

HD81820 DSP-E/ HD817820 DSP-E ZTAT

Floating-Point Digital Signal Processor

HITACHI/ (MCU/MPU)

Description

HD81820 and HD817820 are high-speed digital signal processors realizing floating point operations at a speed of 100 ns. These products incorporate a high-speed floating-point ALU and high-speed floating-point multiplier on chip, enabling them to add/subtract and multiply simultaneously in just one cycle (10 MFLOPS). They also achieve a high degree of parallel processing in other types of operations, making for highly efficient program design. The instruction ROM and data ROM of HD817820 are PROMs (EPROM), which can be written and verified by the same specifications as the HM27C256 using a standard PROM programmer.

The latest CMOS process technology is applied, realizing low power dissipation along with high speed. These products are thus ideally suited to applications in a wide range of areas requiring high-speed product summation or filter processing, including telecommunications, voice encoding, speech synthesis, image processing, and control functions.

Features

Hardware

- Fixed-point (16-bit) and floating-point (16-bit mantissa and 4-bit exponent operations)
- Internal high-speed floating-point ALU (100 ns) and floating-point multiplier
- Pipelining and horizontal micro-instructions for high throughput
- 32-bit dynamic range for floating-point operations

- Large-capacity memories on chip:
 - Instruction ROM: 2 kwords × 22 bits (2 kW version); 4 kwords × 22 bits (4 kW version) (HD817820 uses PROM/EPROM)
 - Data RAM: 512 words × 20 bits
 - Data ROM: 512 words × 20 bits (HD817820 uses PROM/EPROM)
- 8/16-bit microcomputer interfaces
- 16-bit serial I/O
- Parallel I/O allowing internal registers (PC and CTR) to be set externally
- Interrupt by parallel I/O and by serial output
- Up to four nesting levels for subroutines and interrupts
- Run on single +5 V power supply
- Low power dissipation: 150 mW typ. (HD81820), 200 mW typ (HD817820)

Software

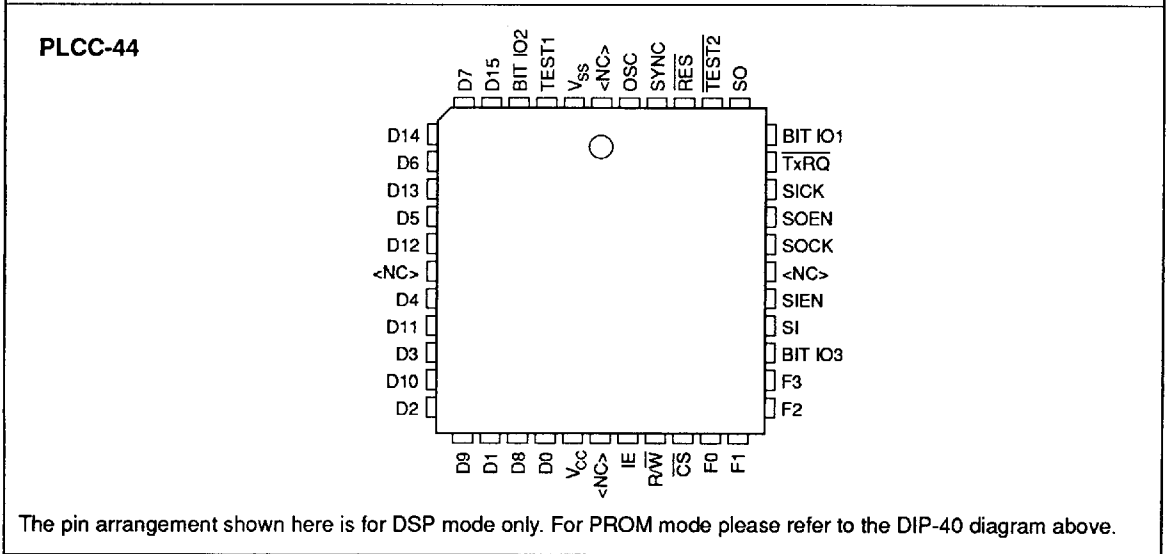
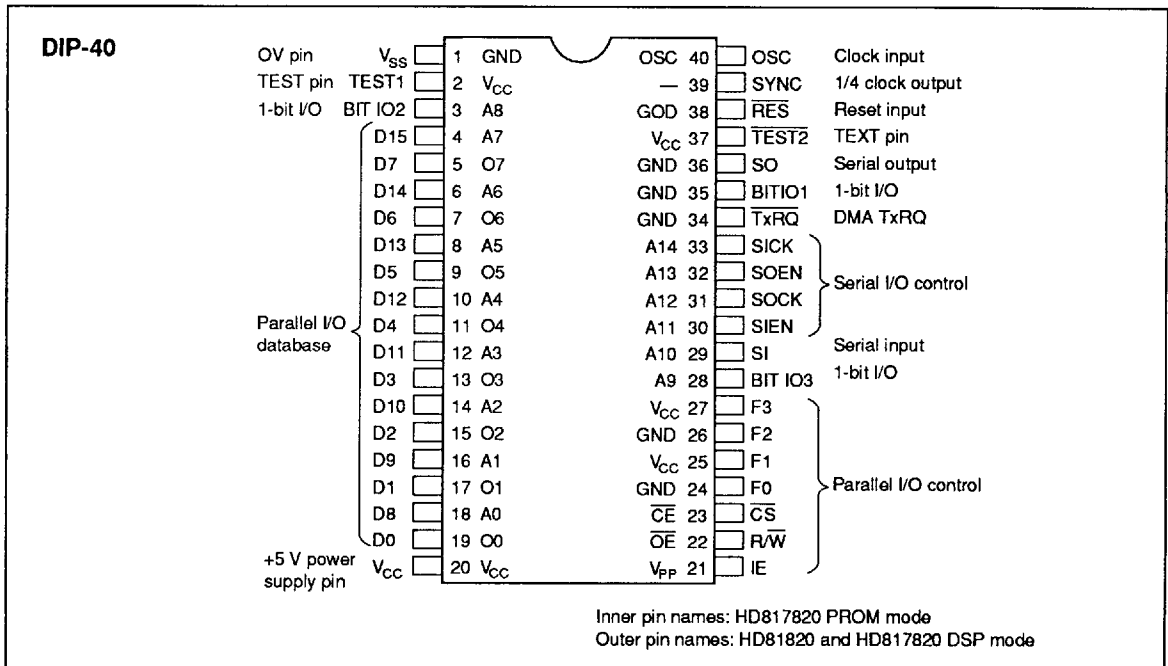
- Instruction set supporting fixed-point/floating-point operations
- All instructions executed in just one cycle
- High-precision floating-point operations with no worry of overflow or underflow (no scaling operations required)
- Single instructions for addition/subtraction, multiplication, memory read (two-port), memory write, pointer increment, and repeat counter decrement operations
- Three addressing modes
- Repeat instructions allowing reiterative product summation operations to be programmed efficiently

