National Semiconductor

COP880CMH/COP881CMH Microcontroller Emulators

General Description

The COP880CMH/COP881CMH hybrid emulators are members of the COPS™ microcontroller family. The device is a two chip system in a dual cavity package. Within the package is the COP880C and a UV-erasable 8k EPROM with port recreation logic code executes of the EPROM. The devices (offered in 44-pin LDCC, 40-pin DIP and 28-pin DIP packages) contain transparent windows which allow the EPROM to be erased and re-programmed. The devices are fully static parts, fabricated using double-metal silicon gate microCMOS technology. Features include an 8-bit memory mapped architecture, MICROWIRE/PLUS™ serial I/O, and a 16-bit timer/counter supporting three modes (PWM generation, External Event counter, and Input Capture). Each I/O pin has software selectable configurations. The devices operate over a voltage range of 4.5V to 6.0V. High throughput is achieved with an efficient, regular instruction set operating at a maximum of 1 μs per instruction rate.

The COP881CMH (28-pin package) can be used to emulate the COP820C/COP840C.

> COP880CMH and COP881CMH are intended primarily as a prototyping design tool. The Electrical Performance Characteristics are not tested but are included for reference only.

Features

- Form fit and function emulation device for the COP880C/COP881C/COP840C/COP820C
- Fully static CMOS
- 1 μs instruction time
- 8191 bytes EPROM/128 bytes RAM
- 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/capture interrupt
  - — Software interrupt
- 8-bit stack pointer (stack in RAM)
- Powerful instruction set; most instructions are single byte
- BCD arithmetic instructions
- MICROWIRE/PLUS serial I/O
- Packages: 44-pin LDCC with 36 I/O pins
  40-pin DIP with 36 I/O pins
  28-pin DIP with 24 I/O pins
- Software selectable I/O options (TRI-STATE®, push-pull, weak pull-up)
- Schmitt trigger inputs on Port G
- Real time emulation and full program debug offered by National's Development Systems

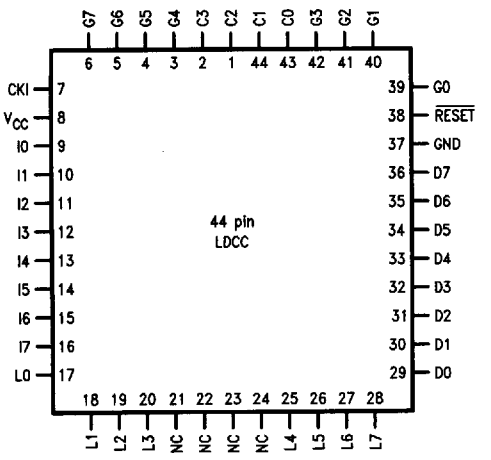
Ordering Information

Hybrid Emulator	Package Type	Part Emulated
COP880CMHD-x	40-Pin DIP	COP880C-XXX/N
COP880CMHEL-x	44-Pin LDCC	COP880C-XXX/V
COP880CMHD-x	28-Pin DIP	COP881C-XXX/N COP840C-XXX/N COP820C-XXX/N

x = 1, 2, 3. See Table III.

Connection Diagrams

Plastic Chip Carrier



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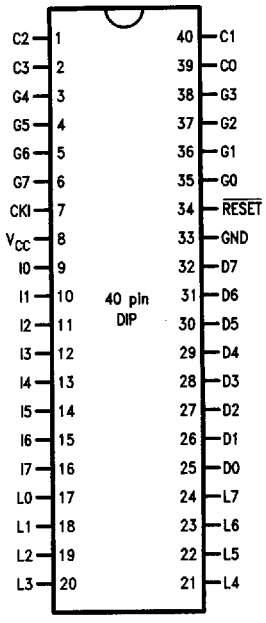
Top View

Dual-In-Line Package



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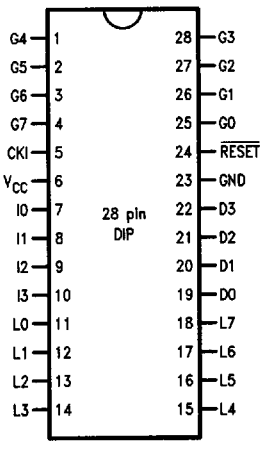
Top View

Dual-In-Line Package



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Top View

Note: X is the number which corresponds to the clock option (X = 1, for Crystal, 2 for External, 3 for RC).

