

## COP820CP-X/COP840CP-X Piggyback EPROM Microcontrollers

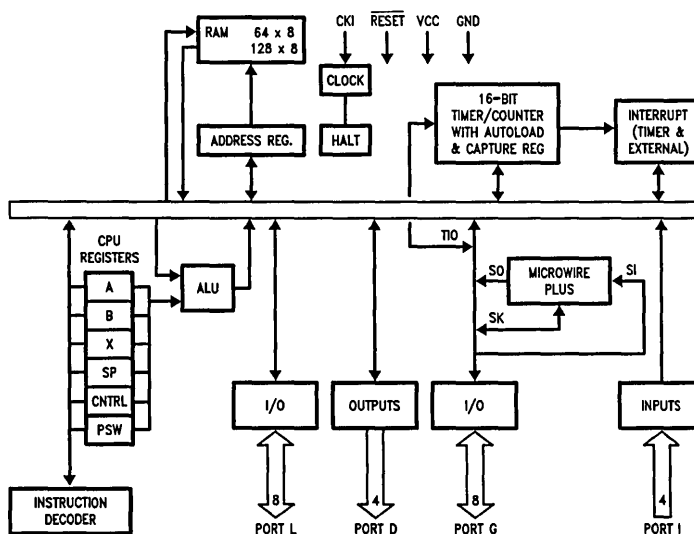
### General Description

The COP820CP/COP840CP are piggyback versions of the COP820C/COP840C microcontroller families. They are fully static parts, fabricated using double-metal silicon gate microCMOS technology. These microcontrollers are a complete microcomputer containing all system timing, interrupt logic, RAM, and I/O necessary to implement dedicated control functions in a variety of applications. Features include an 8-bit memory mapped architecture, MICROWIRE/PLUSTM serial I/O, a 16-bit timer/counter with capture register and a multi-sourced interrupt. Each I/O pin has software selectable options to adapt the emulator to the specific application. The part operates over a voltage range of 4.5V to 5.5V. High throughput is achieved with an efficient, regular instruction set operating at a 1  $\mu$ s per instruction rate. The COP820CP-X/COP840CP-X are totally compatible with the ROM based COP820C/COP840C microcontroller. It serves as an economical low and medium volume emulator devices for the COP820C/COP840C microcontroller family.

### Features

- Low cost 8-bit CORE microcontroller
- Fully static CMOS
- 1  $\mu$ s instruction time (20 MHz clock)
- Low current drain
- Single supply operation: 4.5V to 5.5V
- Up to 32 kbytes of addressable memory
- 64 bytes of RAM (128 bytes for COP840CP)
- 16-bit read/write timer operates in a variety of modes
  - Timer with 16-bit auto reload register
  - 16-bit external event counter
  - Timer with 16-bit capture register (selectable edge)
- Multi-source interrupt
  - Reset master clear
  - External interrupt with selectable edge
  - Timer interrupt or capture interrupt
  - Software interrupt
- 8-bit stack pointer (stack in RAM)
- Powerful instruction set, most instructions single byte
- BCD arithmetic instruction
- MICROWIRE/PLUS serial I/O
- 28 pin package
- 24 input/output pins (28-pin package)
- Software selectable I/O options (TRI-STATE®, push-pull, weak pull-up)
- Schmitt trigger inputs on Port G
- Fully supported by National's MOLE™ development system

### Block Diagram



**FIGURE 1**

TL/DD/9683-1

## Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|                                          |                            |
|------------------------------------------|----------------------------|
| Supply Voltage ( $V_{CC}$ )              | 6V                         |
| Voltage at Any Pin                       | $-0.3V$ to $V_{CC} + 0.3V$ |
| Total Current into $V_{CC}$ Pin (Source) | 150 mA                     |

|                                   |                                                 |
|-----------------------------------|-------------------------------------------------|
| Total Current into GND Pin (Sink) | 160 mA                                          |
| Storage Temperature Range         | $-65^{\circ}\text{C}$ to $+140^{\circ}\text{C}$ |

