National Semiconductor

# COP820CJMH/COP822CJMH Single-Chip microCMOS Microcontroller

## General Description

The COP820CJMH and COP822CJMH hybrid emulators are members of the COPS™ microcontroller family. Each device is a two chip system in a dual cavity package. Within the package is the COP820CJ and a UV-erasable 8k EPROM with port recreation logic. The code executes out of the EPROM. The devices (offered in 28-pin DIP and 20-pin DIP packages) contain transparent windows which allow the EPROM to be erased and reprogrammed. The devices are fully static parts, fabricated using double-metal silicon gate microCMOS technology. Features include an 8-bit memory mapped architecture, MICROWIRE™ serial I/O, a 16-bit timer/counter with capture register, a multi-sourced interrupt, Comparator, WATCHDOG™ Timer, Modulator/Timer, and Multi-Input Wakeup. Each I/O pin has software selectable options to adapt the device to the specific application. The device operates over a voltage range of 4.5V to 6.0V. High throughput is achieved with an efficient, regular instruction set operating at a 1 μs per instruction rate.

COP820CJMH and COP822CJMH are intended primarily as a prototyping design tool. The Electrical Performance Characteristics are not tested but are included for reference only. These devices do not emulate the Brown Out feature.

## Features

- Form, fit and function emulation device for the COP820CJ/COP822CJ
- Fully static CMOS
- 1 μs instruction time
- Single supply operation: 4.5V to 6.0V
- 8191 x 8 on-chip ROM
- 64 bytes on-chip RAM
- WATCHDOG Timer
- Comparator
- Modulator/Timer (High speed PWM Timer for IR Transmission)
- Multi-Input Wakeup (on the 8-bit Port L)
- 4 high current I/O pins with 15 mA sink capability
- MICROWIRE/PLUS™ serial I/O
- 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
  - — 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 instructions
- 28- and 20-pin DIP
- Software selectable I/O options (TRI-STATE®, push-pull, weak pull-up)
- Schmitt trigger inputs on Port G and Port L

## Ordering Information

| Hybrid Emulator | Package Type | Part Emulated |
|---|---|---|
| COP820CJMHD-X | 28-Pin DIP | COP820CJ-XXX/N |
| COP822CJMHD-X | 20-Pin DIP | COP822CJ-XXX/N |

**Note:** X corresponds to clock options.
X = 1,2 or 3.
1 = crystal ÷ 10,
2 = External ÷ 10,
3 = R/C ÷ 10

# COP820CJMH/COP822CJMH

## Absolute Maximum Ratings

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

| | |
|---|---|
| Supply Voltage ($V_{CC}$) | 7.0V |
| Reset ($V_{PP}$) and G6 (ME) | −0.3V to 14V |
| Voltage at any Pin | −0.3V to $V_{CC}$ + 0.3V |
| Total Current into $V_{CC}$ pin (Source) | 80 mA |
| Total Current out of GND pin (sink) | 80 mA |
| Storage Temperature Range | −65°C to +150°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.*

The following AC and DC Electrical Characteristics are not tested but are for reference only.

## DC Electrical Characteristics $-40°C \le T_A \le +85°C$ unless otherwise specified

| Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Operating Voltage | Brown Out Disabled | 4.5 | | 6.0 | V |
| Power Supply Ripple 1 (Note 1) | Peak to Peak | | | 0.1 $V_{CC}$ | V |
| Supply Current (Note 2) | | | | | |
| CKI = 10 MHz | $V_{CC}$ = 6V, tc = 1 μs | | | 18.0 | mA |
| CKI = 4 MHz | $V_{CC}$ = 6V, tc = 2.5 μs | | | 16.0 | mA |
| HALT Current | $V_{CC}$ = 6V, CKI = 0 MHz | | 500 | | μA |
| INPUT LEVELS ($V_{IH}$, $V_{IL}$) | | | | | |
| Reset, CKI: | | | | | |
| Logic High | | 0.8 $V_{CC}$ | | | V |
| Logic Low | | | | 0.2 $V_{CC}$ | V |
| All Other Inputs | | | | | |
| Logic High | | 0.7 $V_{CC}$ | | | V |
| Logic Low | | | | 0.2 $V_{CC}$ | V |
| Hi-Z Input Leakage | $V_{CC}$ = 6.0V | −2 | | +2 | μA |
| Input Pullup Current | $V_{CC}$ = 6.0V | 40 | | 250 | μA |
| L- and G-Port Hysteresis | | | 0.05 $V_{CC}$ | 0.35 $V_{CC}$ | 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 |
| L4–L7 Output Sink | $V_{CC}$ = 4.5V, $V_{OL}$ = 2.5V | 15 | | | mA |
| All Others | | | | | |
| Source (Weak Pull-up Mode) | $V_{CC}$ = 4.5V, $V_{OH}$ = 3.2V | 10 | | 110 | μA |
| 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 | | −2.0 | | +2.0 | μA |
| Allowable Sink/Source Current Per Pin | | | | | |
| D Outputs | | | | 15 | mA |
| L4–L7 (Sink) | | | | 20 | mA |
| All Others | | | | 3 | mA |

