

# **FACTS** engineering

*Automationdirect.com*<sup>™</sup>

Direct Logic 405

405 CoProcessors

F4-CP128-1

F4-CP512-1

F4-CP128-T



Order Number: F4-CP-M



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# CHAPTER 1: INTRODUCTION

This manual describes details specific to each of the 405 CoProcessor part numbers. This document should be used to supplement the FACTS Extended BASIC User's Reference when programming the FACTS Engineering 405 CoProcessor modules.

405 CoProcessor modules are installed in any slot of a D4-440 or D4-430 CPU base. The CoProcessor may be installed in either the CPU base or any of the up to three local expansion bases of a D4-450 CPU system.

The CoProcessor module communicates to the DL405 PLC CPU using the S405\_, BMOVE, and DPORT instructions. A high speed dual port RAM interface, across the parallel bus of the DL405 backplane, is used for CoProcessor to PLC and PLC to CoProcessor communications. Up to 256 bytes can be transferred by the CoProcessor in one PLC scan using the BMOVE instruction. No PLC ladder logic is required for CoProcessor to PLC or PLC to CoProcessor communications. The CoProcessor does not take any X's or Y's from the DL405 PLC CPU's memory map.

The DL405 PLC ladder logic can generate an interrupt in the CoProcessor with the RX or WX ladder instructions and the ONPLC CoProcessor statement. In addition to the 256 bytes that can be transferred using the BMOVE instruction, 128 bytes can be transferred using an RX or WX triggered ONPLC interrupt.

The CoProcessor module communicates to external devices using the built in serial port(s), leased line/radio modem, or built in telephone modem depending on which module that you have. Check the feature overview to verify that you have the correct module for your application.

## 405 COPROCESSOR MODULES - FEATURE OVERVIEW

Module Part #	Memory	232/422/485 Selectable Ports	RS232 Only	Telephone Modem Ports
F4-CP128-1	128K	2	1	No
F4-CP512-1	512K	2	1	No
F4-CP128-T	128K	1	1	Yes

## DL405 CPU SYNCHRONIZATION

Upon application of power the 405 CoProcessor resets and establishes communication with the DL405 PLC CPU. Next the operating mode saved by the last AUTOSTART command is executed. Please see AUTOSTART in the FACTS Extended BASIC User's Reference for additional information.

Unlike the 305 I/O BASIC Modules, the CoProcessor does not reset when the DL405 PLC CPU is reset. If desired, the current state of the DL405 PLC CPU may be determined by examining Special Purpose relays SP11-20. See Chapter 2 (405 CoProcessor Statements) for a description of the S405\_ statement. See the DL405 User's Manual for a description of DL405 PLC CPU special relays.

```
Example      10 IF S405_SP(11) THEN PRINT "Forced running state"
              20 IF S405_SP(12) THEN PRINT "TERM RUN state"
              30 IF S405_SP(13) THEN PRINT "TEST RUN state"
              40 IF S405_SP(15) THEN PRINT "TEST PGM state"
              50 IF S405_SP(16) THEN PRINT "TERM PGM state"
              60 IF S405_SP(17) THEN PRINT "Forced STOP state"
              70 IF S405_SP(20) THEN PRINT "PGM Mode"
```

Often a DL405 CPU control relay or stage status is used as a permissive in the BASIC program. Control relays and stage status bits are used to communicate program status information to the CoProcessor. For example, a control relay may be used to signal the start of a shift report or to simply indicate that the DL405 CPU is running.

```
Example      10 IF S405_C(0) THEN PRINT "CR 0 Energized"
              10 IF S405_SG(10) THEN PRINT "Stage 10 is active"
```

## CHAPTER 2: 405 COPROCESSOR STATEMENTS

### BMOVE

Function        Directly access a block of DL405 CPU memory

Syntax         BMOVE direction, starting operand(number), ending operand(number)  
 BMOVE direction, starting operand(number), K (number of bytes)

See Also        DPORT, ONPLC, and S405\_

Usage          Up to 256 bytes of DL405 memory may be read or written in one scan using BMOVE. Memory in the DL405 CPU is referenced using any one of 11 different operands specified with an octal address number.

Block moves begin in the ABM at shared memory location DPORT(0) and in the DL405 CPU at starting operand(number). The block move continues through consecutive memory addresses up to and including ending operand(number). Alternately, the number of bytes to transfer may be specified as an expression in parenthesis following "K". If number of bytes is 0 then 256 bytes will be copied.

Use either a "R" or "W" for direction to specify a DL405 memory Read or Write. "R" will read DL405 CPU memory and copy to DPORT memory. "W" will read DPORT memory and copy to DL405 CPU memory.

If starting operand or ending operand is a BIT data type, the entire V-Memory address containing the operand is used.

Octal numbering and data types for BMOVE operands

#### 430 CPU BMOVE Operands

Description	Operand	Qty	Octal numbering	Data Type	V-Memory Octal Word
Timer Current	T	128	0-177	BCD	0-177
Count Current	CT	128	0-177	BCD	1000-1177
V-Memory	VH		0-41230	HEX or BCD	0 - 41230
Remote I/O	GX	512	0-777	Bit	40000-40037
Inputs	X	320	0-477	Bit	40400-40423
Outputs	Y	320	0-477	Bit	40500-40523
Internal Relays	C	480	0-737	Bit	40600-40635
Stage Status	SG	384	0-577	Bit	41000-41027
Timer Status	TS	128	0-177	Bit	41100-41107
Counter Status	CS	128	0-177	Bit	41140-41147
Special Relays	SP	96	0-137	Bit	41200-41205
	SP	192	320-617	Bit	41215-41230

#### 440 CPU BMOVE Operands

Description	Operand	Qty	Octal numbering	Data Type	V-Memory Octal Word
Timer Current	T	128	0-177	BCD	0-377
Count Current	CT	256	0-177	BCD	1000-1177
V-Memory	VH		0-41235	HEX or BCD	0-41235
Remote I/O	GX	1024	0-1777	Bit	40000-40077
Inputs	X	320	0-477	Bit	40400-40423
Outputs	Y	320	0-477	Bit	40500-40523
Internal Relays	C	1024	0-1777	Bit	40600-40677
Stage Status	SG	1024	0-1777	Bit	41000-41077
Timer Status	TS	256	0-377	Bit	41100-41117
Counter Status	CS	128	0-177	Bit	41140-41147
Special Relays	SP	96	0-137	Bit	41200-41205
	SP	256	320-717	Bit	41215-41235

#### 450 CPU BMOVE Operands

Description	Operand	Qty	Octal numbering	Data Type	V-Memory Octal Word
Timer Current	T	256	0-377	BCD	0-377
Count Current	CT	256	0-177	BCD	1000-1377
V-Memory	VH		0-41235	HEX or BCD	0-41235
Remote Inputs	GX	2048	0-3777	Bit	40000-40177
Remote Outputs	GY	2048	0-3777	Bit	40200-40377
Inputs	X	1024	0-1777	Bit	40400-40477
Outputs	Y	1024	0-1777	Bit	40500-40577
Internal Relays	C	2048	0-3777	Bit	40600-40777
Stage Status	SG	1024	0-1777	Bit	41000-41077
Timer Status	TS	256	0-377	Bit	41100-41117
Counter Status	CS	256	0-377	Bit	41140-41157
Special Relays	SP	512	0-777	Bit	41200-41237