Throughout this document, DSP-E is used as a general name for HD817820 and HD81820.

Product Lineup

Type No.	Package	Instruction ROM	
HD8178202P	DP-40	2 kW	PROM
HD8178202CP	CP-44		
HD8178204P	DP-40	4 kW	
HD8178204CP	CP-44		
HD8178204G	DG-40 (with window)	4 kW	EPROM

Pin Arrangement



HD81820/HD817820

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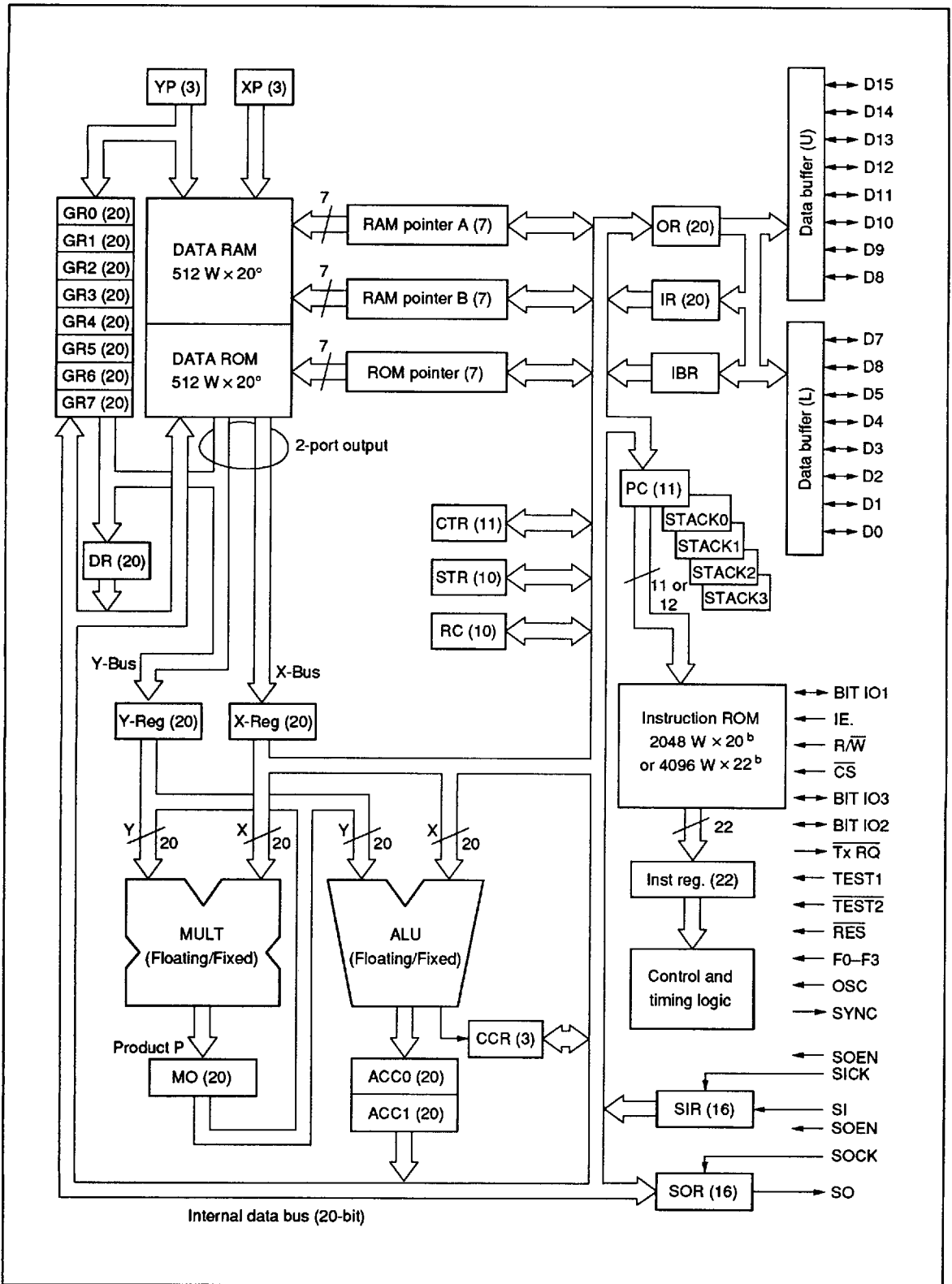
Benchmark Values (Floating-Point Operations)**Arithmetic Operations**

Operation	Execution Time	Remarks
Addition/Subtraction	100 ns	These operations can be performed in parallel
Multiplication	100 ns	
Inversion	2.8 μ s	
Division	4.0 μ s	2.5 μ s when inversion is used
\sqrt{x}	7.4 μ s	
SIN (x), COS (x)	2.8 μ s	Program calculating both sine and cosine simultaneously
TAN (x)	6.8 μ s	

Signal Processing

Operation	Execution Time	Remarks
Transversal filter	0.1 μ s/TAP	
Biquad filter	0.6 μ s/element	
256-point complex FFT	1.92 ms	Loop operation

Block Diagram



Using ALU Operation Instructions in Parallel Processing

Instructions can be executed most efficiently by making use of the DSP-E ALU operation instructions. These instructions execute two or more operations in parallel, as explained below.

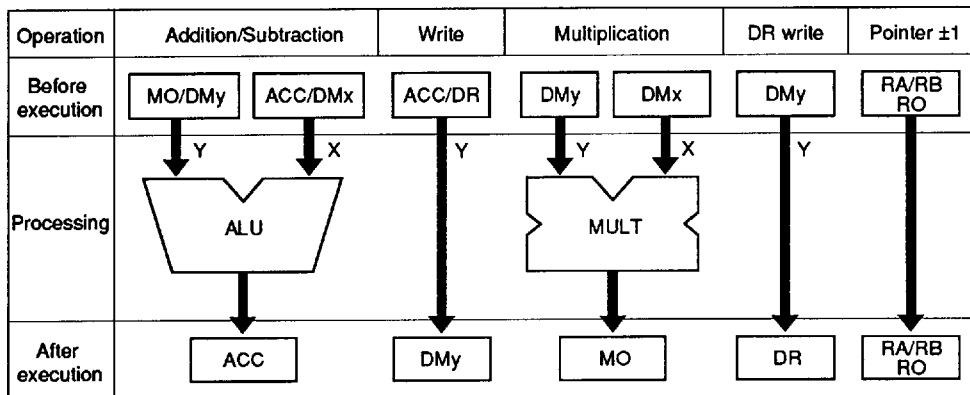
Parallel Processing in Page Indirect/Page Direct Addressing Mode