FIGURE 1. COP880CMH/COP881CMH Connection Diagrams

COP880CMH/COP881CMH Pinouts

Port	Type	Alternate Function	28-Pin DIP	40-Pin DIP	44-Pin LDCC
L0	I/O		11	17	17
L1	I/O		12	18	18
L2	I/O		13	19	19
L3	I/O		14	20	20
L4	I/O		15	21	25
L5	I/O		16	22	26
L6	I/O		17	23	27
L7	I/O		18	24	28
G0	I/O	Interrupt	25	35	39
G1	I/O		26	36	40
G2	I/O		27	37	41
G3	I/O	TIO	28	38	42
G4	I/O	SO	1	3	3
G5	I/O	SK	2	4	4
G6	I	SI	3	5	5
G7	I/CKO	Halt Restart	4	6	6
I0	I		7	9	9
I1	I		8	10	10
I2	I		9	11	11
I3	I		10	12	12
I4	I			13	13
I5	I			14	14
I6	I			15	15
I7	I			16	16
D0	O		19	25	29
D1	O		20	26	30
D2	O		21	27	31
D3	O		22	28	32
D4	O			29	33
D5	O			30	34
D6	O			31	35
D7	O			32	36
C0	I/O			39	43
C1	I/O			40	44
C2	I/O			1	1
C3	I/O			2	2
V_{CC}			6	8	8
GND			23	33	37
CKI			5	7	7
$\overline{\text{RESET}}$			24	34	38

Note: Unused pins 21–24 on 44-pin device are not connected.

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})	7V
Reset (V_{PP}) and G6 (ME)	−0.3V to 14V
Voltage at any other Pin	−0.3V to V_{CC} + 0.3V
Total Current into V_{CC} Pin (Source)	50 mA
Total Current Out of GND Pin (Sink)	60 mA
Storage Temperature Range	−65°C to +140°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		4.5		6.0	V
Power Supply Ripple (Note 1)	Peak to Peak			0.1 V_{CC}	V
Supply Current					
High Speed Mode, CKI = 10 MHz	V_{CC} = 6.0V, t_c = 1 μs			21	mA
Normal Mode, CKI = 5 MHz (Note 2)	V_{CC} = 6.0V, t_c = 2 μs			15	mA
HALT Current (Note 3)	V_{CC} = 6.0V, CKI = 0 MHz		500		μA
INPUT LEVELS					
Reset, CKI					
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} = 6.0V	−2		+2	μA
Input Pullup Current	V_{CC} = 6.0V	40		250	μA
G Port Input Hysteresis			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		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
All Others				3	mA
Maximum Input Current without Latchup (Note 4)	Room Temp			±100	mA
RAM Retention Voltage, V_R	500 ns Rise and Fall Time (Min)	2.0			V
Input Capacitance				7	pF

Note 1: Rate of voltage change must be less than 0.5V/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. HALT test conditions: L and G ports are at TRI-STATE and tied to ground, EPROM window covered.

Note 4: Pins G6 and $\overline{\text{RESET}}$ are designed with a high voltage input network for factory testing. 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	Condition	Min	Typ	Max	Units
Instruction Cycle Time (t_c)					
Crystal/Resonator	$V_{CC} \ge 4.5V$	1		DC	μs
R/C Oscillator Mode (div-by 10)	$V_{CC} \ge 4.5V$	3		DC	μs
CKI Clock Duty Cycle (Note 5)	f_r = Max	40		60	%
Rise Time (Note 5)	f_r = 10 MHz ext clock			12	ns
Fall Time (Note 5)	f_r = 10 MHz ext clock			8	ns
MICROWIRE™ Setup Time (t_{UWS})		20			ns
MICROWIRE Hold Time (t_{UWH})		56			ns
MICROWIRE Output Propagation Delay (t_{UPD})				220	ns
Input Pulse Width					
Interrupt Input High Time		t_C			
Interrupt Input Low Time		t_C			
Timer Input High Time		t_C			
Timer Input Low Time		t_C			
Reset Pulse Width		1.0			μs

Note 5: Parameter sampled (not 100% tested).