## DC Electrical Characteristics $-40°C \le T_A \le +85°C$ unless otherwise specified (Continued)

| Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Maximum Input Current without Latchup (Note 4) | Room Temperature | | | ±100 | mA |
| RAM Retention Voltage, $V_r$ | 500 ns Rise and Fall Time (Min) | 2.0 | | | V |
| Input Capacitance | | | | 7 | pF |
| Load Capacitance on D2 | | | | 1000 | pF |

**Note 1:** Rate of voltage change must be less than 10 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 crystal configurations. HALT test conditions: L, and G0..G5 ports configured as outputs and set high. The D port set to zero. All inputs tied to $V_{CC}$. The comparator and the Brown Out circuits are disabled.

**Note 4:** Pins G6 and $\overline{\text{RESET}}$ are designed with a high voltage input network. These pins allow input voltages greater than $V_{CC}$ and the pins will have sink current to $V_{CC}$ when biased at voltages greater than $V_{CC}$ (the pins do not have source current when biased at a voltage below $V_{CC}$). The effective resistance to $V_{CC}$ is 750Ω (typical). These two pins will not latch up. The voltage at the pins must be limited to less than 14V.

## AC Electrical Characteristics $-40°C \le T_A \le +85°C$ unless otherwise specified

| Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Instruction Cycle Time (tc) | | | | | |
| Crystal/Resonator | $4.5V \le V_{CC} \le 6.0V$ | 1 | | DC | μs |
| R/C Oscillator | $4.5V \le V_{CC} \le 6.0V$ | 3 | | DC | μs |
| $V_{CC}$ Rise Time when Using Brown Out Frequency at Brown Out Reset CKI | | 50 | | | μs |
| Frequency For Modular Output | | | | 4 | MHz |
| | | | | 4 | MHz |
| CKI Clock Duty Cycle (Note 5) | fr = Max | 40 | | 60 | % |
| Rise Time (Note 5) | fr = 10 MHz ext. Clock | | | 12 | ns |
| Fall Time (Note 5) | fr = 10 MHz ext. Clock | | | 8 | ns |
| Inputs | | | | | |
| $t_{Setup}$ | $4.5V \le V_{CC} \le 6.0V$ | 200 | | | ns |
| $t_{Hold}$ | $4.5V \le V_{CC} \le 6.0V$ | 60 | | | ns |
| Output Propagation Delay $t_{PD1}$, $t_{PD0}$ | $R_L$ = 2.2k, CL = 100 pF | | | | |
| SO, SK | $4.5V \le V_{CC} \le 6.0V$ | | | 0.7 | μs |
| All Others | $4.5V \le V_{CC} \le 6.0V$ | | | 1 | μs |
| Input Pulse Width | | | | | |
| Interrupt Input High Time | | 1 | | | tc |
| Interrupt Input Low Time | | 1 | | | tc |
| Timer Input High Time | | 1 | | | tc |
| Timer Input Low Time | | 1 | | | tc |
| MICROWIRE Setup Time ($t_{\mu WS}$) | | 20 | | | ns |
| MICROWIRE Hold Time ($t_{\mu WH}$) | | 56 | | | ns |
| MICROWIRE Output Propagation Delay ($t_{\mu PD}$) | | | | 220 | ns |
| Reset Pulse Width | | 1.0 | | | μs |