ALU operations can be performed using as input the ACC value, memory content, multiplication

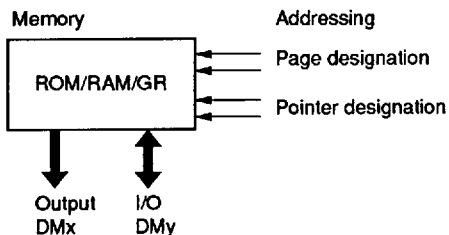
result (MO), and delay register content (DR), up to the previous instruction. Since pipeline processing is used with MO and DR values, these values are rewritten every cycle; for this reason, the execution results of the immediately preceding instruction must always be used. Special care is needed when interrupts are enabled, inasmuch as MO and DR data prior to an interrupt cannot be restored.

Example:

ADDF (YP, XP), ACC0 MULTF (YP, XP), MO ST ACC0, (YP) INCRA NOPRO ;
 [ALU] [MULT] [ST] [RAMP] [ROMP]



ACC: ACC0 or ACC1
 DR: Delay register
 MO: Product
 DMx: ROM, RAM (accessed via X address designation)
 DMy: ROM, RAM, GR (accessed via Y address designation)
 (Delay register may be written only from RAM or GR.)



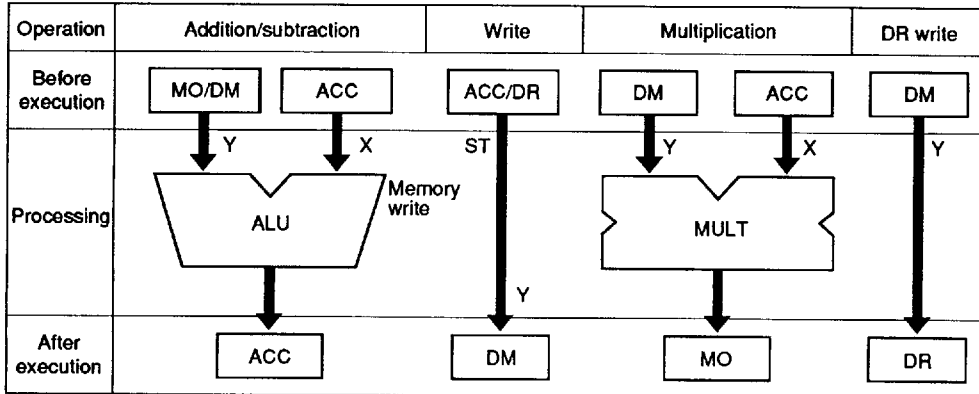
Memory is addressed using XP and XY or instruction page designation, and by ROM/RAM pointers. Since there are two output ports (X bus and Y bus), two data values may be output at the same time. Data input is through the Y bus.

Parallel Processing in Direct Addressing Mode

Example:

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ADDF (DM0, 10, ACC0), ACC0   MULTF (DM0, 10, ACC0), MO   ST ACC0, DM0, 10 ;
      [ALU]                       [MULT]                       [ST]
    
