

# DSP-E/232 ZTAT HD8178232

(Digital Signal Processor-Enhanced)

## Features

The DSP-E/232 is a single chip digital signal processor that integrates peripheral functionality around the Hitachi DSP-E floating point signal processor. This product is instruction and object code compatible with the DSP-E series of Hitachi floating point signal processors, and executes floating point calculations in 100 ns. Furthermore, since this is a built-in PROM type product that inherits the Hitachi ZTAT® series concept, it radically shortens system development time and allows a smooth progression from debugging through mass production.

As peripheral functionality, the DSP-E/232 includes built in two types of timer (16-bit free-running timers, and 8-bit timers), a serial communications interface, an 8-channel 8-bit A/D converter, and I/O ports. Also, it reduces noise by using a crystal oscillator at the same frequency as the machine cycle.

The arithmetic power of the DSP-E/232 derives from the fact that it includes on-chip both a high speed floating point arithmetic unit and a high speed floating point multiplier, and can execute an addition and a multiplication at the same time in a single cycle, thus achieving 10 MFLOPS. In addition to the arithmetic unit and multiplier, the architecture provides a high degree of parallelism, thus allowing the construction of efficient programs. Instruction ROM and data ROM are implemented as PROM, and can be written and verified by general purpose PROM writers, since the DSP-E/232 PROM meets the 27C256 and 27C256H specifications.

Furthermore, the DSP-E/232 is implemented in the most recent CMOS process, and achieves a combination of high speed and low power dissipation. We are confident that the DSPE will prove effective in a wide range of areas, from the control area, where high speed multiply and accumulate and filtering processing are required, to

communications, voice encoding, and voice processing.