Note: *Absolute maximum ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications are not ensured when operating the device at absolute maximum ratings.*

## DC Electrical Characteristics $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ unless otherwise specified

| Parameter                             | Condition                                               | Min          | Typ           | Max          | Units   |
|---------------------------------------|---------------------------------------------------------|--------------|---------------|--------------|---------|
| Operating Voltage                     |                                                         | 4.5          |               | 5.5          | V       |
| Power Supply Ripple (Note 1)          | Peak to Peak                                            |              |               | 0.1 $V_{CC}$ | V       |
| Supply Current (Note 2)               |                                                         |              |               |              |         |
| High Speed Mode, CKI = 20 MHz         | $V_{CC} = 5.5V, t_C = 1 \mu s$                          |              |               | 95           | mA      |
| Normal Mode, CKI = 5 MHz              | $V_{CC} = 5.5V, t_C = 2 \mu s$                          |              |               | 90           | mA      |
| HALT Current (Note 3)                 | $V_{CC} = 5.5V, \text{CKI} = 0 \text{ MHz}$<br>(Note 4) |              |               | 80           | mA      |
| INPUT LEVELS                          |                                                         |              |               |              |         |
| Reset and CKI (Crystal Osc.)          |                                                         |              |               |              |         |
| Logic High                            |                                                         | 0.9 $V_{CC}$ |               |              | V       |
| Logic Low                             |                                                         |              |               | 0.1 $V_{CC}$ | V       |
| All Other Inputs                      |                                                         |              |               |              |         |
| Logic High                            |                                                         | 0.7 $V_{CC}$ |               |              | V       |
| Logic Low                             |                                                         |              |               | 0.2 $V_{CC}$ | V       |
| Hi-Z Input Leakage                    | $V_{CC} = 5.5V$                                         | -10          |               | +10          | $\mu A$ |
| G and L Port Input Hysteresis         | $V_{CC} = 5.5V$                                         |              | 0.05 $V_{CC}$ |              | V       |
| Output Current Levels                 |                                                         |              |               |              |         |
| D Outputs                             |                                                         |              |               |              |         |
| Source                                | $V_{CC} = 4.5V, V_{OH} = 3.8V$                          | 0.4          |               |              | mA      |
| Sink                                  | $V_{CC} = 4.5V, V_{OL} = 1.0V$                          | 10           |               |              | mA      |
| All Others                            |                                                         |              |               |              |         |
| Source (Weak Pull-Up Mode)            | $V_{CC} = 4.5V, V_{OH} = 3.2V$                          | 10           |               | 100          | $\mu A$ |
| Source (Push-Pull Mode)               | $V_{CC} = 4.5V, V_{OH} = 3.8V$                          | 0.4          |               |              | mA      |
| Sink (Push-Pull Mode)                 | $V_{CC} = 4.5V, V_{OL} = 0.4V$                          | 1.6          |               |              | mA      |
| TRI-STATE Leakage                     | $V_{CC} = 5.5V$                                         | -2.0         |               | +2.0         | $\mu A$ |
| Allowable Sink/Source Current per Pin |                                                         |              |               |              |         |
| D Outputs (Sink)                      |                                                         |              |               | 15           | mA      |
| All Others                            |                                                         |              |               | 3            | mA      |
| RAM Retention Voltage, $V_r$          | 500 ns<br>Rise and Fall Time (Min)                      |              | 2.0           |              | V       |
| Input Capacitance                     |                                                         |              |               | 7            | pF      |
| Load Capacitance on D2                |                                                         |              |               | 1000         | pF      |