```



ACC: ACC0 or ACC1
 DR: Delay register
 MO: Product
 DM: ROM, RAM (accessed by direct address designation)
 (Delay register may be written only from RAM.)
 DM0, 10 designates a memory address (10) in page 0.

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Programming the On-Chip PROM

In PROM mode, the HD817820 on-chip PROM can be programmed. The DSP-E itself does not operate in this mode.

The PROM can be programmed and read by the same specifications as the 27C256 EPROM. It can be programmed using a standard PROM programmer and 40-to-28 pin socket adapter. Addresses H'0000 through H'4FFF must be designated, since these are assigned to the PROM.

A 4 MHz clock must be input through the OSC pin. V_{CC} power can be used as the power source of the external clock circuit. Hitachi recommends using a ceramic oscillator with a short oscillation setup time. An oscillator is built into the socket adapter. Of the 40 HD817820 pins, the socket adapter makes use of the 28 pins required for programming, thereby adapting to the standard EPROM pin arrangement shown in figure 1.

- Notes:
1. Be sure pin direction that the PROM programmer, socket adapter, and LSI match. Using the wrong programmer or adapter may cause an overvoltage and damage the LSI. Make sure the LSI, programmer and socket adapter are properly mounted before programming.
 2. EPROM programmers available use a V_{pp} of either 12.5 V or 21 V; the correct voltage for programming the HD817820 is 12.5 V. Programming at 21 V may cause permanent damage to the LSI. Setting the PROM programmer to match 27256 (Intel) specifications results in a correct V_{pp} of 12.5 V.

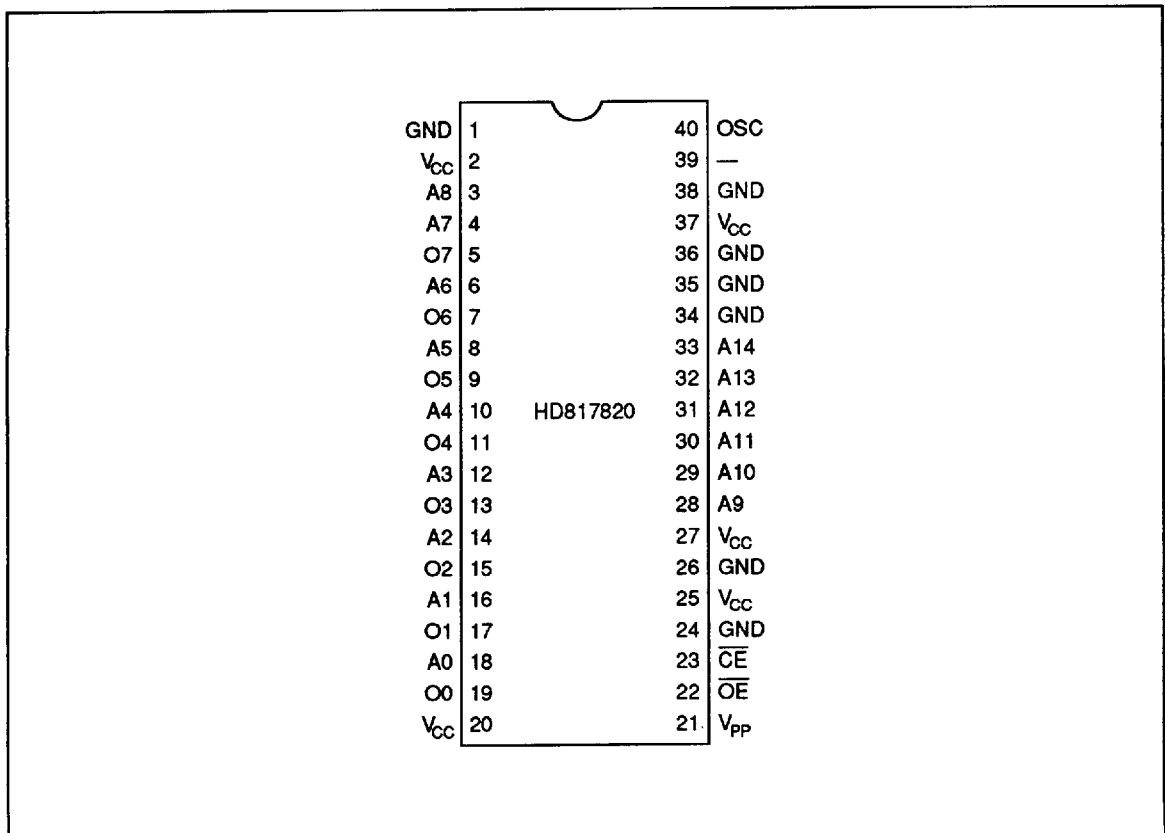


Figure 1 Pin Arrangement in PROM Mode

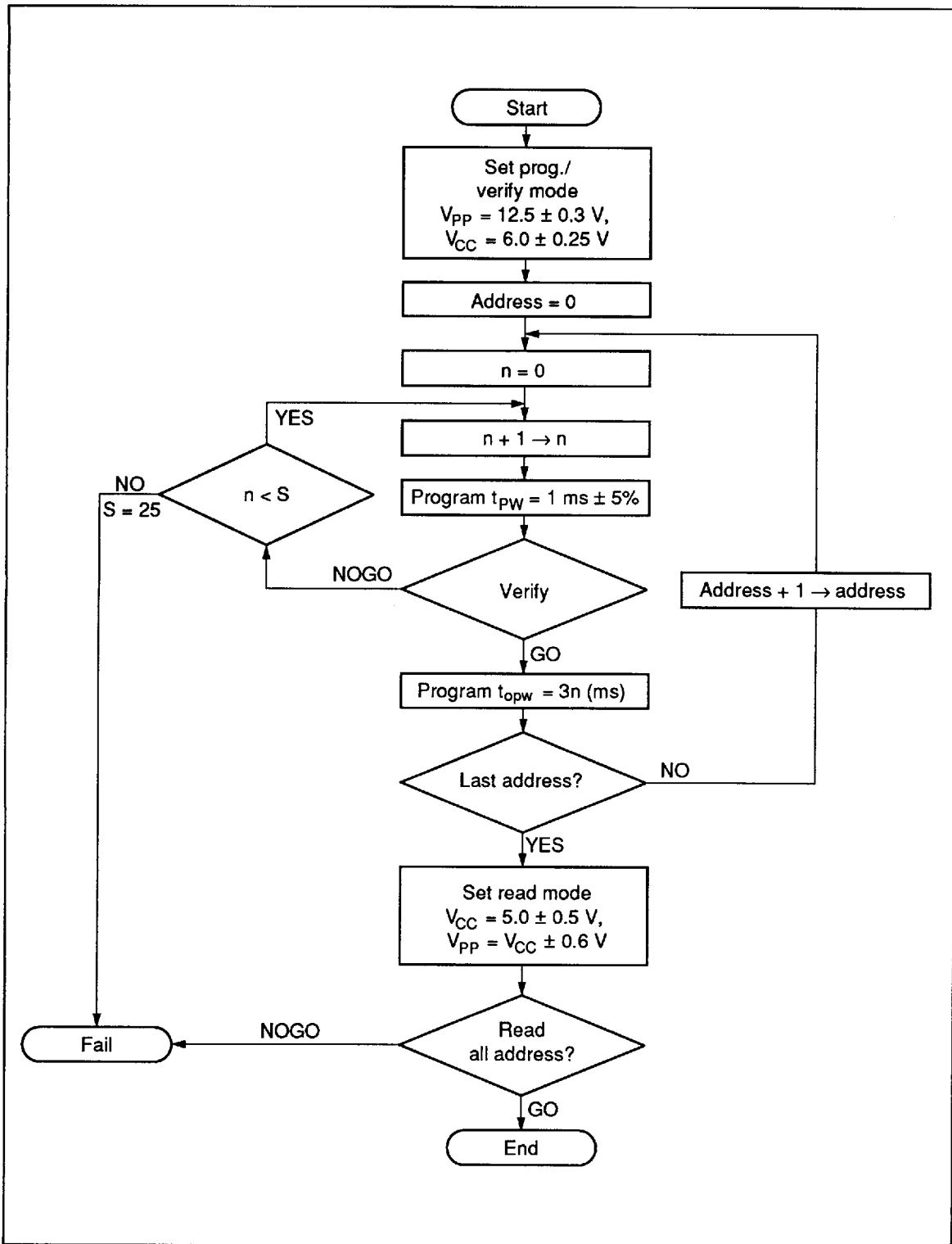


Figure 2 High-Speed Programming Flow Chart

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Electrical Characteristics in PROM Mode**Program Operation**

DC Characteristics (where not otherwise specified, $V_{CC} = 6\text{ V} \pm 0.25\text{ V}$, $V_{PP} = 12.5\text{ V} \pm 0.3\text{ V}$, $V_{SS} = 0\text{ V}$, $T_a = 25^\circ\text{C} \pm 5^\circ\text{C}$)

Item		Symbol	Min	Typ	Max	Unit	Test Condition
Input high voltage	$\overline{O_0-O_7}, A_0-A_{14},$ $\overline{OE}, \overline{CE}$	V_{IH}	2.2	—	$V_{CC} + 0.3$	V	
Input low voltage	$\overline{O_0-O_7}, A_0-A_{14},$ $\overline{OE}, \overline{CE}$	V_{IL}	-0.3	—	0.8	V	
Output high voltage	O_0-O_7	V_{OH}	2.4	—	—	V	$I_{OH} = -200\ \mu\text{A}$
Output low voltage	O_0-O_7	V_{OL}	—	—	0.45	V	$I_{OL} = 1.6\text{ mA}$
Input leakage current	$\overline{O_0-O_7}, A_0-A_{14},$ $\overline{OE}, \overline{CE}$	$ I_{LI} $	—	—	2	μA	$V_{in} = 5.25\text{ V}/$ 0.5 V
V_{CC} current		I_{CC}	—	—	100	mA	$f_{OSC} = 4\text{ MHz}$
V_{PP} current		I_{PP}	—	—	50	mA	

For further details on the products in this document, please refer to the User's Manual (ADE-607-003).