Example      Load a table of 6 constants into user V-Memory starting at V1400

```

10 REM Load the table into shared memory
20 DPORT(0)=10H
30 DPORT(2)=20H
40 DPORT(4)=25H
50 DPORT(6)=30H
60 DPORT(8)=100H
70 DPORT(10)=9798H
80 REM Copy the table to DL405 CPU V-Memory
90 BMOVE W, VH(1400), K(12)

```

Example Multiply a range of user V-Memory by a constant value

```
10 BMOVE R, VH(1400), K(32) : REM Get the values
20 REM Multiply by 2.5
30 FOR ADDR = 0 TO 31 STEP 2
40 DPORT(ADDR)=DPORT(ADDR)*2.5
50 NEXT ADDR
60 BMOVE W, VH(1400), K(32) : REM Put the values back
```

Example Get the DL405 X (Input) image table

```
10 BMOVE R, X(0), X(477)
```

Advanced If no operand is specified then address number is the hexadecimal representation of the Octal V-Memory address plus one (80H = Octal V-Memory 177). BMOVE R, VH(1400), K(10) is the same as BMOVE R, (301H), K(10).

This feature simplifies FOR-NEXT loops and other types of "calculated" PLC memory accesses.

Example Find all user V-Memory locations which match a constant

```
10 K = 1234 : REM Match value
15 REM Search all of user V-Memory
20 FOR INDEX=301H TO 1000H STEP 127 : REM 2 BYTES/V-MEM
30 BMOVE R, (INDEX), K(254)
40 FOR ADDR = 0 TO 252 STEP 2
50 IF DPORT(ADDR)<>K THEN 70
60 PRINT1 "Matched at V-Memory hex address = ",
62 PRINT1 HEX$(INDEX+ADDR-1)
70 NEXT ADDR
80 NEXT INDEX
```

## DPORT

Function Read or write memory shared with the DL405

Syntax DPORT (address, portion) = expression  
variable = DPORT (address, portion)

Usage DPORT (dual port) is used in conjunction with ONPLC interrupt and BMOVE (block move) statements to access the DL405.

The DPORT operator retrieves the value at the shared memory address and assigns it to the variable.

The DPORT statement stores the value of expression at the shared memory address.

address is an expression from 0 to 387, which selects two bytes of shared memory. DPORT retrieves or assigns an integer value (0 to 65535) at address.

portion is optional and is used to specify a bit position, a nibble (group of 4 bits), a byte (group of 8 bits), or a BCD word.

Use "B(n)" to specify one of 16 bit positions, where n = 0-15.

Use "N(n)" to specify one of four nibbles, where n= 0-3.

Use "H" to specify the high byte or use "L" to specify the low byte.

Use "B" to specify a word hexadecimal to BCD conversion.

The first 256 bytes of shared memory, DPORT(0) to DPORT(255), are used by the BMOVE statement to move blocks of data in and out of DL405 CPU memory (see BMOVE for a complete description).

The next 128 bytes of shared memory, DPORT(256) to DPORT(383), are used in conjunction with the ONPLC statement. This block of memory is accessed by the DL405 using the WX and RX instructions. The last 4 bytes of shared memory, DPORT(384) to DPORT(387), are control bytes for WX and RX (see ONPLC for a complete description).



Example        Retrieve a 4 digit BCD value from shared memory

```
10 REM Put a BCD number at V-Memory 1400
20 S405_VB(1400)=1234
30 REM Get it back with a block move
40 BMOVE R, VH(1400), K(1)
50 PRINT1 "BCD value at V-Memory 1400 =",
52 PRINT1 HEX$(DPORT(0))
```

Example        Store 4 digit BCD values in V-Memory 1400 and 1401 using BMOVE

```
10 DPORT(0) = 1234H : REM Constant for V-Memory 1400
20 A = 5678 : REM A Must be a BCD value from 0 - 9999
30 DPORT(2) = VAL(HEX$(A)) : REM Same as DPORT(2,B)=A
40 BMOVE W, VH(1400), VH(1401)
```

```

Example      Using DPORT with PICK statement type modifiers
1000 V=1120H
1010 DPORT(0)=V : PRINT1 "Retrieving values from DPORT"
1020 PH1. "DPORT(0) = ",V," in hexadecimal"
1030 PRINT1 "1st nibble = ",DPORT(0,N(0)), SPC (5),
1040 PRINT1 "3rd nibble = ",DPORT(0,N(2))
1050 PRINT1 "DPORT(0) in binary = "; : FOR BT=15 TO 0 STEP -1
1060 IF DPORT(0,B(BT)) THEN PRINT1 "1"; ELSE PRINT1 "0";
1070 NEXT BT : PRINT1
1080 PH1. DPORT(0),
1090 PRINT1 " or ",V," treated as BCD = ",DPORT(0,B)," decimal"
1100 HB=DPORT(0,H) : REM  Swap the bytes
1110 DPORT(0,H)=DPORT(0,L) : DPORT(0,L)=HB
1120 PH1. "Value with bytes swapped = ",DPORT(0)
1130 PRINT1 : PRINT1 "Assigning bits and nibbles in DPORT"
1140 DPORT(0)=0
1150 FOR BT=0 TO 15
1160 DPORT(0,B(BT))=1
1170 IF BT=8 THEN PRINT1
1180 PH1. DPORT(0), SPC (3),
1190 NEXT : PRINT1
1200 DPORT(0)=0
1210 FOR N=0 TO 3
1220 DPORT(0,N(N))=0FH
1230 PH1. DPORT(0), SPC (3),
1240 NEXT : PRINT1
1250 PRINT1 "BCD ASSIGNMENT"
1260 DPORT(0,B)=1120
1270 PH1. DPORT(0)," = 1120"

```

READY

>run

```

Retrieving values from DPORT
DPORT(0) = 1120H in hexadecimal
1st nibble = 0   3rd nibble = 1
DPORT(0) in binary = 0001000100100000
1120H or 4384 treated as BCD = 1120 decimal
Value with bytes swapped = 2011H

```

Assigning bits and nibbles in DPORT

```

0001H 0003H 0007H 000FH 001FH 003FH 007FH 00FFH 01FFH 03FFH 07FFH 0FFFH
1FFFH 3FFFH 7FFFH FFFFH 000FH 00FFH 0FFFH FFFFH
BCD ASSIGNMENT
1120H = 1120

```

## ONPLC

Function	Ladder logic based interrupt of normal BASIC program flow
Syntax	ONPLC line number
See Also	BMOVE, DPORT, and S405_
Usage	ONPLC enables interruption of normal BASIC program flow in response to requests made by the DL405 CPU.

ONPLC specifies the beginning line number where program execution will continue when the interrupt occurs. The interrupt is delayed until the current BASIC statement is completed (Execution begins immediately if the current statement is IDLE or DELAY).

After a RETI statement is executed, execution resumes with the statement following the last statement executed before the interrupt occurred.