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

## AC Electrical Characteristics (Continued)

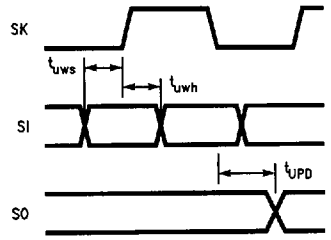


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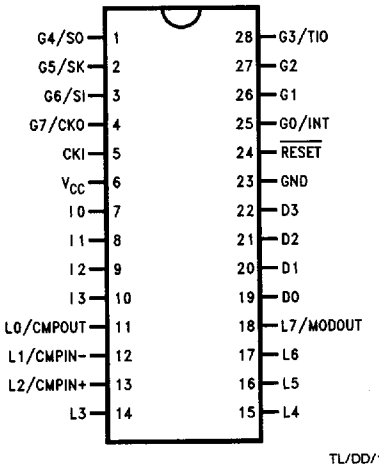
**FIGURE 1. MICROWIRE/PLUS Timing**

## COP820CJMH Connection Diagrams

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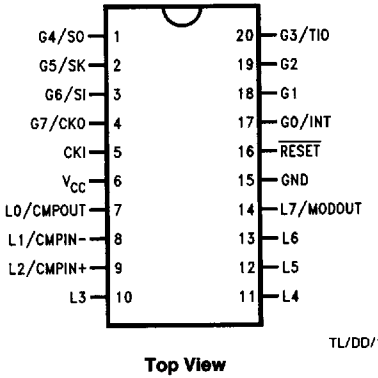
**Top View**

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**Top View**

**FIGURE 2. COP820CJMHD/COP822CJMHD Pinout**

## Pin Assignment

| Port Pin | Typ | ALT Funct. | 20 Pin | 28 Pin |
|---|---|---|---|---|
| L0 | I/O | MIWU/CMPOUT | 7 | 11 |
| L1 | I/O | MIWU/CMPIN− | 8 | 12 |
| L2 | I/O | MIWU/CMPIN+ | 9 | 13 |
| L3 | I/O | MIWU | 10 | 14 |
| L4 | I/O | MIWU | 11 | 15 |
| L5 | I/O | MIWU | 12 | 16 |
| L6 | I/O | MIWU | 13 | 17 |
| L7 | I/O | MIWU/MODOUT | 14 | 18 |
| G0 | I/O | INTR | 17 | 25 |
| G1 | I/O | | 18 | 26 |
| G2 | I/O | | 19 | 27 |
| G3 | I/O | TIO | 20 | 28 |
| G4 | I/O | SO | 1 | 1 |
| G5 | I/O | SK | 2 | 2 |
| G6 | I | SI | 3 | 3 |
| G7 | I | CKO | 4 | 4 |
| I0 | I | | | 7 |
| I1 | I | | | 8 |
| I2 | I | | | 9 |
| I3 | I | | | 10 |
| D0 | O | | | 19 |
| D1 | O | | | 20 |
| D2 | O | | | 21 |
| D3 | O | | | 22 |
| $V_{CC}$ | | | 6 | 6 |
| GND | | | 15 | 23 |
| CKI | | | 5 | 5 |
| $\overline{\text{RESET}}$ | | | 16 | 24 |

## Pin Description

**$V_{CC}$** and **GND** are the power supply pins.

**CKI** is the clock input. This can come from an external source, a R/C generated oscillator or a crystal (in conjunction with CKO). See Oscillator description.

**$\overline{\text{RESET}}$** is the master reset input. See Reset description.

**PORT I** is a 4-bit Hi-Z input port.

**PORT L** is an 8-bit I/O port.

There are two registers associated with the L port: a data register and a configuration register. Therefore, each L I/O bit can be individually configured under software control as shown below:

| Port L Config. | Port L Data | Port L Setup |
|---|---|---|
| 0 | 0 | Hi-Z Input (TRI-STATE) |
| 0 | 1 | Input with Weak Pull-up |
| 1 | 0 | Push-pull Zero Output |
| 1 | 1 | Push-pull One Output |

Three data memory address locations are allocated for this port, one each for data register [00D0], configuration register [00D1] and the input pins [00D2].

