to 70°C, -20 to 85°C, -40 to 85°C or -40 to 125°C)

Symbol	Alt	Parameter	M29F040				Unit
			-70 (3)		-90		
			V_{CC} = 5V ± 5%		V_{CC} = 5V ± 10%		
			SRAM Interface		EPROM Interface		
			Min	Max	Min	Max	
t_{WHQ7V1} (2)		Write Enable High to DQ7 Valid (Program, $\overline{W}$ Controlled)	10		10		µs
t_{WHQ7V2} (2)		Write Enable High to DQ7 Valid (Sector Erase, $\overline{W}$ Controlled)	1.5	30	1.5	30	sec
t_{EHQ7V1} (2)		Chip Enable High to DQ7 Valid (Program, $\overline{E}$ Controlled)	10		10		µs
t_{EHQ7V2} (2)		Chip Enable High to DQ7 Valid (Sector Erase, $\overline{E}$ Controlled)	1.5	30	1.5	30	sec
t_{Q7VQV}		Q7 Valid to Output Valid (Data Polling)		30		35	ns
t_{WHQV1}		Write Enable High to Output Valid (Program)	10		10		µs
t_{WHQV2}		Write Enable High to Output Valid (Sector Erase)	1.5	30	1.5	30	sec
t_{EHQV1}		Chip Enable High to Output Valid (Program)	10		10		µs
t_{EHQV2}		Chip Enable High to Output Valid (Sector Erase)	1.5	30	1.5	30	sec

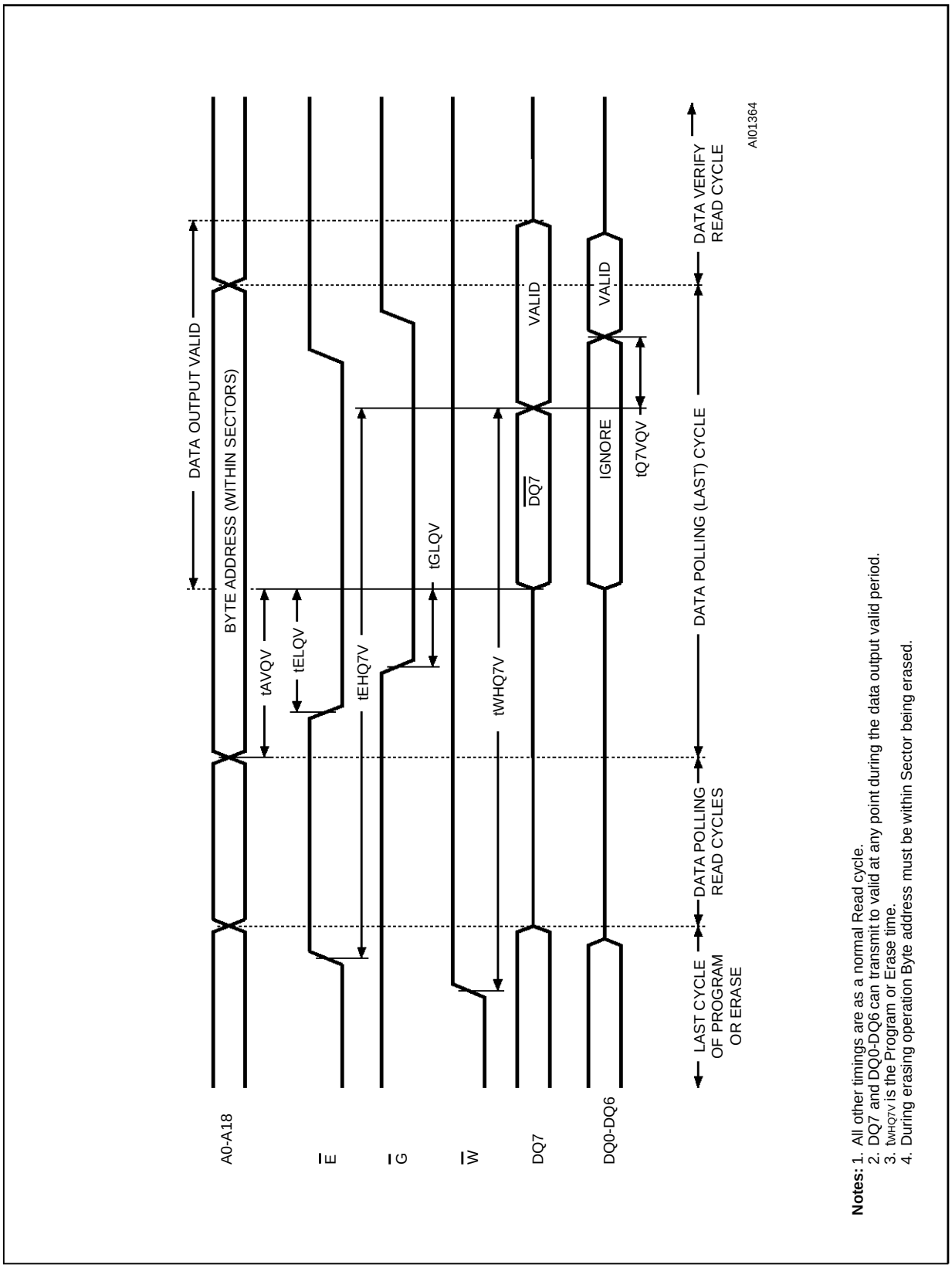
Notes: 1. All other timings are defined in Read AC Characteristics table.
2. t_{WHQ7V} is the Program or Erase time.
3. At grade 1 (0 to 70°C) temperature range.

