Introduction 9800 Calculator

Several advantages from calculator

small, seltcontained, easily transportered,
they can be brought directly to the user's desk.
Are quiet,
and fit easily into a laboratory or office no complicate power on procedure
are friendly
provide immediate feedback and answers dedicated to their user.

The 9800 series is a line of powerful programmable calculator and an extensive set of calculator peripherals.

so designed to cover a broad range of applications
a choice of calculator that are flexible and expandable
with comprehensive applications software and peripherals.

The 9800 series is the successor of the 9100 A/B

HP's first programmable calculator
as powerful as the limit of technology at the
time of their conception

Models of the 9800 series:

Model 10

- key-per-function calculator
- keyboard and language are extensions of the 9100A/B.
- three register numeric display like the 9100 but use seven sengment light-emitting diode.

Model 20/21

- statement-oriented algebraic language

- no special register for variables
- no keep track of temporary results
- enter arithmetic expressions in the same order as he would read them
- allows implied multiplications
- display
- display of 16 alphanumeric characters
- display the whole statement at a time
- alphanumeric display can be used during program execution to display commanda and instinations as well as numeric results
- difference model 20 - 21 is the cardreader change by cassette.

Model 30

- keyboard is alphanumeric, like a typewriter
- display is 32 - character alphanumeric for enter text and messages
- Basic is the programming language
- Basic is easy to learn, designed for use in interactive environments.

ELECTRONICS

9800 Series

- general elektronics for all 4 calculators
- CPU (Central processing unit) is mikroprogrammed, 16 bit serial processor that implements a general computer machine language
- firmeware routines are implemented the three separate keyboard languages and the arithmetic routines, stored in MOS - Read-only-memory.

- *User programs are stored in MOS - Read-write-memory.*

- *Input /output structure is a general purpose system which makes it possible to interface with a wide variety of peripherals.*

Some important Peripherals

9860A Card Reader

9862A X-Y Plotter

9863A Mechanical Paper Tape Reader

9864A Digitizer

9865A Magnetic Tape Cassette

9866A Thermal line printer

9869A Hopper Fed. Card Reader

9871A Printer

9880B Mass Memory

11285A Data communications Interface

Add on ROMS

- *flexibility and expandability of the keyboard and programming languages.*
- *user can select the language features that are required by his particular discipline*

Model 10

- *3 ROM blocks of up to 2048 bytes each may be added to the calculator*
- *first block is used to define and implement the functions of a set of 15 keys*
- *second and third blocks are control of internal and external peripheral.*

Model 20/21

- *three blocks may be added*
- *each controlling one of the three sets of ten keys*

Model 30

- *eight blocks may be added*

- no special keys must be required (alphanumeric)
- ROMS accessed through mnemonics which entered as a sequence of alphabetic character.

Different Models

Model 10

- low cost
- compatibility with 9100A/B which is the basic for an extensive applications program library
- surveying and statistic applications packages for the 9100, have been updated and expanded for the model 10.

Model 20

- for users, who want to do their own programming
- editing features
- program flags and relativ addressing
- use as a controller in instrumentation systems.

Model 30

- large memory
- arry-variable capability
- built in tape cassettes
- for user with large programs and data bases
- alphanumeric keyboard
- string variable capability
- page width printer
- for users in scientific,education and business
- many users know the basic language
- with a Therminal ROM, time share user can transform the Model 30 into a versatile terminal.

By all three calculators the user can specify a system of optional ROMs, peripherals and read/write memory size to meet his own need.

- user definable keys
- programs loaded from a cardreader or tape cassette

THEORY OF OPERATION

A) Central Processing Unit
B) Memory unit
C) Input/output units

A) the central processing unit

16 bit serial processor that is capable of executing
75 basic machine-language instructions.

- perform logical and binary or decimal arithmetic operations on data in the working registers
- controls the data flow between memory and working registers
- performs logical decisions based on the states of 16 qualifiers, operation codes in machine-language instructions.
- controlls the internal clock for variable-cycle time microprogram steps
- transfers control to the I/O controller for input and output instruction execution

Processing unit is implemented with MSI bipolar logic circuitry.

In these ROMs are stored

- control of the processor, the memory, I/O unit.

The mikroprocessor executes machine-language instructions in cycles by following these microprograms.

Important to note: two levels of ROMs in the 9800 Calc.

1) MOS ROMs (part of memory system)

- keystrokes or user program statements initiate sequences of machine-language instructions

2) Bipolar ROM (part of mikroprocessor)

- each from 75 machine-language instructions stored in these ROMs.

7 Bipolar ROMs organized in 256 words of 28 bits 8 MHz clock frequency.

Fig. 1 Processor organization features

- three buses
- five working registers
- mikroprocessor
- arithmetic/logic unit

The bus configuration

R and S bus carry date to ALU

T bus carries ALU output

The working registers

P - Register - program counter
- control the ship and jump function
- successive instructions to be read out of the memory
- used for simplify digit and word counter

A - Register - Accumulator binary and dec. Operation

B - Register - " decimal arithmetic

E - Register - flexible four-bit extension of all other registers.