Port L has the following alternate features:

L0 MIWU or CMPOUT
L1 MIWU or CMPIN−
L2 MIWU or CMPIN+
L3 MIWU
L4 MIWU (high sink current capability)
L5 MIWU (high sink current capability)
L6 MIWU (high sink current capability)
L7 MIWU or MODOUT (high sink current capability)

The selection of alternate Port L function is done through registers WKEN [00C9] to enable MIWU and CNTRL2 [00CC] to enable comparator and modulator.

All eight L-pins have Schmitt Triggers on their inputs.

**PORT G** is an 8-bit port with 6 I/O pins (G0–G5) and 2 input pins (G6, G7).

All eight G-pins have Schmitt Triggers on the inputs.

There are two registers associated with the G port: a data register and a configuration register. Therefore each G port bit can be individually configured under software control as shown below:

| Port G Config. | Port G Data | Port G Setup |
|---|---|---|
| 0 | 0 | Hi-Z Input (TRI-STATE) |
| 0 | 1 | Input with Weak Pull-up |
| 1 | 0 | Push-pull Zero Output |
| 1 | 1 | Push-pull One Output |

Three data memory address locations are allocated for this port, one for data register [00D3], one for configuration register [00D5] and one for the input pins [00D6]. Since G6 and G7 are Hi-Z input only pins, any attempt by the user to configure them as outputs by writing a one to the configuration register will be disregarded. Reading the G6 and G7 configuration bits will return zeros. Note that the device will be placed in the Halt mode by writing a "1" to the G7 data bit.

Six pins of Port G have alternate features:

G0 INTR (an external interrupt)
G3 TIO (timer/counter input/output)
G4 SO (MICROWIRE serial data output)
G5 SK (MICROWIRE clock I/O)
G6 SI (MICROWIRE serial data input)
G7 CKO crystal oscillator output (selected by mask option) or HALT restart input/general purpose input (if clock option is R/C or external clock)

## Pin Description (Continued)

Pins G1 and G2 currently do not have any alternate functions.

The selection of alternate Port G functions are done through registers PSW [00EF] to enable external interrupt and CNTRL1 [00EE] to select TIO and MICROWIRE operations.

**PORT D** is a four bit output port that is preset when RESET goes low. One data memory address location is allocated for the data register [00DC].

## Oscillator Circuits

### EXTERNAL OSCILLATOR

CKI can be driven by an external clock signal provided it meets the specified duty cycle, rise and fall times, and input levels. CKO is available as a general purpose input G7 and/or Halt control.

### CRYSTAL OSCILLATOR

By selecting CKO as a clock output, CKI and CKO can be connected to create a crystal controlled oscillator. Table I shows the component values required for various standard crystal values.

### R/C OSCILLATOR

By selecting CKI as a single pin oscillator, CKI can make a R/C oscillator. CKO is available as a general purpose input and/or HALT control. Table II shows variation in the oscillator frequencies as functions of the component (R and C) values.

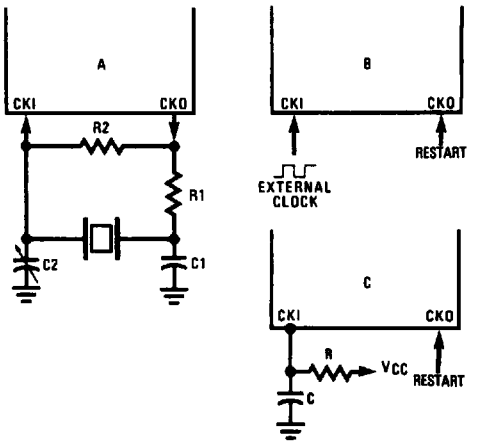


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**FIGURE 3. Clock Oscillator Configurations**

**TABLE I. Crystal Oscillator Configuration**

| R1 (kΩ) | R2 (MΩ) | C1 (pF) | C2 (pF) | CKI Freq. (MHz) | Conditions |
|---|---|---|---|---|---|
| 0 | 1 | 30 | 30–36 | 10 | $V_{CC}$ = 5V |
| 0 | 1 | 30 | 30–36 | 4 | $V_{CC}$ = 5V |
| 5.6 | 1 | 100 | 100–156 | 0.455 | $V_{CC}$ = 5V |