The ONPLC statement will enable only a single BASIC program interrupt to occur. Future ONPLC interrupts are disabled until another ONPLC statement is executed. Normally another ONPLC statement is included in the interrupt subroutine.

An ONPLC statement with a line number of 0 will disable the ONPLC interrupt.

The DL405 CPU passes data to the ABM and causes an ONPLC interrupt to occur using a Write Data To Network (WX) instruction. Up to 128 bytes of data may be transferred with one WX instruction. The data is transferred to the CoProcessor dual port locations DPORT(256) to DPORT(383). The number of bytes written is stored in DPORT(385).

Executing a DL405 RX or WX instruction will turn ON the Special Purpose Data Communication BUSY relay associated with the ABM's slot. A BASIC RETI statement resets the BUSY Relay. If a BASIC RETI statement is not executed within 16 seconds following a DL405 WX instruction then a Special Purpose Data Communication ERROR Relay associated with the ABM's slot is energized (see table on the next page).

Special Purpose (SP) Data Communications Relays									
Slot	0	1	2	3	4	5	6	7	BASE
BUSY	120	122	124	126	130	132	134	136	CPU BASE 0 ALL CPUS
ERROR	121	123	125	127	131	133	135	137	
BUSY	140	142	144	146	150	152	154	156	EXPANSION BASE 1 D4-450 ONLY
ERROR	141	143	145	147	151	153	155	157	
BUSY	160	162	164	166	170	172	174	176	EXPANSION BASE 2 D4-450 ONLY
ERROR	161	163	165	167	171	173	175	177	
BUSY	200	202	204	206	210	212	214	216	EXPANSION BASE 3 D4-450 ONLY
ERROR	201	203	205	207	211	213	215	217	

Example Write V-Memory to the ABM using WX

The high byte of the first load (LD) in the following example, holds the ABM's base number (0-3) and the slot number (0-7). For a D4-430 or a D4-440 CPU the base number must be 0. The low byte contains a two digit BCD code from 1 to 90 which gets written to the ABM at DPORT(384). This value may be used as required in the application program and does not effect the execution of the WX instruction. The value loaded will be in the second stack register when the WX instruction executes.

The first stack register holds the BCD number of bytes to write to the ABM. This is specified by the second LD in the following example. The byte count gets stored in the ABM at DPORT(385).

The accumulator holds the octal V-Memory source address of the data in the DL405. This is specified by the LDA instruction in the following example. Up to 128 bytes or 64 consecutive V-Memory locations may be moved to the ABM with one WX instruction. The data is stored in the ABM beginning at DPORT(256).

The address used with the WX instruction is arbitrary. This address is converted from octal to hexadecimal and is stored in the ABM, low byte first, in DPORT(386) and DPORT(387).

In the ladder logic example following, an arbitrary coil, C0 comes ON to initiate an ONPLC interrupt.

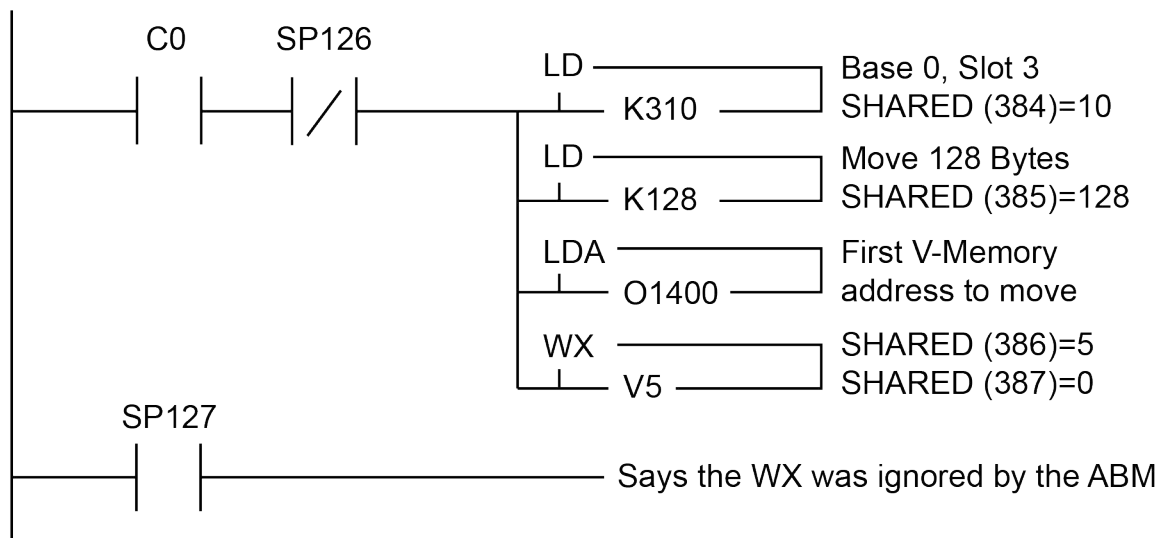
SP126 is used to prevent another WX from executing while the ABM is busy.

LD K0310 directs the WX to the ABM in CPU base (base 0) of slot 3 and stores the value 10 in DPORT(384). LD K128 specifies that 128 bytes will be written. LDA O1400 specifies the source V-Memory address. Data will be moved from V-Memory 1400-1477 to DPORT(256)-DPORT(383). The WX V5 instruction sets the BUSY relay SP126, resets the ERROR relay SP127, writes the data, and stores 5 in DPORT(386).

```

10 ONPLC 100
20 GOTO 10 : REM Do nothing while we wait for the interrupt
100 REM
110 REM Start of PLC interrupt service routine - PRINT the data
120 REM
130 PRINT "Data identification codes ",
140 PRINT DPORT(384,L),SPC(2),DPORT(386)-1
150 FOR K = 0 TO DPORT(385,L)-1 STEP 2
160 PRINT "Dual Port Word ",K/2+1," = ",DPORT(256+K)
170 NEXT K
180 RETI

```



## S405\_

Function Directly access DL405 CPU memory

Syntax S405\_operand(number) = expression  
variable = S405\_operand(number)

Shorthand S.

See Also BMOVE, DPORT, and ONPLC

Usage DL405 memory may be accessed directly each scan using any one of 12 different operands specified with an octal address number.

The S405\_ statement moves the value of expression into the DL405 memory address specified by operand(number). If the memory address is written to by the DL405 CPU program, the S405\_ statement will be overridden.

The S405\_ operator copies the value from the DL405 memory address specified by operand(number) into a numeric variable.

S405\_ values will be BCD, HEXadecimal, or BIT data types depending on the operand used. Discrete operands such as I/O points and control relays operate on bits and return logical values. Timer and counter accumulated values are in BCD.

The table below specifies the octal numbering and data types for each of the S405\_ operands (typical VB and VH operand usage is shown).