**AC Electrical Characteristics**  $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$  unless otherwise specified

| Parameter                                        | Condition                                | Min | Typ | Max | Units         |
|--------------------------------------------------|------------------------------------------|-----|-----|-----|---------------|
| Instruction Cycle Time ( $t_c$ )                 |                                          |     |     |     |               |
| High Speed Mode<br>(Div-by 20)                   | $V_{CC} \geq 4.5\text{V}$                | 1   |     | DC  | $\mu\text{s}$ |
| Normal Mode<br>(Div-by 10)                       | $V_{CC} \geq 4.5\text{V}$                | 2   |     | DC  | $\mu\text{s}$ |
| R/C Oscillator Mode<br>(Div-by 10)               | $V_{CC} \geq 4.5\text{V}$                | 3   |     | DC  | $\mu\text{s}$ |
| CKI Clock Duty Cycle<br>(Note 5)                 | $f_r = \text{Max}$                       | 33  |     | 66  | %             |
| Rise Time (Note 5)                               | $f_r = 20\text{ MHz Ext Clock}$          |     |     | 12  | ns            |
| Fall Time (Note 5)                               | $f_r = 20\text{ MHz Ext Clock}$          |     |     | 8   | ns            |
| Inputs                                           |                                          |     |     |     |               |
| $t_{\text{SETUP}}$                               | $V_{CC} \geq 4.5\text{V}$                | 200 |     |     | ns            |
| $t_{\text{HOLD}}$                                | $V_{CC} \geq 4.5\text{V}$                | 60  |     |     | ns            |
| Output Propagation Delay                         | $R_L = 2.2\text{k}, C_L = 100\text{ pF}$ |     |     |     |               |
| $t_{PD1}, t_{PD0}$ (Note 6)                      |                                          |     |     |     |               |
| SO, SK                                           | $V_{CC} \geq 4.5\text{V}$                |     |     | 0.7 | $\mu\text{s}$ |
| All Others                                       | $V_{CC} \geq 4.5\text{V}$                |     |     | 1   | $\mu\text{s}$ |
| MICROWIRE™ Setup Time ( $t_{\text{UWS}}$ )       |                                          | 20  |     |     | ns            |
| MICROWIRE Hold Time ( $t_{\text{UWH}}$ )         |                                          | 56  |     |     | ns            |
| MICROWIRE Output Valid Time ( $t_{\text{UPD}}$ ) |                                          |     |     | 220 | ns            |
| Input Pulse Width                                |                                          |     |     |     |               |
| Interrupt Input High Time                        |                                          | 1   |     |     | $t_c$         |
| Interrupt Input Low Time                         |                                          | 1   |     |     | $t_c$         |
| Timer Input High Time                            |                                          | 1   |     |     | $t_c$         |
| Timer Input Low Time                             |                                          | 1   |     |     | $t_c$         |
| Reset Pulse Width                                |                                          | 1   |     |     | $\mu\text{s}$ |

**Note 1:** The rate of voltage change must be less than 0.5 V/ms.

**Note 2:** Supply current is measured after running 2000 cycles with a square wave CKI input, CKO open, inputs at rails and outputs open.

**Note 3:** The HALT mode will stop CKI from oscillating in the RC and the Crystal configurations. Test conditions: All inputs tied to  $V_{CC}$ , L and G ports in the TRI-STATE mode and tied to ground, all outputs low and tied to ground.