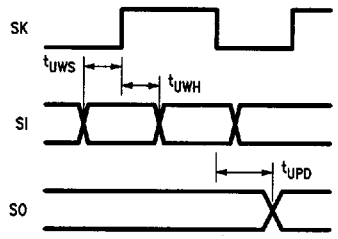

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FIGURE 2. MICROWIRE Timing Diagram

Pin Descriptions

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

CKI is the clock input. This can come from an external source, an 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 an 8-bit Hi-Z input port.

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

PORT C is a 4-bit I/O port.

Three memory locations are allocated for the L, G and C ports, one each for data register, configuration register and the input pins. Reading bits 4–7 of the C-Configuration register, data register, and input pins returns undefined data.

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

Config.	Data	Ports L and C Setup
0	0	Hi-Z Input (TRI-STATE Output)
0	1	Input with Pull-Up (Weak One Output)
1	0	Push-Pull Zero Output
1	1	Push-Pull One Output

On the 28-pin part, it is recommended that all bits of Port C be configured as outputs.

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:

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

Since G6 and G7 are 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. The device will be placed in the HALT mode by writing to the G7 bit in the G-port data register.

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)

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

PORT D is an 8-bit output port that is preset high when RESET goes low.

Oscillator Circuits

A. CRYSTAL OSCILLATOR

By selecting CKO as a clock output, CKI and CKO can be connected to make a crystal controlled oscillator. See Table II for value of R & C.

B. 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 (G7) is available as a general purpose input and/or Halt Control.

C. R/C OSCILLATOR

CKI is configured as a single pin R/C controlled Schmitt trigger oscillator. CKO (G7) is available as a general purpose input and/or HALT restart control.

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

OSCILLATOR MASK OPTIONS

The devices can be driven by crystal or external clock inputs between DC and 10 MHz. Table IV shows the clock option per package.

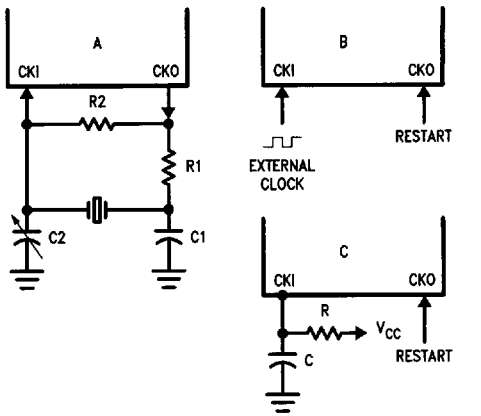

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FIGURE 3. Crystal, External, and R/C Oscillator Diagrams

Oscillator Circuits (Continued)

TABLE I. Crystal Oscillator Configuration, $T_A = 25°C$, $V_{CC} = 5V$

R1 (kΩ)	R2 (MΩ)	C1 (pF)	C2 (pF)	CKI Freq. (MHz)
0	1	30	30–36	10
0	1	30	30–36	4
0	1	200	100–150	0.455

TABLE II. RC Oscillator Configuration, $T_A = 25°C$

R (kΩ)	C (pF)	CKI Freq. (MHz)	Instr. Cycle (μs)
3.3	82	2.8 to 2.2	3.6 to 4.5
5.6	100	1.5 to 1.1	6.7 to 9
6.8	100	1.1 to 0.8	9 to 12.5

TABLE III. Clock Option Per Package

Order Part Number	Package	Clock Option
COP880CMHEL-1 COP880CMHD-1 COP881CMHD-1	44 LDCC 40 DIP 28 DIP	Crystal Oscillator ÷ 10
COP880CMHEL-2 COP880CMHD-2 COP881CMHD-2	44 LDCC 40 DIP 28 DIP	External Oscillator ÷ 10
COP880CMHEL-3 COP880CMHD-3 COP881CMHD-3	44 LDCC 40 DIP 28 DIP	R/C Oscillator ÷ 10

Programming the COP880CMH/COP881CMH

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.