Octal numbering and data types for S405\_ operands

### 430 CPU S405\_ Operands

Description	Operand	Qty	Octal numbering	Data Type	V-Memory Octal Word
Timer Current	T	128	0-177	BCD	0-177
Count Current	CT	128	0-177	BCD	1000-1177
V-Memory User System	VH or VB VH	3072 256	1400-7377 7400-7777	HEX or BCD HEX	1400-7377 7400-7777
Remote I/O	GX	512	0-777	Bit	40000-40037
Inputs	X	320	0-477	Bit	40400-40423
Outputs	Y	320	0-477	Bit	40500-40523
Internal Relays	C	480	0-737	Bit	40600-40635
Stage Status	SG	384	0-577	Bit	41000-41027
Timer Status	TS	128	0-177	Bit	41100-41107
Counter Status	CS	128	0-177	Bit	41140-41147
Special Relays	SP SP	96 192	0-137 320-617	Bit Bit	41200-41205 41215-41230

#### 440 CPU S405\_ Operands

Description	Operand	Qty	Octal numbering	Data Type	V-Memory Octal Word
Timer Current	T	128	0-177	BCD	0-377
Count Current	CT	256	0-177	BCD	1000-1177
V-Memory Special	VH	32	700-737	HEX	700-737
User	VH or VB	3072	1400-7377	HEX or BCD	1400-7377
System	VH	256	7400-7777	HEX	7400-7777
User	VH or VB	4096	10000-17777	HEX or BCD	10000-17777
Remote I/O	GX	1024	0-1777	Bit	40000-40077
Inputs	X	320	0-477	Bit	40400-40423
Outputs	Y	320	0-477	Bit	40500-40523
Internal Relays	C	1024	0-1777	Bit	40600-40677
Stage Status	SG	1024	0-1777	Bit	41000-41077
Timer Status	TS	256	0-377	Bit	41100-41117
Counter Status	CS	128	0-177	Bit	41140-41147
Special Relays	SP	96	0-137	Bit	41200-41205
	SP	256	320-717	Bit	41215-41235

#### 450 CPU S405\_ Operands

Description	Operand	Qty	Octal numbering	Data Type	V-Memory Octal Word
Timer Current	T	256	0-377	BCD	0-377
Count Current	CT	256	0-177	BCD	1000-1377
V-Memory	VH		0-41235	HEX or BCD	0-41235
Remote Inputs	GX	2048	0-3777	Bit	40000-40177
Remote Outputs	GY	2048	0-3777	Bit	40200-40377
Inputs	X	1024	0-1777	Bit	40400-40477
Outputs	Y	1024	0-1777	Bit	40500-40577
Internal Relays	C	2048	0-3777	Bit	40600-40777
Stage Status	SG	1024	0-1777	Bit	41000-41077
Timer Status	TS	256	0-377	Bit	41100-41117
Counter Status	CS	256	0-377	Bit	41140-41157
Special Relays	SP	512	0-777	Bit	41200-41237

Example Using DL405 bit data type operands:

```

10 REM Display status on Input X4
20 IF S405_X(4) THEN PRINT1 "ON" ELSE PRINT1 "OFF"

10 REM Turn ON DL405 internal Control Relay C400
20 S405_C(400) = 1

10 REM Output Y23=OFF if CT2 is ON and X17 is OFF
20 IF S405_CS(2).AND.NOT(S405_X(17)) THEN S405_Y(23) =0

```

Example Using BCD data type operands:

```
10 REM Display current count for CNT C10 and TMRF T0
20 PRINT1 "Counter 10 = ",S405_CT(10)
30 PRINT1 "Timer 0 = ",S405_TS(0)/100
```

```
10 REM Divide the current count of CNT C7 by 2
20 S405_CT(7) = S405_CT(7)/2
```

```
10 REM Value from Analog Input is in V-Memory 1400
20 REM V-Memory 1401 gets the value for an Analog Out
30 REM Keep the Analog Out proportional to Analog In
40 AOUT = S405_VB(1400) * SCALE - OFFSET
50 REM Limit range of Analog Out value (0-4095)
60 IF AOUT < 0 THEN AOUT = 0
70 IF AOUT > 4095 THEN AOUT = 4095
80 S405_VB(1401) = AOUT
```

Example Using hexadecimal data types:

```
10 REM Display the current scan time
20 PRINT1 "Current scan time = ",S405_VH(7775)
```

Advanced The V-Memory numbering for each operand is shown in the previous table. The VH and VB operands may be used to access any portion of V-Memory.

```
Display current count for CNT C0
>P. S.VB(1000)
```

```
Display status of first 16 point Input module, X0 - X17
>P. S.VH(40400)
```

S405\_ with no operand permits hexadecimal V-Memory addressing. The V-Memory hexadecimal address is equal to the octal address + 1. S405\_VH(1400) is the same as S405\_(301H). This feature is useful for FOR-NEXT loops and other types of "calculated" PLC memory accesses.



## CHAPTER 3: F4-CP128-1 Triple Port OverDrive CoProcessor

### F4-CP128-1 GENERAL SPECIFICATIONS

Mounting Requirement	- Any I/O Slot in the DL405 CPU Local Base - Up to 8 modules per DL405 CPU Local Base
Power Consumption	- 235 mA @ 5 Vdc maximum (supplied by 405 base)
Operating Environment	- 0 to 60 degrees C (32 to 140 degrees F) - 5 to 95% humidity (non-condensing)
Processor	- Dallas 80C320
Clock Speed	- 26 Mhz
User Memory	- 128K Total (64K Data, 64K Program)
Physical Connectors	- Two 9 Pin D type connectors - Port 1 (top 9 Pin) - Port 2 (bottom 9 Pin)
Indicator LEDs	- POWER, TXD1, RXD1, TXD2 (Green)/RTS1 (Red), RXD2 (Green) /CTS1 (Red)
Port 1	- RS232/422/485 Selectable - 115200 Baud Maximum
Port 2	- RS232/422/485 Selectable - 57600 Baud Maximum
Port 3	- RS232 - 9600 Baud Maximum
Additional Features	- Battery Backed Calendar/Clock - Programmable from Port 1 or Port 2

## F4-CP128-1 DESCRIPTION

This DL405 family compatible CoProcessor Module features 128K of non-volatile memory, three serial ports, real-time battery backed calendar clock, floating point math, and the FACTS Extended BASIC interpreter.

128K bytes of nonvolatile memory allows multiple program storage and execution, DL405 register expansion, and retentive data storage and retrieval.

Port 1 is a high performance 115.2K baud maximum fully configurable RS-232 or RS-422/485 serial interface. Port 2 is a 57.6K baud maximum fully configurable RS-232 or RS-422/485 serial interface. Port 3 is a 19.2K baud maximum fully configurable RS-232 serial interface. All three ports have 255 character type-a-head input buffers for simultaneous communication with three or more external devices.