Table 15B. Data Polling and Toggle Bit AC Characteristics (1)
(T_A = 0 to 70°C, -20 to 85°C, -40 to 85°C or -40 to 125°C)

Symbol	Alt	Parameter	M29F040				Unit
			-120		150		
			V_{CC} = 5V ± 10%		V_{CC} = 5V ± 10%		
			EPROM Interface		EPROM Interface		
			Min	Max	Min	Max	
t_{WHQ7V1} (2)		Write Enable High to DQ7 Valid (Program, W Controlled)	10		10		ms
t_{WHQ7V2} (2)		Write Enable High to DQ7 Valid (Sector Erase, W Controlled)	1.5	30	1.5	30	sec
t_{EHQ7V1} (2)		Chip Enable High to DQ7 Valid (Program, E Controlled)	10		10		ms
t_{EHQ7V2} (2)		Chip Enable High to DQ7 Valid (Sector Erase, E Controlled)	1.5	30	1.5	30	sec
t_{Q7VQV}		Q7 Valid to Output Valid (Data Polling)		50		55	ns
t_{WHQV1}		Write Enable High to Output Valid (Program)	10		10		µs
t_{WHQV2}		Write Enable High to Output Valid (Sector Erase)	1.5	30	1.5	30	sec
t_{EHQV1}		Chip Enable High to Output Valid (Program)	10		10		µs
t_{EHQV2}		Chip Enable High to Output Valid (Sector Erase)	1.5	30	1.5	30	sec

Notes: 1. All other timings are defined in Read AC Characteristics table.
2. t_{WHQ7V} is the Program or Erase time.

Figure 9. Data Polling DQ7 AC Waveforms



Notes: 1. All other timings are as a normal Read cycle.
2. DQ7 and DQ0-DQ6 can transmit to valid at any point during the data output valid period.
3. t_{WHQ7V} is the Program or Erase time.
4. During erasing operation Byte address must be within Sector being erased.