**TABLE II. RC Oscillator Configuration (Part-To-Part Variation)**

| R (kΩ) | C (pF) | CK1 Freq. (MHz) | Instr. Cycle (μs) | Conditions |
|---|---|---|---|---|
| 3.3 | 82 | 2.2 to 2.7 | 3.7 to 4.6 | $V_{CC}$ = 5V |
| 5.6 | 100 | 1.1 to 1.3 | 7.4 to 9.0 | $V_{CC}$ = 5V |
| 6.8 | 100 | 0.9 to 1.1 | 8.8 to 10.8 | $V_{CC}$ = 5V |

## Programming the COP820CJMH/ COP822CJMH

Programming the hybrid emulators is accomplished through the duplicator board which is a stand alone programmer capable of supporting different package types. It works in conjunction with a pre-programmed EPROM (either via the NSC development system or a standard programmer) holding the application program. The duplicator board essentially copies the information in the EPROM into the hybrid emulator.

The last byte of program memory (EPROM location 01FFF Hex) must contain the proper value specified in the following table

| Device | Package Type | Contents of Last Byte (Address 01FFF) |
|---|---|---|
| COP820CJMH | 28 DIP | 6F |
| COP822CJMH | 20 DIP | E7 |

### ERASING THE PROGRAM MEMORY

Erasure of the EPROM program memory is achieved by removing the device from its socket and exposing the transparent window to an ultra-violet light source.

The erasure characteristics of the device are such that the erasure begins to occur when exposed to light with wavelengths shorther than approximately 4000 Angstroms (Å). It should be noted that sunlight and certain types of flouresecent lamps have wavelengths in the 3000Å to 4000 range.

After programming, opaque labels should be placed over the window of the device to prevent temporary functional failure due to the generation of photo currents, erasure, and excessive HALT current. Note that the device will also draw more current than normal (especially in HALT mode) when the window of the device is not covered with an opaque label.

The recommended erasure procedure for the devices is exposure to short wave ultraviolet light which as a wavelength of 2537Å. The integrated dose (UV intensity × exposure time) for erasure should be a miniumum of 15 w-sec/cm$^2$.

The device should be placed within one inch of the lamp tubes during erasure. Some lamps have a filter on their tubes which should be removed before erasure. The following table shows the minimum erasure time for various light intensities.

| Minimum Erasure Time | | |
|---|---|---|
| Light Intensity (Micro-Watts/cm$^2$) | Erasure Time (Minutes) | |
| | 28-Pin Package | 20-Pin Package |
| 15,000 | 20 | 40 |
| 10,000 | 25 | 50 |
| 5,000 | 50 | 100 |

An erasure system should be calibrated periodically. The distance from lamp to device should be maintained at one inch. The erasure time increases as the square of the distance. Lamps lose intensity as they age. When a lamp has aged, the system should be checked to make certain that adequate UV dosages are being applied for full erasure.

## Development Support

### IN-CIRCUIT EMULATOR

The MetaLink iceMASTER™-COP8 Model 400 In-Circuit Emulator for the COP8 family of microcontrollers features high-performance operation, ease of use, and an extremely flexible user-interface for maximum productivity. Interchangeable probe cards, which connect to the standard common base, support the various configurations and packages of the COP8 family.

The iceMASTER provides real time, full speed emulation up to 10 MHz, 32 kBytes of emulation memory and 4k frames of trace buffer memory. The user may define as many as 32k trace and break triggers which can be enabled, disabled, set or cleared. They can be simple triggers based on code or address ranges or complex triggers based on code address, direct address, opcode value, opcode class or immediate operand. Complex breakpoints can be ANDed and ORed together. Trace information consists of address bus values, opcodes and user selectable probe clips status (external event lines). The trace buffer can be viewed as raw hex or as disassembled instructions. The probe clip bit values can be displayed in binary, hex or digital waveform formats.

During single-step operation the dynamically annotated code feature displays the contents of all accessed (read and write) memory locations and registers, as well as flow-of-control direction change markers next to each instruction executed.

The iceMASTER's performance analyzer offers a resolution of better than 6 μs. The user can easily monitor the time spent executing specific portions of code and find "hot spots" or "dead code". Up to 15 independent memory areas based on code address or label ranges can be defined. Analysis results can be viewed in bargraph format or as actual frequency count.

Emulator memory operations for program memory include single line assembler, disassembler, view, change and write to file. Data memory operations include fill, move, compare, dump to file, examine and modify. The contents of any memory space can be directly viewed and modified from the corresponding window.