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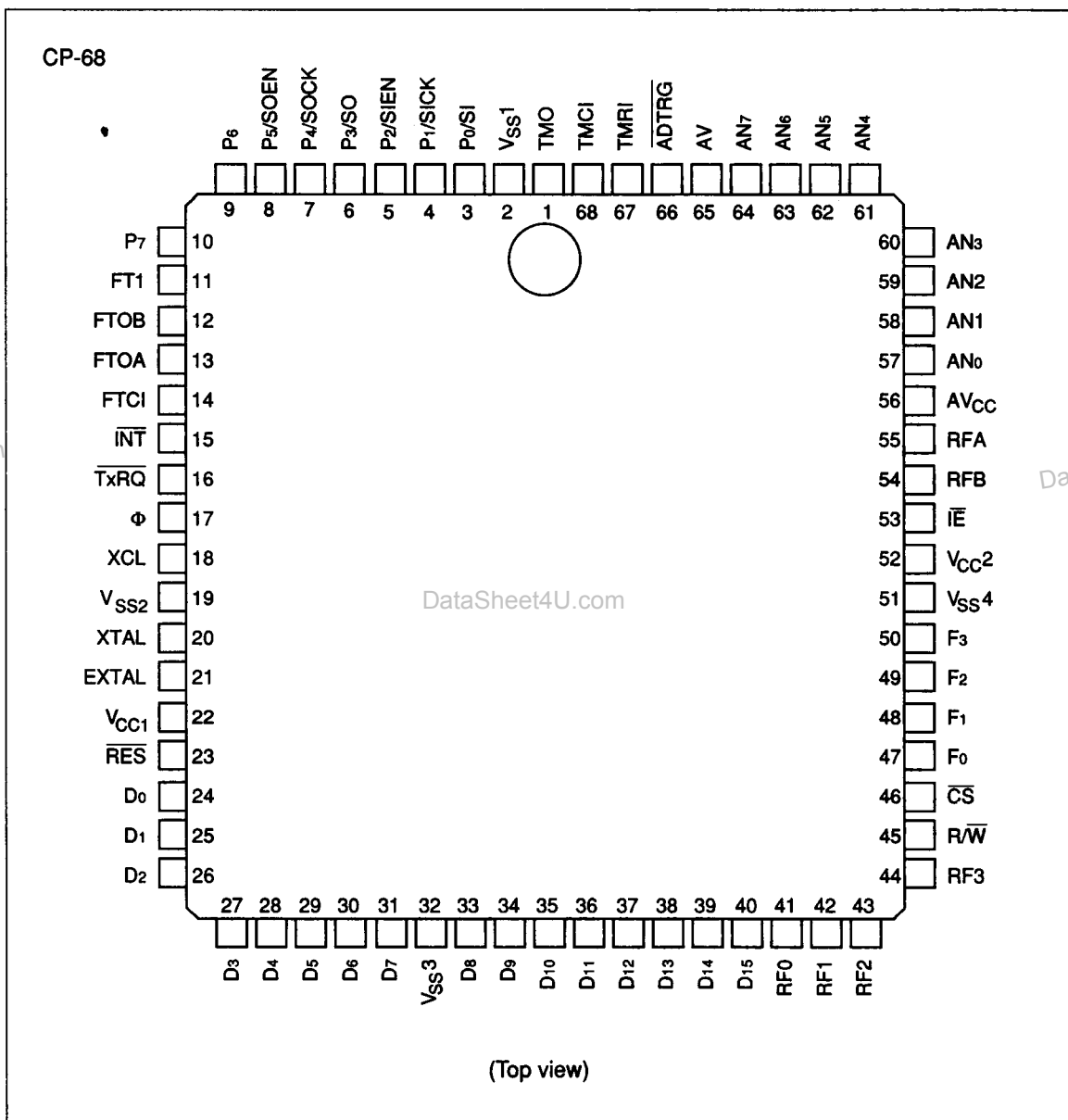
- Fixed-point (16-bit) and floating-point (16-bit mantissa and 4-bit exponent) operations
- Internal high-speed floating-point ALU (100 ns) and floating-point multiplier (16-bit + 4-bit)
- Pipelining and horizontal micro-instructions for high throughput
- 32-bit dynamic range for floating-point operations
- Large-capacity memories on chip:
  - Instruction: 2048 words × 22 bits
  - Data RAM: 512 words × 20 bits
  - Data ROM: 512 words × 20 bits
- 8/16-bit microcomputer interface
- 16-bit free running timer
  - Input capture × 1
  - Output compare × 2
- 8-bit Timer
  - Time constant register × 2
- 8-bit A/D converter (8ch)
- 8-bit I/O port
- 16-bit serial I/O
- Built-in oscillator circuit same as machine cycle and reducing high frequency noise
- Parallel I/O allowing internal registers (PC and CTR) to be set externally
- Up to four nesting levels for subroutines and interrupts
- I/O, peripheral module, and external interrupt
- 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

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summation operations to be programmed efficiently

- Run on single +5 V power supply
- Low power dissipation: 200 mW Typ

### Pin Arrangement



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

Item	Execution time	Remarks
Addition/ Subtraction	100 ns	These operations can be performed parallel
Multiplication	100 ns	
Inversion	2.8 $\mu$ s	
Division	4.0 $\mu$ s	Inversion is used
$\sqrt{X}$	7.4 $\mu$ s	
SIN (X), COS (X)	2.8 $\mu$ s	Program calculating both sine and cosine simultaneously
TAN (X)	6.8 $\mu$ s	