**Note 4:** This includes the EPROM, and the pull-up resistors on the D and I ports.

**Note 5:** Parameter sampled but not 100% tested.

**Note 6:** There is one cycle delay on ports I and D.

## EPROM Selection

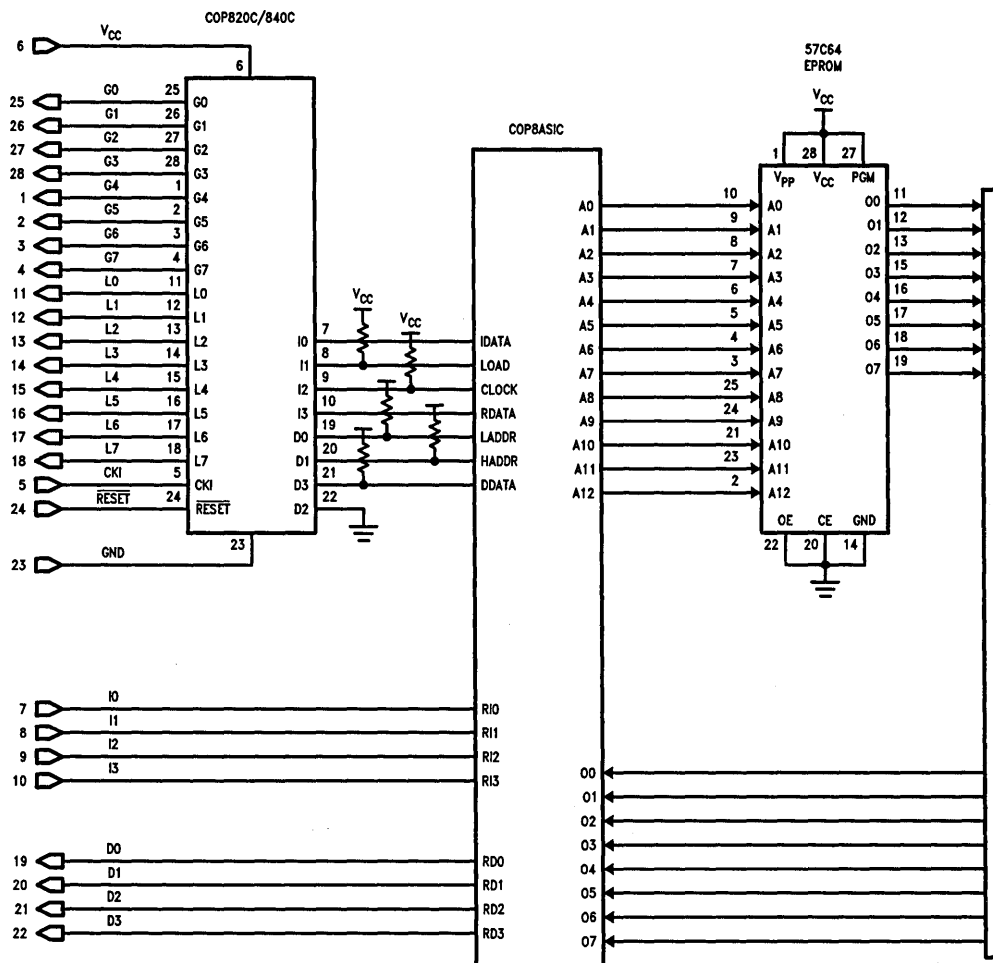
The COP820CP-X/COP840CP-X, (where X = 1, 2, 3, 4 or 5, see Table I), are the piggyback versions of the COP820C/COP840C microcontrollers. They are identical to their respective devices except that the program memory has been removed. The device package incorporates the circuitry and the socket on top of the package to allow plugging-in the EPROM 57C64, an 8 kbyte device, or any other comparable EPROM, for high speed operation. With the addition of an EPROM, these devices will perform exactly as their factory masked equivalent.

Table I lists the minimum EPROM access time for a given instruction cycle time of the microcontroller.

**TABLE I**

| EPROM Minimum Access Time | COP8 Instruction Cycle Time |
|---------------------------|-----------------------------|
| 120 ns                    | 1.00 $\mu\text{s}$          |
| 150 ns                    | 1.10 $\mu\text{s}$          |
| 200 ns                    | 1.27 $\mu\text{s}$          |
| 250 ns                    | 1.44 $\mu\text{s}$          |
| 300 ns                    | 1.60 $\mu\text{s}$          |
| 400 ns                    | 1.94 $\mu\text{s}$          |