Figure 10. Data Polling Flow-chart

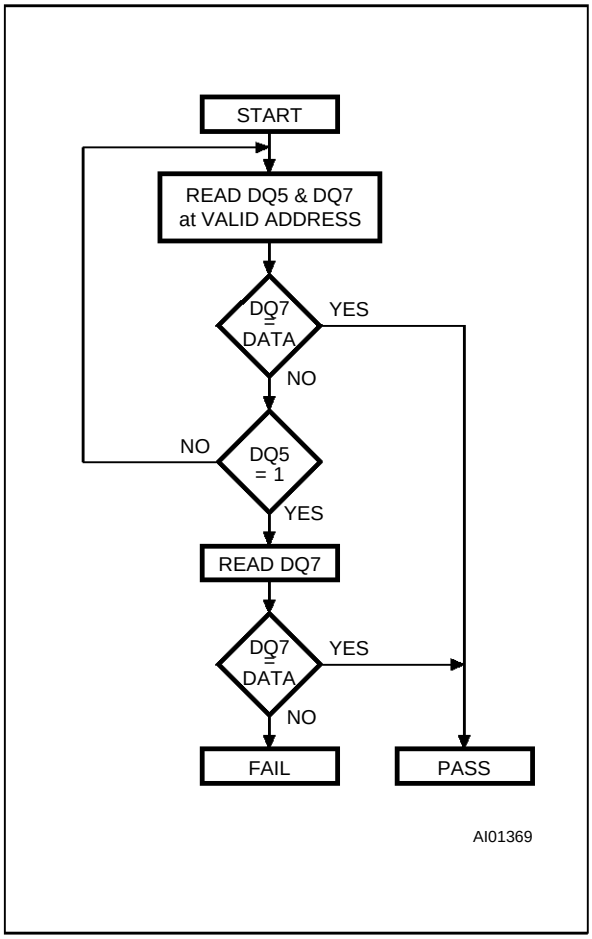


Figure 11. Data Toggle Flow-chart

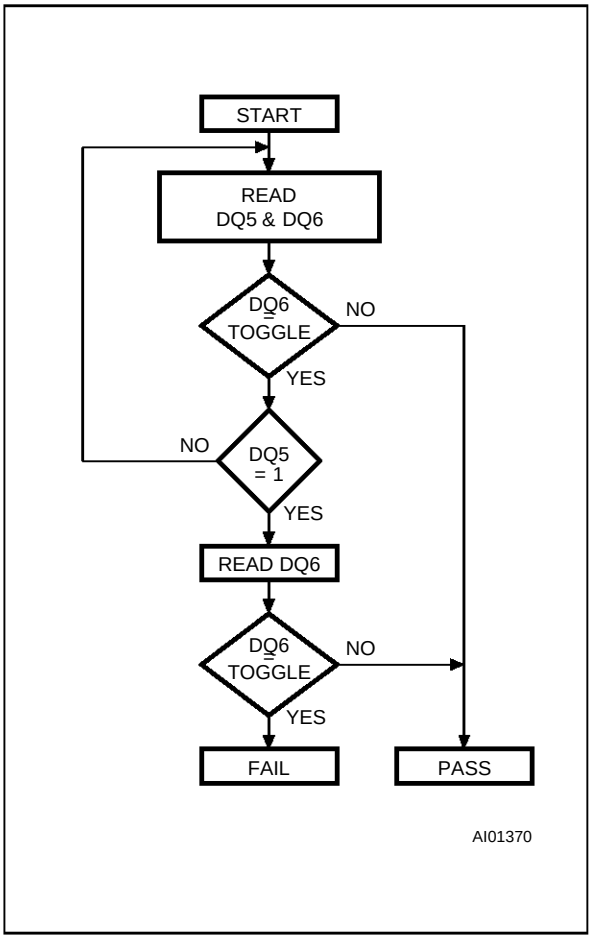


Table 16. Program, Erase Times and Program, Erase Endurance Cycles
(T_A = 0 to 70°C; V_{CC} = 5V ± 10% or 5V ± 5%)

Parameter	M29F040			Unit
	Min	Typ	Max	
Chip Program (Byte)		6		sec
Bulk Erase (Preprogrammed)		2.5	30	sec
Bulk Erase		8.5		sec
Sector Erase (Preprogrammed)		1	30	sec
Sector Erase		1.5		sec
Byte Program	10		1200	µs
Program/Erase Cycles (per Sector)	100,000			cycles