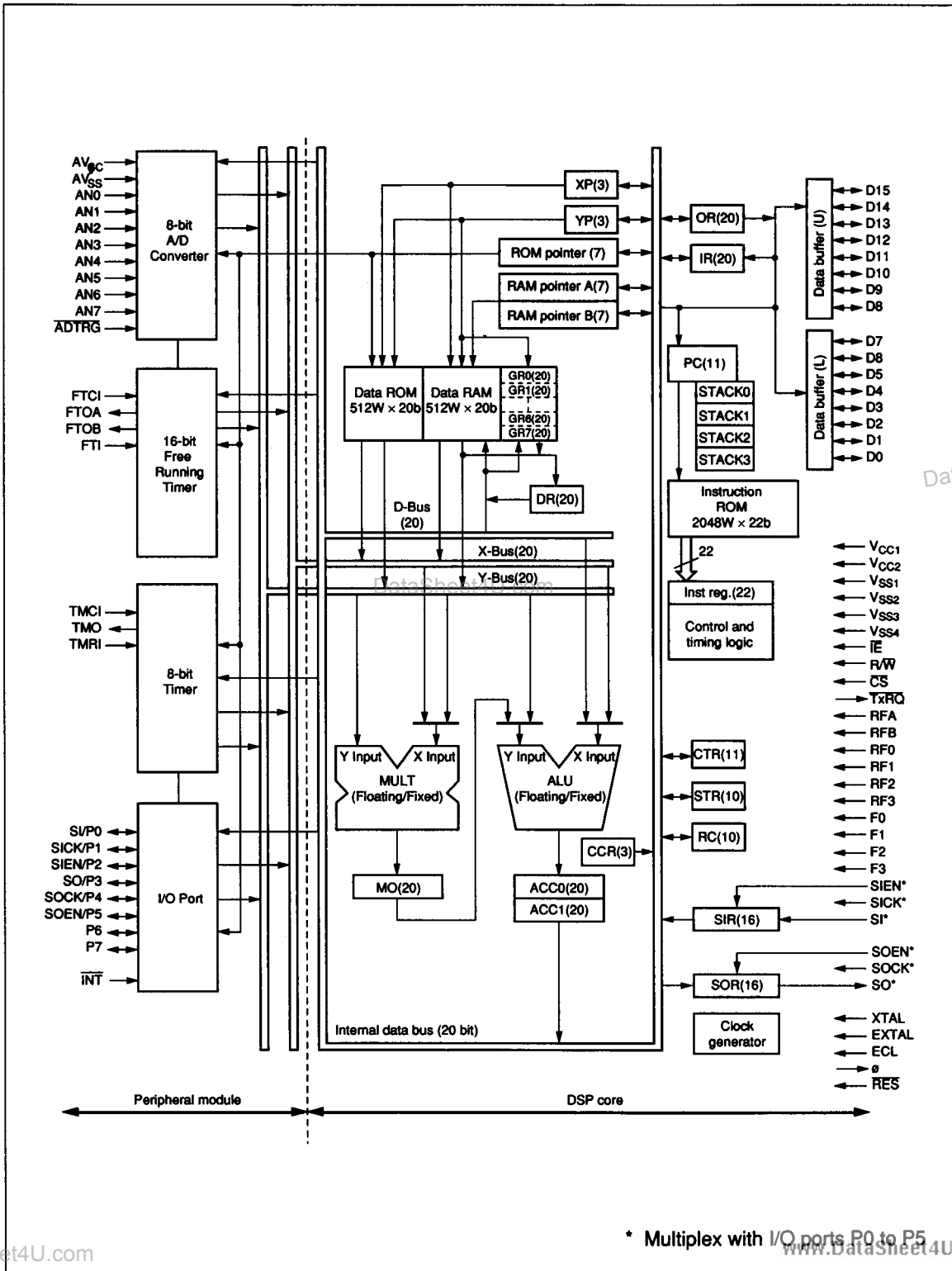
**Signal Processing**

Item	Execution time	Remarks
Transversal filter	0.1 $\mu$ s/TAP	
Biquad filter	0.6 $\mu$ s/ element	
256-point complex FET	1.92 ms	Loop operation
Matrix (3 $\times$ 3)	1.5 $\mu$ s	

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## Block Diagram

The block diagram of DSP-E/232 consists of DSP-E core and peripheral module.



Absolute Maximum Ratings ( $V_{SS} = AV_{SS} = 0\text{ V}$ )

Item	Symbol	Ratings	Unit	Remarks
Supply voltage	$V_{CC}$	-0.3 to +7.0	V	
Terminal voltage	$V_{in}$	-0.3 to $V_{CC} + 0.3$	V	
Operating temperature	$T_{opr}$	-20 to +75	°C	Normal
		-40 to +85	°C	Wide range
Storage temperature	$T_{stg}$	-55 to +150	°C	
Program voltage	$V_{PP}$	-0.3 to +13.5	V	
Analog supply voltage	$AV_{CC}$	-0.3 to +7.0	V	
Analog input voltage	$AV_{in}$	-0.3 to $AV_{CC} + 0.3$	V	