# Connection Diagram

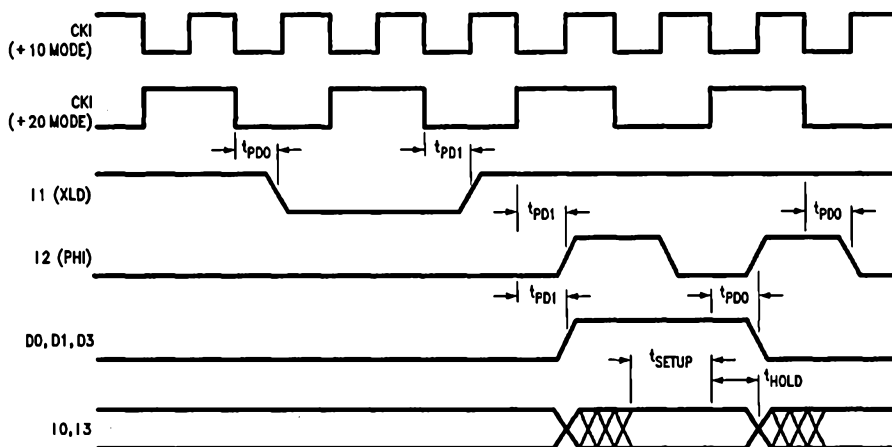


All resistors are 330Ω ± 20%

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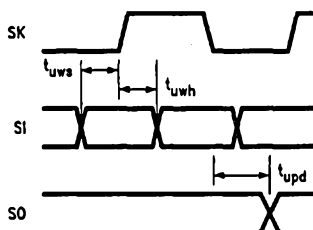
FIGURE 2

## AC Timing Diagram



TL/DD/9683-3

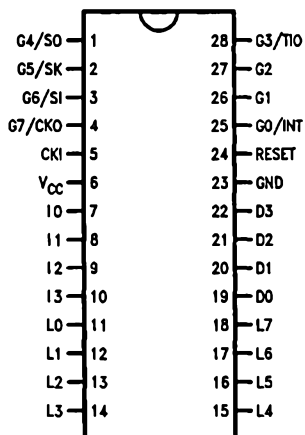
FIGURE 3



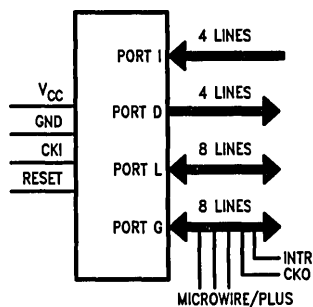
TL/DD/9683-10

FIGURE 3b

## COP820CP-X/COP840CP-X Pinout Diagrams



TL/DD/9683-4



TL/DD/9683-5

Order Number COP820CP-X or COP840CP-X

FIGURE 4

## Oscillator Circuits

Figure 5 shows the clock oscillator configurations available for the COP820CP-X/COP840CP-X.

### A. CRYSTAL OSCILLATOR

The COP820CP-X/COP840CP-X can be driven by a crystal clock. The crystal network is connected between the pins CKI and CKO.

Table IA shows the component values required for various standard crystal values.

### B. EXTERNAL OSCILLATOR

CKI can be driven by an external clock signal. CKO is available as a general purpose input and/or HALT restart control.

### C. RC OSCILLATOR

CKI is configured as a single pin RC controlled Schmitt trigger oscillator. CKO is available as a general purpose input and/or HALT control.

Table IB shows the variation in the oscillator frequencies as functions of the R and C component values.

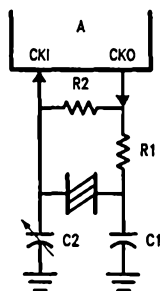
TABLE IA. Crystal Oscillator Configuration,  $T_A = 25^\circ\text{C}$

| R1<br>(k $\Omega$ ) | R2<br>(M $\Omega$ ) | C1<br>(pF) | C2<br>(pF) | CKI Freq<br>(MHz) | Conditions           |
|---------------------|---------------------|------------|------------|-------------------|----------------------|
| 0                   | 1                   | 30         | 30–36      | 20                | $V_{CC} = 5\text{V}$ |
| 0                   | 1                   | 30         | 30–36      | 10                | $V_{CC} = 5\text{V}$ |
| 0                   | 1                   | 30         | 30         | 20 ( $\div 20$ )  | $V_{CC} = 5\text{V}$ |