Figure 12. Data Toggle DQ6 AC Waveforms

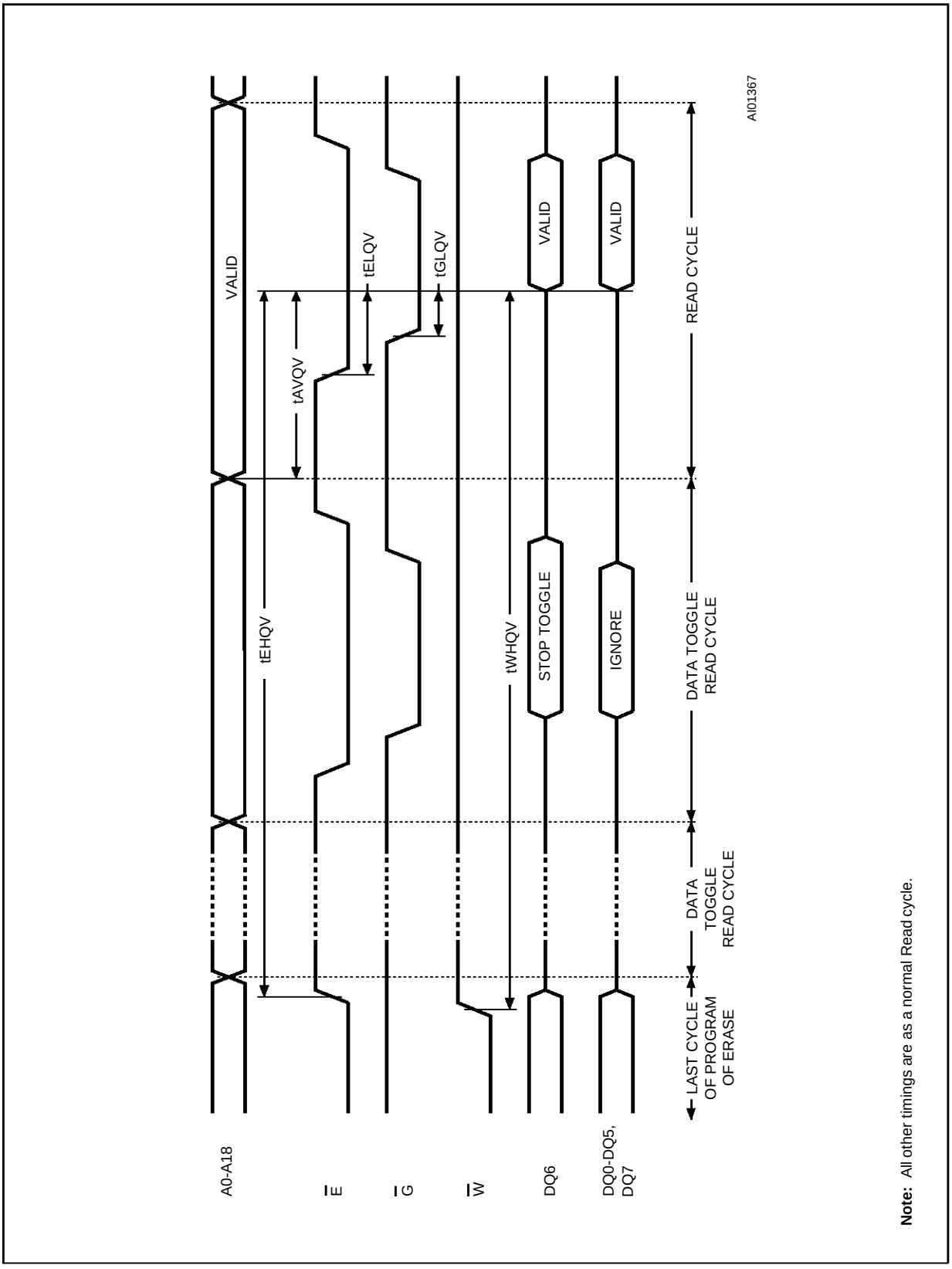