The iceMASTER comes with an easy to use windowed interface. Each window can be sized, highlighted, color-controlled, added, or removed completely. Commands can be accessed via pull-down-menus and/or redefinable hot keys. A context sensitive hypertext/hyperlinked on-line help system explains clearly the options the user has from within any window.

The iceMASTER connects easily to a PC via the standard COMM port and its 115.2 kBaud serial link keeps typical program download time to under 3 seconds.

The following tables list the emulator and probe cards ordering information.

**Emulator Ordering Information**

| Part Number | Description |
|---|---|
| IM-COP8/400 | MetaLink base unit in-circuit emulator for all COP8 devices, symbolic debugger software and RS 232 serial interfcace cable |
| MHW-PS3 | Power Supply 110V/60 Hz |
| MHW-PS4 | Power Supply 220V/50 Hz |

## Development Support (Continued)

**Probe Card Ordering Information**

| Part Number | Package | Voltage Range | Emulates |
|---|---|---|---|
| MH-820CJ20D5PC | 20 DIP | 4.5V–5.5V | COP822CJ |
| MHW-820CJ20DWPC | 20 DIP | 2.3V–6.0V | COP822CJ |
| MHW-820CJ28D5PC | 28 DIP | 4.5V–5.5V | COP820CJ |
| MHW-820CJ28DWPC | 28 DIP | 2.3V–6.0V | COP820CJ |

### MACRO CROSS ASSEMBLER

National Semiconductor offers a COP8 macro cross assembler. It runs on industry standard compatible PCs and supports all of the full-symbolic debugging features of the MetaLink iceMASTER emulators.

**Assembler Ordering Information**

| Part Number | Description | Manual |
|---|---|---|
| MOLE-COP8-IBM | COP8 macro cross assembler for IBM® PC-XT®, PC-AT® or compatible | 424410527-001 |

### SINGLE CHIP EMULATOR

The COP8 family is fully supported by single chip form, fit and function emulators. For more detailed information refer to the emulation device specific data sheets and the form, fit, function emulator selection table below.

### PROGRAMMING SUPPORT

Programming of the single chip emulator devices is supported by different sources. National Semiconductor offers a duplicator board which allows the transfer of program code from a standard programmed EPROM to the single chip emulator and vice versa. Data I/O supports COP8 emulator device programming with its uniSite 48 and System 2900 programmers. Further information on Data I/O programmers can be obtained from any Data I/O sales office or the following USA numbers:

Telephone: (206) 881-6444 Fax: (206) 882-1043

**Single Chip Emulator Selection Table**

| Device Number | Clock Option | Package | Description | Emulates |
|---|---|---|---|---|
| COP820CJMHD-X | X = 1: crystal<br>X = 2: external<br>X = 3: R/C | 28 DIP | Multi-Chip Module (MCM), UV erasable | COP820CJ |
| COP820CJMHEA-X | X = 1: crystal<br>X = 2: external<br>X = 3: R/C | 28 LCC | MCM (same footprint as 28 SO), UV erasable | COP820CJ |
| COP822CJMHD-X | X = 1: crystal<br>X = 2: external<br>X = 3: R/C | 20 DIP | MCM, UV erasable | COP822CJ |

**Duplicator Board Ordering Information**

| Part Number | Description | Devices Supported |
|---|---|---|
| COP8-PRGM-28D | Duplicator board for 28 DIP and for use with Scrambler Boards | COP820CJMHD |
| COP-8-SCRM-DIP | Scrambler board for 20 DIP socket | COP822CJMHD |
| COP8-SCRM-SBX | Scrambler board for 28 LCC sockets | COP820CJMHEA |
| COP8-PRGM-DIP | Duplicator Board with COP8-SCRM-DIP Scrambler board | COP822CJMHD<br>COP820CJMHD |

**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.

**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.

**FACTORY APPLICATIONS SUPPORT**

Dial-A-Helper also provides immediate factory applications support. If a user has questions, he can leave messages on our electronic bulletin board.

Voice: (408) 721-5582
Modem: (408) 739-1162
Baud: 300 or 1200 baud
Setup: Length: 8-Bit
Parity: None
Stop Bit: 1
Operation: 24 Hrs. 7 Days