TABLE IB. RC Oscillator Configuration,  $T_A = 25^\circ\text{C}$

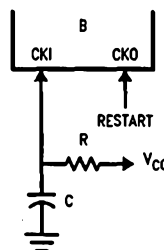
| R<br>(k $\Omega$ ) | C<br>(pF) | CKI Freq.<br>(MHz) | Instr. Cycle<br>( $\mu\text{s}$ ) | Conditions           |
|--------------------|-----------|--------------------|-----------------------------------|----------------------|
| 3.3                | 82        | 2.8–2.2            | 3.6 to 4.5                        | $V_{CC} = 5\text{V}$ |
| 5.6                | 100       | 1.5–1.1            | 6.7 to 9                          | $V_{CC} = 5\text{V}$ |

Crystal Oscillator



TL/DD/9683-6

RC Oscillator



TL/DD/9683-7

FIGURE 5. Crystal and RC Oscillator Connection Diagrams

TABLE II. Clock Options Per Package

| X | Order Part Number     | Clock Option                                        |
|---|-----------------------|-----------------------------------------------------|
| 1 | COP820CP-1/COP840CP-1 | Crystal Oscillator Divide by 10 Option              |
| 2 | COP820CP-2/COP840CP-2 | External Oscillator Divide by 10 Option             |
| 3 | COP820CP-3/COP840CP-3 | RC Oscillator Divide by 10 Option                   |
| 4 | COP820CP-4/COP840CP-4 | Crystal Oscillator Divide by 20 Option (High Speed) |
| 5 | COP820CP-5/COP840CP-5 | External Oscillator Divide by 20 Option             |

## COP820CP/840CP Dimensions Diagram

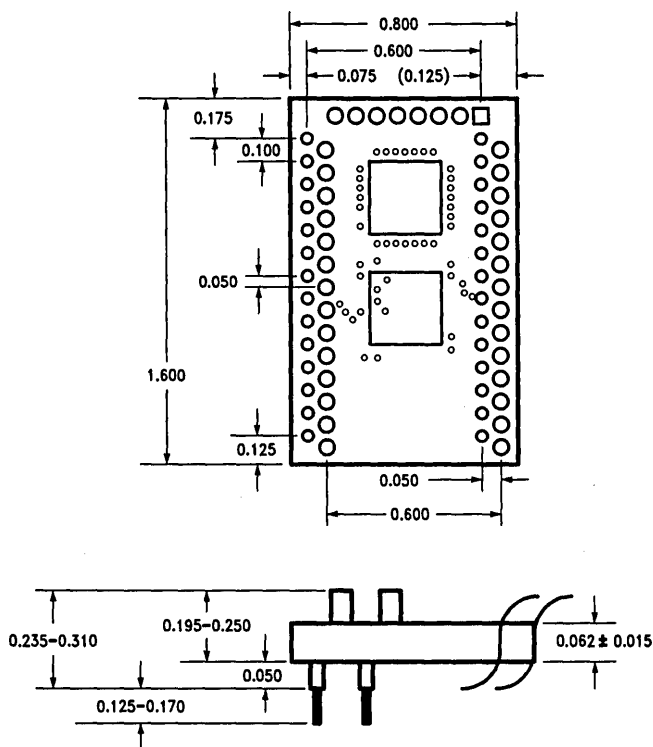


FIGURE 6

TL/DD/9683-8

## Development Support

### MOLE DEVELOPMENT SYSTEM

The MOLE (Microcomputer On Line Emulator) is a low cost development system and emulator for all microcontroller products. These include COPs and the HPC family of products. The MOLE consists of a BRAIN Board, Personality Board and optional host software.

The purpose of the MOLE is to provide the user with a tool to write and assemble code, emulate code for the target microcontroller and assist in both software and hardware debugging of the system.