Figure 13. Sector Protection Flow-chart

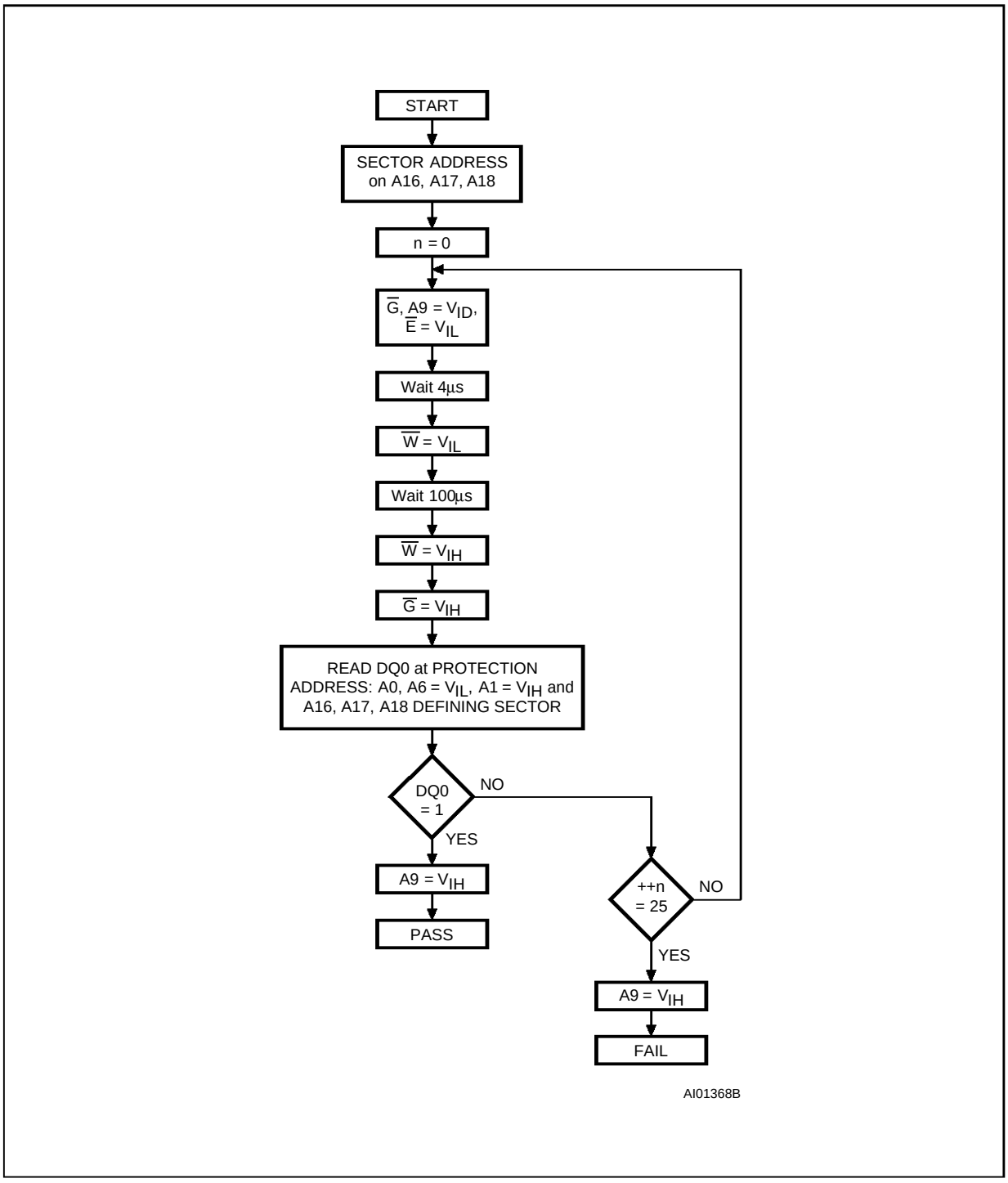