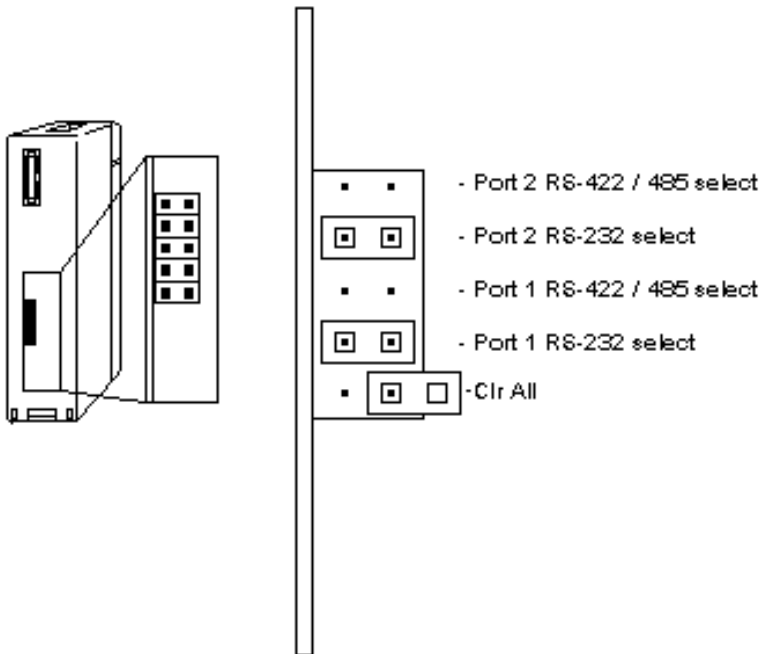
The real-time battery-backed calendar clock maintains time and date when power outages occur. Time based BASIC interrupts can be programmed to .005 of a second.

Floating point math solves complex formulas to 8 significant digits.

The FACTS Extended BASIC interpreter has many features and statements that simplify control oriented programming.

- Program from Port 1 or Port 2 (COMMAND@)
- Flexible bit manipulation instruction (BITS and PICK)
- Serial port and timer interrupts (ONPORT and ONTIME)
- Extensive serial port control (SETPORT, SETINPUT, PRINT, INPUT, INPLEN, INLEN)
- Extensive string manipulation instructions (MID\$, LEFT\$, RIGHT\$, REVERSE\$, ASC, CHR\$, LCASE\$, UCASE\$, STR\$, VAL, HEX\$, OCTHEX\$, DATE\$, TIME\$)
- Debugging tools (TRACE, STOP, CONT)
- Program chaining (GOPRM)
- Statements and control structures common to most BASICs

## F4-CP128-1 JUMPER DESCRIPTIONS AND LOCATIONS



### PORT 2

The communication interface type for port 2 is selected by placing a jumper on one of the port 2 options, either RS422/485 or RS232. The RS232 selection is the default factory setting.

### PORT 1

The communication interface type for port 1 is selected by placing a jumper on one of the port 1 options, either RS422/485 or RS232. The RS232 selection is the default factory setting.

### CLR ALL

The CLR all jumper specifies the AUTOSTART mode that the module will use at reset. Placing the jumper on both posts disables AUTOSTART and waits for a space bar character in port 1. Placing the jumper on one

post allows the module to use the last stored AUTOSTART parameters (this is the default factory setting).

**CAUTION:** Installing the CLR ALL jumper will erase program 0, all stored variables, cancel a COMMAND@2, remove LOCKOUT, and clear stored AUTOSTART information.

## F4-CP128-1 PORT PINOUTS

F4-CP128-1 Port Pinouts

PORT 1 - Programming / Communication		
Pin	Signal Name	Description
1	RXD1+	Data Input high, RS-422
2	TXD1	Data Output, RS-232
3	RXD1	Data Input, RS-232
4	RTS1 / <b>TXD3 *</b>	DTE has data to xmit, RS-232
5	CTS1 / <b>RXD3 *</b>	DTE may xmit data, RS-232
6	RXD1-	Data Input low, RS-422
7	GND	Signal ground
8	TXD1-	Data Output low, RS-422
9	TXD1+	Data Output high, RS-422

\* - the Port 3 TXD / RXD signals appear at unused hardware handshaking lines, RTS / CTS. If Port 3 is not used then the lines maybe used for hardware handshaking.

RXD2 LED = Port2 RX if Green / Port 1 CTS or Port 3 RX if Red

TXD2 LED = Port 2 TX if Green / Port 1 RTS or Port 3 TX if Red

PORT 2 - Programming / Communication		
Pin	Signal Name	Description
1	RXD2+	Data Input high, RS-422
2	TXD2	Data Output, RS-232
3	RXD2	Data Input, RS-232
4	RTS2	DTE has data to xmit, RS-232
5	CTS2	DTE may xmit data, RS-232
6	RXD2-	Data Input low, RS-422
7	GND	Signal ground
8	TXD2-	Data Output low, RS-422
9	TXD2+	Data Output high, RS-422

## CHAPTER 4: F4-CP512-1 Triple Port Data Storage CoProcessor

### F4-CP512-1 GENERAL SPECIFICATIONS

Mounting Requirement	- Any I/O Slot in the DL405 CPU Local Base - Up to 8 modules per DL405 CPU Local Base
Power Consumption	- 305 mA @ 5 Vdc maximum (supplied by 405 base)
Operating Environment	- 0 to 60 degrees C (32 to 140 degrees F) - 5 to 95% humidity (non-condensing)
Processor	- Dallas 80C320
Clock Speed	- 26 Mhz
User Memory	- 512K Total (64K Data, 64K Program, 384K Data Storage)
Physical Connectors	- Two 9 Pin D type connectors - Port 1 (top 9 Pin) - Port 2 (bottom 9 Pin)
Indicator LEDs	- POWER, TXD1, RXD1, TXD2 (Green)/RTS1 (Red), RXD2 (Green) /CTS1 (Red)
Port 1	- RS232/422/485 Selectable - 115200 Baud Maximum
Port 2	- RS232/422/485 Selectable - 57600 Baud Maximum
Port 3	- RS232 - 9600 Baud Maximum
Additional Features	- Battery Backed Calendar/Clock - Programmable from Port 1 or Port 2

**NOTE:** This module replaces the F4-CP512.

## F4-CP512-1 DESCRIPTION

This DL405 family compatible CoProcessor Module features 512K of non-volatile memory, two serial ports, real-time battery backed calendar clock, floating point math, and the FACTS Extended BASIC interpreter.

512K bytes of nonvolatile memory allows multiple program storage and execution, DL405 register expansion, and high capacity retentive data storage and retrieval.

Addresses in the range 0 to 65535 (0FFFFH) access BASIC data memory and PROGRAM 0. Addresses in the range 65536 to 131071 (1FFFFH) access the program storage space (PROGRAM 1 is saved beginning at address 65536). Use BYTE, WORD, STORE@, LOAD@, and COPY to store and retrieve memory addressed in the range 131072 (20000H) to 524287 (7FFFFH). This section of memory is useful for permanent storage of look-up tables, set-up and configuration parameters and for historical data logging with or without time and date stamp.