Q - Register - for program instruction currently being executed.
the individual bits can be tested as an qualifier
to perform microprogramming branching
for temporary storage of internal processor
information.

The programmable clock - Masterclock
Shiftclock
Romclock

The ALU (binary/BCD arithmetic logic unit)

performs - one-bit binary logic and arithmetic operation

Fig. 2 - four bit binary-coded-decimal arithmetic operations

Two bipolar ROM with 1024 bit oranisated 256 x 4

The mikroprocessor
- a state machine
- Primary and secondary address flip-flops form a microprogram counter, which selects the memory location
- 7 Bipolar ROMs, stored microinstruction
- 28 Bit wide each mikroinstruction
- control the data flow
- generated the proper number of shift clock pulses.

Fig. 3

B) Memory Unit

ROM and RWM needed the processor for its tasks
Information are delay program steps or instruction
ROM used for permanent storage of machine-language
instructions, the calculators language
RWM used for data and programs from the user

Memory system

- is an parallel-in and out device
- must have support electronics
  interface the memory to processor
  these are two 16 Bit shift Registers and a control system.

Registers called	M - Register	Addressing the memory
	T - Register	temporary store for the word being written or read from memory.

ROM
- build and design by HP
- compatible with TTL for input and output
- fabricated on a 0.107 x 0.110 siliconchip
- 4096 programmable bits per chip
- organized as 512 words of 8 bits
- static devices
- comsum no power when they are not enable
- used 12V for chi-enable input

RWM
- 1024 bit dynamic chip (Intel 1103)
- p-channel MOS chip uses silicon-gate technology
- refreshed every two milliseconds
- 32 refresh amplifies are refreshed with each read
- 32 milliseconds and the refresh is accomplish
- logic levels on all inputs 0 and + 16V for address lines, three clock lines, data input line
- sense amplifies brings output data (600 microamperes max.) to the TTL level.

Two techniques in organizing the chips

Model 20 and 30 used 16 chips in parallel to build a 1024-word-by-16 bit block of Memory

Model 10 use eight chips in parallel and access each chip twice per memory cycle. The multiplexing of chips allows each block of memory to be 512 words by 16 bits.

Memory System Operation

Memory System - *direct control by the mikroprocessor*
- *control M-Register*
- *chip enable decoder*
- *adress - buffer gate*
- *Read or Write Instruction*

Memory cycle - *Read/Write instruction and 12 clock pulses from system clock*

Memory control - *makes the address available to the memory during the entire memory cycle*
- *used clock pulses*
- *generate the timing signals for ROM and TWM*

Read cycle - *memory control allows the T-Reg. to accept parallel data from the memory*

Write cycle - *Word stored in T-Reg.*
- *appear at the inputs to all RW-chips*

C. I/O Units

The I/O structure of 9800 serie - *versatile and easy to use*
- *interface HP peripherals*
- *standard units*
- *users own design*

I/O Processor

- *is a self-contained microprocessor composed of commercially available TTL logic circuits*
- *generate the mikroinstruction*
- *ten input/output instructions*
- *fully synchronous with system block and main processor*
- *I/O instruction require six to twelve microseconds to execute*

I/O instructions

- *setting or clearing fli-flops*
- *moving data between registers in main processor and the input/output register*

I/O Register

- *16 bit universal data register serial in /out, parallel in/out*

- *16 bit parallel output provide the source for an output information bus structure which is common to all connecting peripherals*

- *input information is received via an input information bus structure terminated by the twelve least-significant parallel inputs of the I/O Register.*

Handshake methode

- *CEO from Calculator*
- *Flag from Peripheral*

Interrupt methode

- *peripheral interrupt the calculator*
- *Calculator stopped and disable all other peripheral (Keyboard, Marked - Cardreader statusbits from Tapecassette.*

Internal Peripheral - Keyboard
- Display
- Magnetic-card storage
- Thermal printer
- I/O-Register

External Peripheral - connected to the calculator by an external signal cable
- addressed indirectly from the I/O Register
- the driver is contained in a plug in ROM.

Peripheral Communication

All peripherals are addressed by the I/O instructions. Therefore, the receiving peripherals have access to the full 16 bit field of the I/O register. The internal peripheral has its own control and flag logic. The external peripheral requires that a 16 bit word be formed in the processor.

Channel code bit - bit 16 - 13 address-bit
Status bit - bit 12 - 9
Data bit - bit 8 - 0

Select-code - max. 15 different address
- 10 - 15 fixed
- 1 - 9 variable
selected by jumper wires or switch on a peripheral interface card
- basic calculator has 4 slots for Peripheral.