## Electrical Characteristics

## • DC characteristics

( $V_{CC} = AV_{CC} = 5.0\text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ , Normal temperature range:  $T_a = -20$  to  $+75^\circ\text{C}$ , Wide temperature range unit:  $T_a = -40$  to  $+85^\circ\text{C}$  unless otherwise specified)

Item	Applicable Pin	Symbol	Min	Typ	Max	Unit	Test Conditions
Input high voltage	$D_0$ to $D_{15}$	$V_{IH}$	$V_{CC} \times 0.7$	—	$V_{CC} + 0.3$	V	
	IE, SICK, SOCK FTCI, TMCI		$V_{CC} \times 0.7$	—	$V_{CC} + 0.3$	V	
	*1		$V_{CC} \times 0.7$	—	$V_{CC} + 0.3$	V	
	RES, RF0 to RF3, RFA, RFB		$V_{CC} \times 0.7$	—	$V_{CC} + 0.3$	V	
Input low voltage	$D_0$ to $D_{15}$	$V_{IL}$	-0.3	—	0.4	V	
	IE, SICK, SOCK FTCI, TMCI		-0.3	—	0.4	V	
	*1		-0.3	—	0.4	V	
	RES, RF0 to RF3, RFA, RFB		-0.3	—	0.4	V	
Input leak current	IE, INT, ADTRG, CS, RES, R/W, TMCI, TMRI, FTCI, FTI, F <sub>0</sub> to F <sub>3</sub> , RFA, RF0 to RF3	$ I_{IL} $	—	—	10	μA	$V_{in} = 0.4$ to $2.4\text{ V}$
Three state current (off)	$D_0$ to $D_{15}$ , P <sub>0</sub> to P <sub>7</sub> , SO	$ I_{TS} $	—	—	10	μA	$V_{in} = 0.4$ to $2.4\text{ V}$
Input pull-up MOS current	P <sub>0</sub> to P <sub>7</sub>	$-I_P$	50	—	200	μA	$V_{CC} = 5.0\text{ V}$ $V_{in} = 0\text{ V}$
Open drain current (off)	TxRQ	$ I_{LOH} $	—	—	10	μA	$V_{in} = 0.4$ to $2.4\text{ V}$
Output high voltage	$D_0$ to $D_{15}$ , P <sub>0</sub> to P <sub>7</sub> , TMO, FTOA, FTOB	$V_{OH}$	$V_{CC} \times 0.8$	—	—	V	$-I_{OH} = 400\text{ μA}$

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- DC characteristics (cont)

( $V_{CC} = AV_{CC} = 5.0 \text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0 \text{ V}$ , Normal temperature range:  $T_a = -20$  to  $+75^\circ\text{C}$ , Wide temperature range unit:  $T_a = -40$  to  $+85^\circ\text{C}$  unless otherwise specified)

Item	Applicable Pin	Symbol	Min	Typ	Max	Unit	Test Conditions
Output low voltage	D <sub>0</sub> to D <sub>15</sub> , P <sub>0</sub> to P <sub>7</sub> , TMO, FTOA, FTOB	V <sub>OL</sub>	—	—	0.8	V	I <sub>OL</sub> = 1.6 mA
	TxRQ		—	—	0.8	V	I <sub>OL</sub> = 1.6 mA
Input capacitance	F3, TMRI	C <sub>in</sub>	—	—	50	pF	V <sub>in</sub> = 0 V, f =
	Other input		—	—	12.5	pF	1 MHz, T <sub>a</sub> = 25°C
Consumption current		I <sub>CC</sub>	—	—	150	mA	Output no load

Note: 1. IE, INT, ADTRG, CS, RES, R/W, TMCI, TMRI, FTCL, FTI, F<sub>0</sub> to F<sub>3</sub>, RFA-B, RF0 to RF3, D<sub>0</sub> to D<sub>15</sub>, P<sub>0</sub> to P<sub>7</sub>, SI, SIEN, SOEN