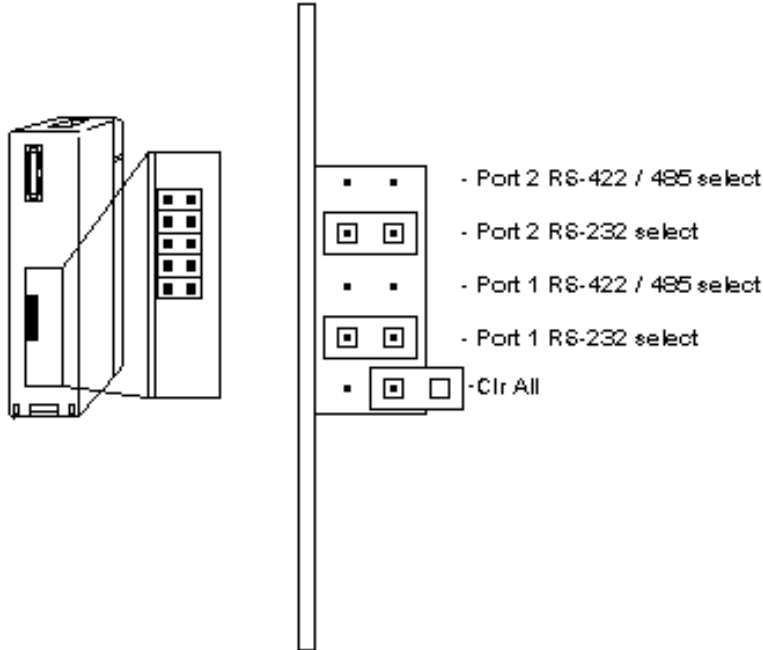
Port 1 is a high performance 57.6K baud fully configurable RS-232 or RS-422/485 serial interface. Port 2 is a 9600 baud fully configurable RS-232 or RS-422/485 serial interface. Both ports have 255 character type-a-head input buffers for simultaneous communication with three or more external devices. The real-time battery-backed calendar clock maintains time and date when power outages occur. Time based BASIC interrupts can be programmed to .005 of a second.

Floating point math solves complex formulas to 8 significant digits.

The FACTS Extended BASIC interpreter has many features and statements that simplify control oriented programming.

- ✓ Program from Port 1 or Port 2 (COMMAND@)
- ✓ Flexible bit manipulation instruction (BITS and PICK)
- ✓ Serial port and timer interrupts (ONPORT and ONTIME)
- ✓ Extensive serial port control (SETPORT, SETINPUT, PRINT, INPUT, INPLEN, INLEN)
- ✓ Extensive string manipulation instructions (MID\$, LEFT\$, RIGHT\$, REVERSE\$, ASC, CHR\$, LCASE\$, UCASE\$, STR\$, VAL, HEX\$, OCTHEX\$, DATE\$, TIME\$)
- ✓ Debugging tools (TRACE, STOP, CONT)
- ✓ Program chaining (GOPRM)
- ✓ Statements and control structures common to most BASICs

## F4-CP512-1 JUMPER DESCRIPTIONS AND LOCATIONS



### PORT 2

The communication interface type for port 2 is selected by placing a jumper on one of the port 2 options, either RS422/485 or RS232. The RS232 selection is the default factory setting.

### PORT 1

The communication interface type for port 1 is selected by placing a jumper on one of the port 1 options, either RS422/485 or RS232. The RS232 selection is the default factory setting.

### CLR ALL

The CLR all jumper specifies the AUTOSTART mode that the module will use at reset. Placing the jumper on both posts disables AUTOSTART and waits for a space bar character in port 1. Placing the jumper on one post

allows the module to use the last stored AUTOSTART parameters (this is the default factory setting).

**CAUTION:** Installing the CLR ALL jumper will erase program 0, all stored variables, cancel a COMMAND@2, remove LOCKOUT, and clear stored AUTOSTART information.

## F4-CP512-1 PORT PINOUTS

F4-CP512-1 Port Pinouts

PORT 1 - Programming / Communication		
Pin	Signal Name	Description
1	RXD1+	Data Input high, RS-422
2	TXD1	Data Output, RS-232
3	RXD1	Data Input, RS-232
4	RTS1 / <b>TXD3 *</b>	DTE has data to xmit, RS-232
5	CTS1 / <b>RXD3 *</b>	DTE may xmit data, RS-232
6	RXD1-	Data Input low, RS-422
7	GND	Signal ground
8	TXD1-	Data Output low, RS-422
9	TXD1+	Data Output high, RS-422

\* - the Port 3 TXD / RXD signals appear at unused hardware handshaking lines, RTS / CTS. If Port 3 is not used then the lines maybe used for hardware handshaking.

RXD2 LED = Port2 RX if Green / Port 1 CTS or Port 3 RX if Red

TXD2 LED = Port 2 TX if Green / Port 1 RTS or Port 3 TX if Red

PORT 2 - Programming / Communication		
Pin	Signal Name	Description
1	RXD2+	Data Input high, RS-422
2	TXD2	Data Output, RS-232
3	RXD2	Data Input, RS-232
4	RTS2	DTE has data to xmit, RS-232
5	CTS2	DTE may xmit data, RS-232
6	RXD2-	Data Input low, RS-422
7	GND	Signal ground
8	TXD2-	Data Output low, RS-422
9	TXD2+	Data Output high, RS-422



## CHAPTER 5: F4-CP128-R Radio Modem CoProcessor

### F4-CP128-R GENERAL SPECIFICATIONS

Mounting Requirement	- Any I/O Slot in the DL405 CPU Local Base - Up to 8 modules per DL405 CPU Local Base
Power Consumption	- 350 mA @ 5 Vdc maximum (supplied by 405 base)
Operating Environment	- 0 to 60 degrees C (32 to 140 degrees F) - 5 to 95% humidity (non-condensing)
Processor	- Intel 80C51FA-1
Clock Speed	- 16 Mhz
User Memory	- 128K Total (64K Data, 64K Program)
Physical Connectors	- Two 9 Pin D type connectors - Port 1 (top 9 Pin) - Port 2 (bottom 9 Pin)
Indicator LEDs	- POWER, TXD1, RXD1, RXD2
Port 1	- RS232 - 57600 Baud Maximum
Port 2	- Leased Line / Radio Modem - 1200 Baud Maximum - Typical Leased Line Distance is 10 Miles
Port 3	- RS232 - 9600 Baud Maximum
Additional Features	- Battery Backed Calendar/Clock - Programmable from Port 1 or Port 2

**NOTE: This module has been obsoleted and should not be used in new applications.**

## **F4-CP128-R DESCRIPTION**

This DL405 family compatible CoProcessor Module incorporates a 300/600/1200 baud FSK, asynchronous modem. The modem is Bell 103/113/108, Bell 202, CCITT V.21, and V.23 compatible with fast response times for direct connection to leased-line networks and radios. BASIC statements are used to control the modem and communicate with external devices.

Modem operation is selected by jumper placement for either a 2-wire or 4-wire connection. Communication at 300 baud full-duplex or 600/1200 baud half-duplex is achieved using a two wire interface. Full-duplex operation at 300 to 1200 baud is supported over a four wire interface.

DC isolation and common-mode rejection between the modem and the telephone line or radio is achieved with transmit and receive transformers.

Transmit and receive circuits are balanced to match the telephone network load impedance, which in the U.S.A. is typically 600Ω.

Although the modem is not FCC or DOC (Canada) approved for direct connection to the Public Switched Telephone Network (PSTN), transmit level and receive sensitivity may be fixed by jumper placement to conform to FCC Part 68. Alternate jumper placement permits transmit level adjustment and receive attenuation for non-telephone standard interfaces.