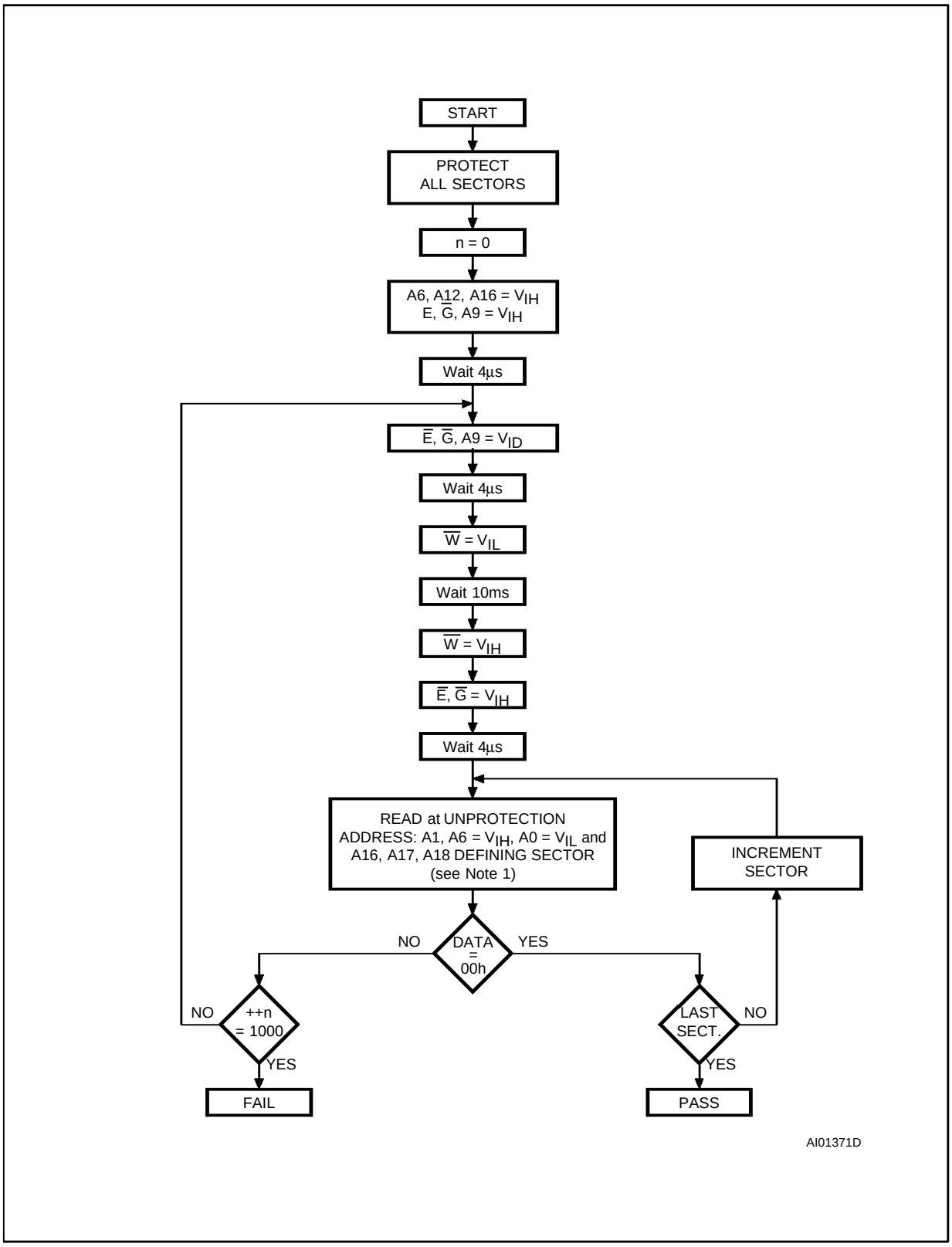
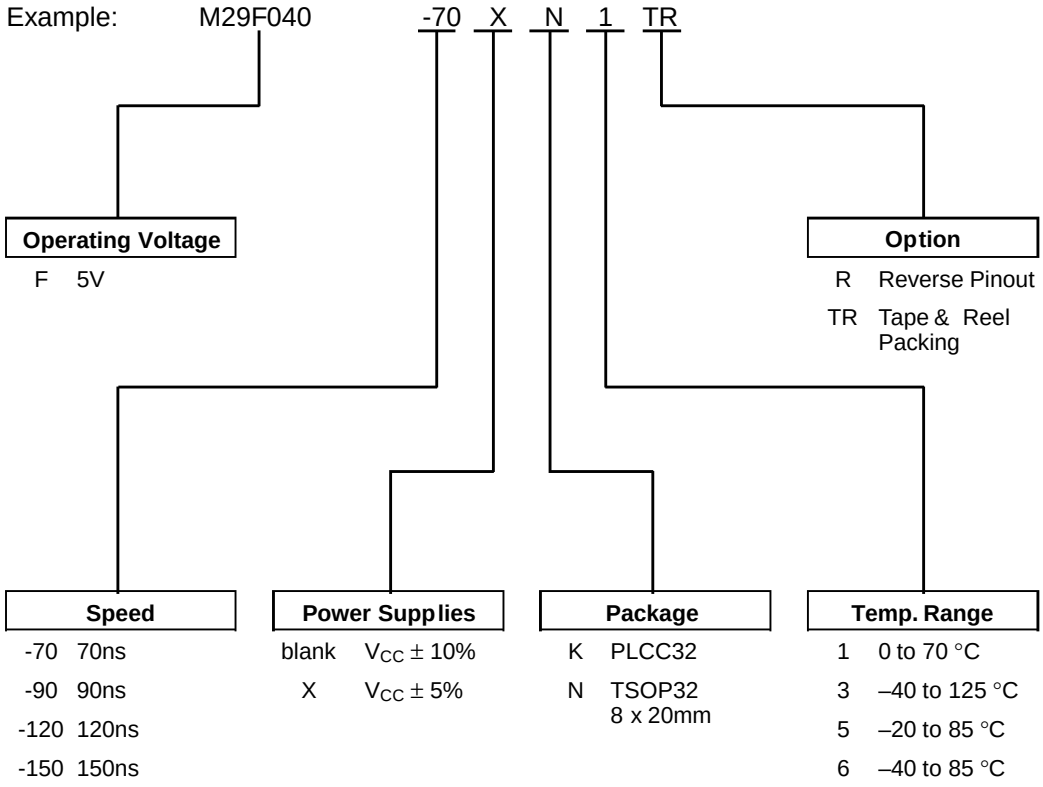