It is a self contained computer with its own firmware which provides for all system operation, emulation control, communication, PROM programming and diagnostic operations.

It contains three serial ports to optionally connect to a terminal, a host system, a printer or a modem, or to connect to other MOLEs in a multi-MOLE environment.

MOLE can be used in either a stand alone mode or in conjunction with a selected host system using PC-DOS communicating via a RS-232 port.

### How to Order

To order a complete development package, select the section for the microcontroller to be developed and order the parts listed.

**Development Tools Selection Table**

| Microcontroller | Order Part Number | Description                | Includes                                       | Manual Number |
|-----------------|-------------------|----------------------------|------------------------------------------------|---------------|
| COP820C/COP840C | MOLE-BRAIN        | Brain Board                | Brain Board Users Manual                       | 420408188-001 |
|                 | MOLE-COP8-PB1     | Personality Board          | COP820/COP840 Personality Board Users Manual   | 420410806-001 |
|                 | MOLE-COP8-IBM     | Assembler Software for IBM | COP800 Software Users Manual and Software Disk | 424410527-001 |
|                 | 420410703-001     | Programmer's Manual        | PC-DOS Communications Software Users Manual    | 420040416-001 |
|                 |                   |                            |                                                | 420410703-001 |



**DIAL-A-HELPER**

Dial-A-Helper is a service provided by the Microcontroller Applications group. The Dial-A-Helper is an Electronic Bulletin Board Information System and additionally, provides the capability of remotely accessing the MOLE development system at a customer site.

**INFORMATION SYSTEM**

The Dial-A-Helper system provides access to an automated information storage and retrieval system that may be accessed over standard dial-up telephone lines 24 hours a day. The system capabilities include a MESSAGE SECTION (electronic mail) for communications to and from the Microcontroller Applications Group and a FILE SECTION which consists of several file areas where valuable application software and utilities could be found. The minimum requirement for accessing the Dial-A-Helper is a Hayes compatible modem.

If the user has a PC with a communications package then files from the FILE SECTION can be down loaded to disk for later use.

**Order P/N: MOLE-DIAL-A-HLP**

Information System Package Contains  
DIAL-A-HELPER Users Manual P/N  
Public Domain Communications Software

**FACTORY APPLICATIONS SUPPORT**

Dial-A-Helper also provides immediate factory applications support. If a user is having difficulty in operating a MOLE, he can leave messages on our electronic bulletin board, which we will respond to, or under extraordinary circumstances he can arrange for us to actually take control of his system via modem for debugging purposes.

Voice: (408) 721-5582

Modem: (408) 739-1162

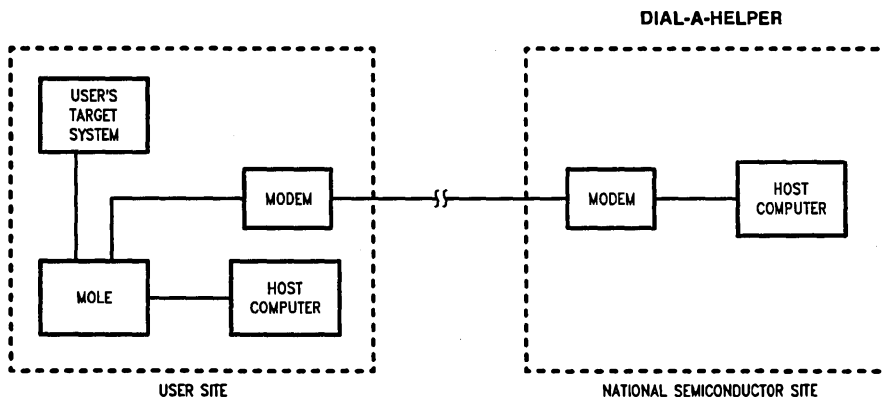
Baud: 300 or 1200 baud

Set-Up: Length: 8-bit

Parity: None

Stop bit: 1

Operation: 24 hrs., 7 days



TL/DD/9683-11