Hazard protection is provided by Metal-oxide varistors (MOVs) and back to back zener diodes which effectively clamp transients at the supply rails. An external 0.5A Slow Blow Fuse is recommended for each transformer to protect against power line shorts to the phone lines. Use of a Slow Blow type fuse will prevent safe transients from blowing the fuse.

## FULL-DUPLEX, 2 or 4-WIRE OPERATION

### General Description:

In a 4-wire leased-line or radio connection, the transmit signals are isolated from the receive signals thus allowing the same frequencies to be used to communicate in both directions. This is necessary since a high speed single Bell 202 or CCITT V.23 channel uses more than half of the available bandwidth.

For the lower speed (300 baud) Bell 103 and CCITT V.21, bandwidth is shared between two channels. This permits 2-wire full-duplex operation (transmit and receive simultaneously).

### Communication Protocol:

The calling modem asserts RTS which enables its' transmitter. After "Carrier Detect ON Delay" the called modem begins to receive data. After a longer time period, "RTS to CTS ON Delay", the calling modem begins to transmit data. In this manner, data may be transmitted in both directions simultaneously.

### Lease-line Communication:

When hardware handshaking is enable for Port 2 with the SETPORT statement, communication timing is taken care of automatically as follows.

- 1) A PRINT2 statement will assert RTS. This will close the relay contact and begin carrier transmission.
- 2) After 8 msec (25 msec at 300 baud) data transmission of the PRINT statement list will begin.
- 3) Two character times after the last data bit has been transmitted, RTS will turn OFF thus dropping the carrier and opening the relay contact (RTS can be extended at the end of a PRINT2 statement by changing the contents of DBY(27), the default is DBY(27)=2).
- 4) Data reception begins automatically after a valid carrier signal has been detected for 3 to 5 msec (10 to 16 msec at 300 baud). Received data is placed into the 255 character Port 2 input buffer. Use the FACTS Extended BASIC statements ONPORT2, INPUT2, INLEN2, INKEY\$, and SETINPUT to process the received data.

## **BELL 202 OR V.23 HALF-DUPLEX, 2-WIRE OPERATION**

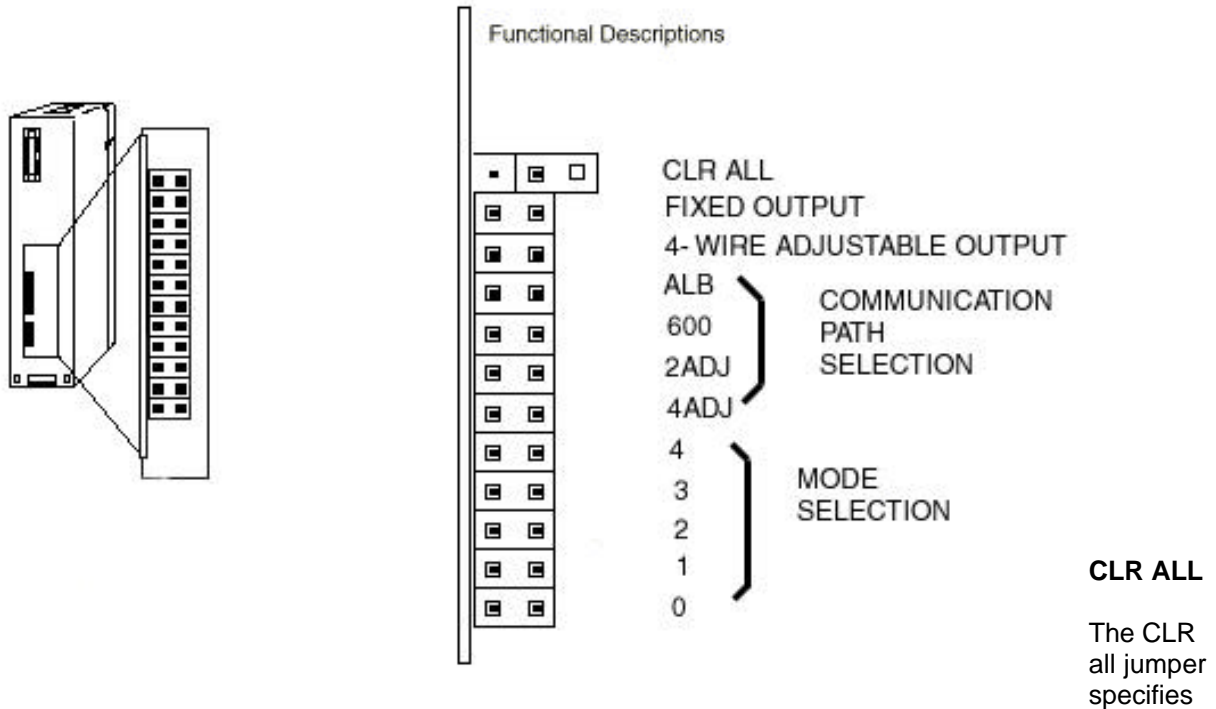
### Communication Protocol:

The calling modem asserts RTS which enables its' transmitter (Mark carrier is output). After "Carrier Detect ON Delay" the called modem begins to receive data. After a longer time period, "RTS to CTS ON Delay", the calling modem begins to transmit data. Data transmission continues until RTS turns OFF. If a soft turn-off mode is selected, a soft turn-off tone (900 Hz) is output for 8 msec. A squelch period of 9 msec also begins as soon as RTS turns OFF. During the squelch period carry detect is clamped OFF.

### Squelch:

The local receiver is clamped OFF after RTS is turned OFF so that line transients are not demodulated. Half-duplex squelch delay is 9 msec for 600/1200 baud modes. After the squelch delay modem carrier detect is enabled.

## F4-CP128-R JUMPER DESCRIPTIONS AND LOCATIONS



the AUTOSTART mode that the module will use at reset. Placing the jumper on both posts disables AUTOSTART and waits for a space bar character in port 1. Placing the jumper on one post allows the module to use the last stored AUTOSTART parameters (this is the default factory setting).

**CAUTION:** Installing the CLR ALL jumper will erase program 0, all stored variables, cancel a COMMAND@2, remove LOCKOUT, and clear stored AUTOSTART information.

## TRANSMIT LEVEL ADJUSTMENT POT

Access to the transmit level adjustment pot is made via the small hole above the Port 2 DE-9 connector marked TXL. Turn the 25 turn pot clockwise to reduce the transmit level. Place a jumper on the Fixed Output posts to select the fixed -9 dBm transmit level. Place a jumper on the Four Wire Adjustable Output posts to enable transmit level adjustment.

## RECEIVE SENSITIVITY ADJUSTMENT POT

Access to the receive sensitivity pot is made via the small hole above the Port 1 DE-9 connector marked SENS. Turn the 25 turn pot counter-clockwise to attenuate (decrease) the receive sensitivity. To disable the pot place a jumper on the "600" pins. To enable 2-wire or 4-wire sensitivity adjustment, position a jumper on the pins labeled "2ADJ" or "4ADJ" respectively.