Figure 14. Sector Unprotecting Flow-chart



Note: 1. A6 is kept at V_{IH} during unprotection algorithm in order to secure best unprotection verification. During all other protection status reads, A6 must be kept at V_{IL}.

ORDERING INFORMATION SCHEME

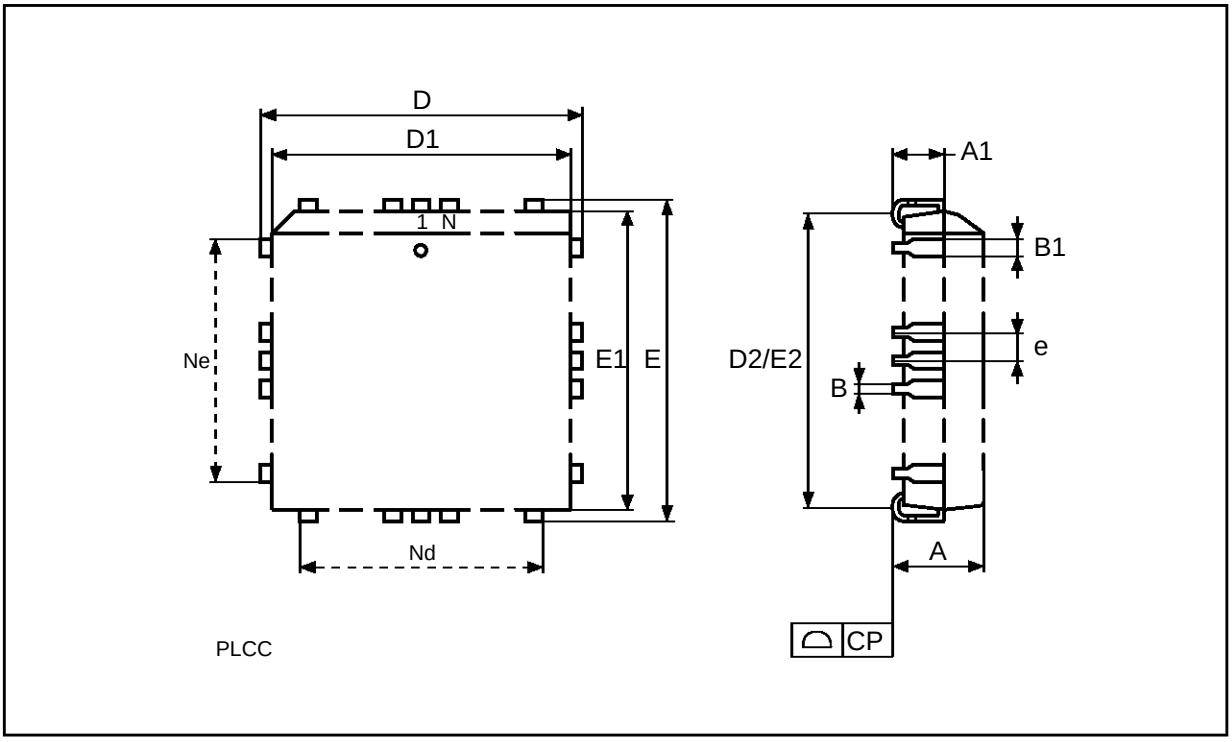


For a list of available options (V_{CC} Range, Speed, etc...) refer to the current Memory Shortform catalogue. For further information on any aspect of this device, please contact the SGS-THOMSON Sales Office nearest to you.

PLCC32 - 32 lead Plastic Leaded Chip Carrier, rectangular

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A		2.54	3.56		0.100	0.140
A1		1.52	2.41		0.060	0.095
B		0.33	0.53		0.013	0.021
B1		0.66	0.81		0.026	0.032
D		12.32	12.57		0.485	0.495
D1		11.35	11.56		0.447	0.455
D2		9.91	10.92		0.390	0.430
E		14.86	15.11		0.585	0.595
E1		13.89	14.10		0.547	0.555
E2		12.45	13.46		0.490	0.530
e	1.27	–	–	0.050	–	–
N	32			32		
Nd	7			7		
Ne	9			9		
CP			0.10			0.004