TABLE V

Device	Package Type	RAM Size Emulated	Contents of Last Byte (Address 01FFF)
COP880CMH	44 LDCC 40 DIP	128	7F
COP881CMH	28 DIP	128	6F
COP881CMH	28 DIP	64	EF

ORDERING INFORMATION

P/N	Description	Documentation
COP8-PRGM-PCC	Duplicator Board for 44-Pin LDCC	User Instruction Manual
COP8-PRGM-DIP	Duplicator Board for 40-Pin DIP	User Instruction Manual
COP8-PRG-28D	Duplicator Board for 28-Pin DIP	User Instruction Manual

The device will also program on a Data I/O programmer. The following table provides the programming information on a Data I/O Programmer.

COPS Part Number	Package Type	Family Code	Pin	Software Rev	Adapter
COP881CMHD	28 DIP	16F	19E	V3.3	SITE 48
COP880CMHD	40 DIP	16F	19F	V3.3	SITE 48
COP880CMHEL	44 LDCC	16F	175	V3.2	PINSITE

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.

Programming the COP880CMH/COP881CMH (Continued)

The erasure characteristics of the device are such that erasure begins to occur when exposed to light with wavelengths shorter than approximately 4000 Angstroms (Å). It should be noted that sunlight and certain types of flourescent lamps have wavelengths in the 3000Å to 4000Å 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 has a wavelength of 2537Å. The integrated dose (UV intensity × exposure time) for erasure should be a minimum 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)**
15,000	20
10,000	25
5,000	50

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

Development Tools Selection Table

Microcontroller	Order Part Number	Description	Includes	Manual Number
COP880C/881C	MOLE-BRAIN	Brain Board	Brain Board Users Manual	420408188-001
	MOLE-COP8-PB1A	Personality Board	COP880 Personality Board Users Manual	420410806-001
	MOLE-COP8-IBM	Assembler Software for IBM	COP800 Software Users Manual and Software Disk PC-DOS Communications Software Users Manual	424410527-001 420040416-001
	420411060-001	Programmer's Manual		420411060-01

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 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

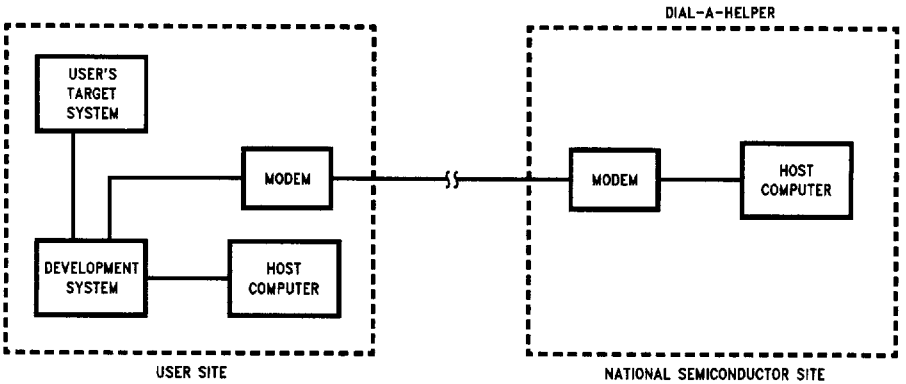
Information System Package contains:
Dial-A-Helper Users Manual
Public Domain Communications Software

FACTORY APPLICATIONS SUPPORT

Dial-A-Helper also provides immediate factor applications support. If a user is having difficulty in operating the development system, 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.

Development Support (Continued)

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



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