PLCC32



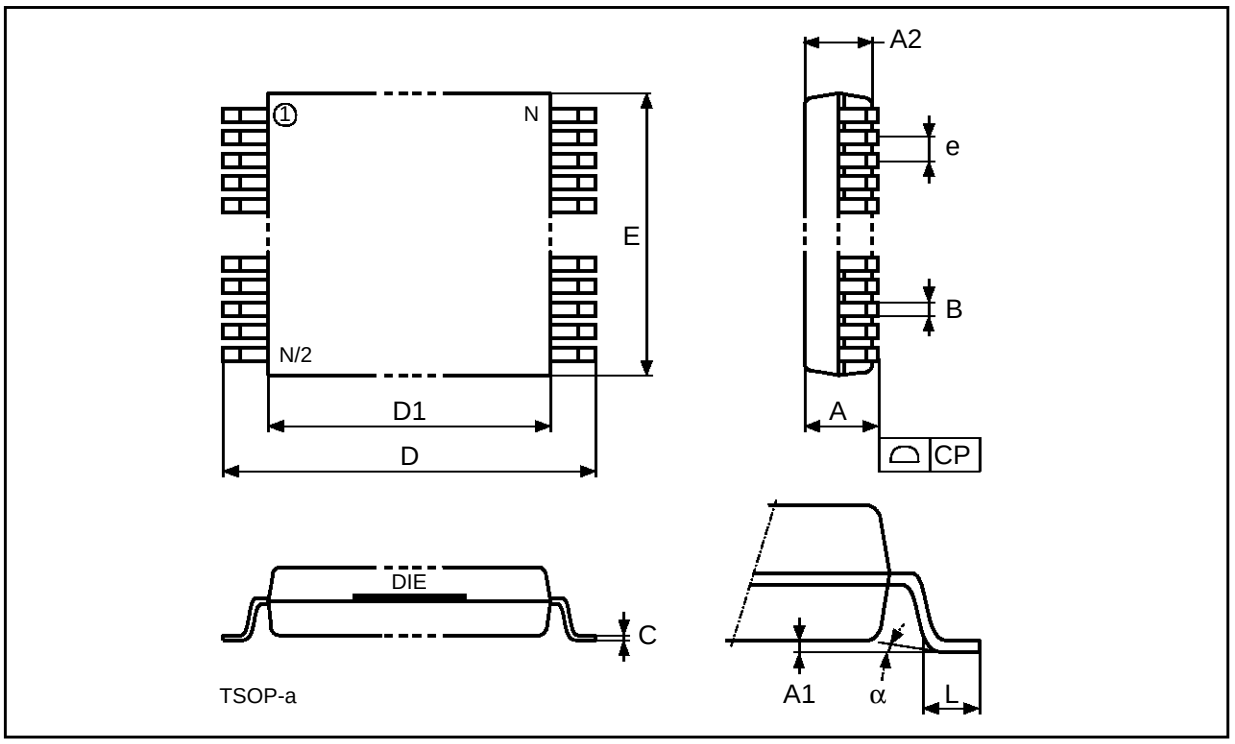
PLCC

Drawing is not to scale

TSOP32 Normal Pinout - 32 lead Plastic Thin Small Outline, 8 x 20mm

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A			1.20			0.047
A1		0.05	0.17		0.002	0.006
A2		0.95	1.50		0.037	0.059
B		0.15	0.27		0.006	0.011
C		0.10	0.21		0.004	0.008
D		19.80	20.20		0.780	0.795
D1		18.30	18.50		0.720	0.728
E		7.90	8.10		0.311	0.319
e	0.50	–	–	0.020	–	–
L		0.50	0.70		0.020	0.028
α		0°	5°		0°	5°
N	32			32		
CP			0.10			0.004

TSOP32



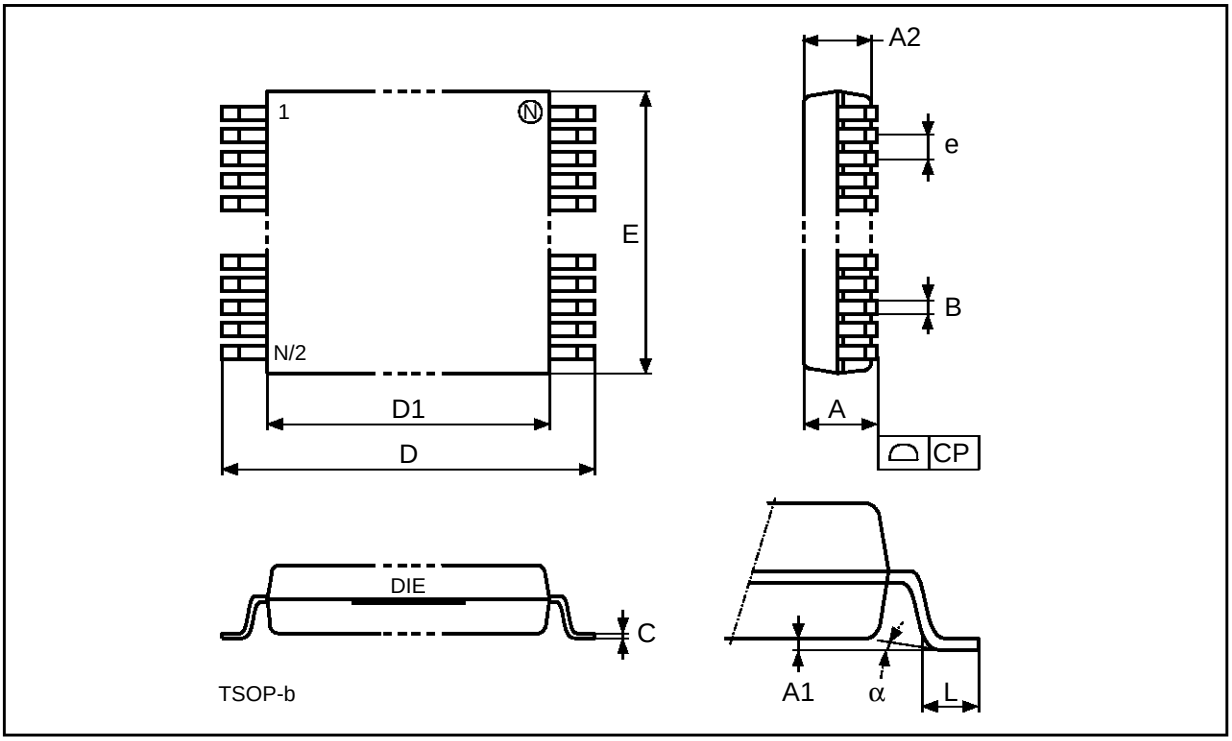
TSOP-a

Drawing is not to scale

TSOP32 Reverse Pinout - 32 lead Plastic Thin Small Outline, 8 x 20mm

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A			1.20			0.047
A1		0.05	0.17		0.002	0.006
A2		0.95	1.50		0.037	0.059
B		0.15	0.27		0.006	0.011
C		0.10	0.21		0.004	0.008
D		19.80	20.20		0.780	0.795
D1		18.30	18.50		0.720	0.728
E		7.90	8.10		0.311	0.319
e	0.50	–	–	0.020	–	–
L		0.50	0.70		0.020	0.028
α		0°	5°		0°	5°
N		32			32	
CP			0.10			0.004

TSOP32



TSOP-b

Drawing is not to scale