## COMMUNICATION PATH SELECTION

Install a single jumper in one of the four sets of pins labeled ALB, 600, 2ADJ, OR 4ADJ in the diagram below. This selects the signal path as shown in the table below.

Communication Path	ALB	600	2ADJ	4ADJ
Data TXD to RXD (analog loop back)	O	Q	Q	Q
4-wire w/ no RXD sensitivity adjustment	Q	O	Q	Q
2-wire w/ RXD sensitivity adjustment	Q	Q	O	Q
4-wire w/ RXD sensitivity adjustment	Q	Q	Q	O

## EQUALIZATION

The Equalized modes use fixed digital filters to compensate for both amplitude and group delay distortion (group delay is the derivative of the phase of a signal with respect to frequency). CCITT V.23 equalization is for a typical European phone line. Bell 202 Equalization is for a typical U.S. phone line.

## MODE SELECTION

Modem operating mode selection is made by positioning jumpers on the last 5 pairs of pins labeled "4" to "0" as shown in the following tables. A "0" in the following tables indicates that the jumper should be removed whereas a "1" indicates that it should be installed.

### 300 BAUD

Modem Operating Mode Description	4	3	2	1	0
Bell 103 orig., 300 bps, full-duplex, 2-wire	0	0	0	0	0
Bell 103 orig., 300 bps, full-duplex, 4-wire (Receive = Transmit Frequency, 1070/1270 Hz)	1	0	0	0	0
Bell 103 answer, 300 bps, full-duplex, 2-wire	0	0	0	0	1
Bell 103 answer, 300 bps, full-duplex, 4-wire (Receive = Transmit Frequency, 2025/2225 Hz)	1	0	0	0	1

### 600 BAUD

Modem Operating Mode Description	4	3	2	1	0
CCITT V.23 mode 1, 600 bps, half-duplex, 2-wire	0	1	0	0	0
CCITT V.23 mode 1, 600 bps, full-duplex, 4-wire	1	1	0	0	0
CCITT V.23 mode 1, 600 bps, half-duplex, 2-wire with soft turn off	0	1	1	0	0

## MODE SELECTION (cont)

### 1200 BAUD

Modem Operating Mode Description	4	3	2	1	0
Bell 202, 1200 bps, half-duplex, 2-wire	O	O	O	Q	O
Bell 202, 1200 bps, full-duplex, 4-wire	Q	O	O	Q	O
Bell 202 w/equ., 1200 bps, half-duplex, 2-wire	O	O	O	Q	Q
Bell 202 w/equ., 1200 bps, full-duplex, 4-wire	Q	O	O	Q	Q
CCITT V.23 mode 2, 1200 bps, half-duplex, 2-wire	O	O	Q	Q	O
CCITT V.23 mode 2, 1200 bps, full-duplex, 4-wire	Q	O	Q	Q	O
CCITT V.23 mode 2, 1200 bps, half-duplex, 2 wire with soft turn off	O	Q	Q	Q	O
CCITT V.23 mode 2 w/ equ., 1200 bps, half-dup.	O	O	Q	Q	Q
CCITT V.23 mode 2 w/ equ., 1200 bps, full-dup.	Q	O	Q	Q	Q
CCITT V.23 mode 2 w/ equ., 1200 bps, half-dup., 2 wire with soft turn off	O	Q	Q	Q	Q

## SOFT TURN-OFF

When RTS is turned OFF at the end of a message, transients occur which may cause spurious space signals to be received at a remote modem (thus generating unwanted characters). During soft turn-off the modem transmits a soft carrier frequency of 900 Hz for 8 msec. This results in a steady Mark on the receive line of the remote modem. Soft turn-off is selectable for 1200 baud operation, full or half duplex.

Soft turn-off modes are only appropriate for leased-line communication (turning off RTS turns off the radio transmitter). Radio communication soft turn-off is accomplished by holding RTS ON for 1 or 2 character times after PRINTing the data (see BASIC example program).



## F4-CP128-R PORT PINOUTS

PORT 1 - PROGRAMMING/COMMUNICATION		
PIN	SYMBOL	DESCRIPTION
1	N/C	NOT CONNECTED, RESERVED
2	TXD1	DATA OUTPUT, RS-232
3	RXD1	DATA INPUT, RS-232
4	RTS1/TXD3*	DTE HAS DATA TO XMIT RS232
5	CTS1/RXD3*	DTE MAY XMIT DATA RS232
6	N/C	NOT CONNECTED, RESERVED
7	GND	SIGNAL GROUND
8	N/C	NOT CONNECTED, RESERVED
9	N/C	NOT CONNECTED, RESERVED

\* The Port 3 TXD/RXD signals appear at unused hardware handshaking lines, RTS/CTS. If Port 3 is not used then the lines may be used for hardware handshaking.

PORT 2 - COMMUNICATION	
PIN	DESCRIPTION
1	MODEM TRANSMIT -
2	MODEM TRANSMIT +
3	RESERVED
4	MODEM RECEIVE -
5	MODEM RECEIVE +
6	NOT CONNECTED
7	RELAY OUTPUT N.O.
8	RELAY OUTPUT COM
9	NOT CONNECTED

### TRANSMIT RELAY

An on-board Solid State relay provides a normally open contact closure which can be used to key a radio transmitter. Maximum load current is 100 mA from 0 to 300 V ac or dc. Maximum ON state resistance is 24Ω . The relay is controlled from BASIC using the DTR2 statement (DTR2 is same as modem RTS).



## CHAPTER 6: F4-CP128-T Telephone Modem CoProcessor

### F4-CP128-T GENERAL SPECIFICATIONS

Mounting Requirement	- Any I/O Slot in the DL405 CPU Local Base - Up to 8 modules per DL405 CPU Local Base
Power Consumption	- 350 mA @ 5 Vdc maximum (supplied by 405 base)
Operating Environment	- 0 to 60 degrees C (32 to 140 degrees F) - 5 to 95% humidity (non-condensing)
Processor	- Intel 80C51FA-1
Clock Speed	- 16 Mhz
User Memory	- 128K Total (64K Data, 64K Program)
Physical Connectors	- Two 9 Pin D type connectors - Port 1 and 3 (top 9 Pin) - Port 2 (bottom 9 Pin) - One RJ11 Telephone Jack
Indicator LEDs	- POWER, TXD1, RXD1, TXD2, RXD2
Port 1	- RS232/422/485 Jumper Selectable - 57600 Baud Maximum
Port 2	- Telephone Modem - 2400 Baud Maximum OR - RS232 - 9600 Baud Maximum
Port 3	- RS232 - 9600 Baud Maximum
Additional Features	- Battery Backed Calendar/Clock - Programmable from Port 1 or Port 2 - Meets all FCC Part 68 and DOC requirements

## **F4-CP128-T DESCRIPTION**

This DL405 family compatible CoProcessor Module incorporates a full duplex, 300/1200/2400 baud PSK/FSK, asynchronous modem on Port 2. Port 3 is a fully configurable RS-232 port, 9600 baud maximum. Port 1 is a high performance 57.6K baud fully configurable RS-232 or RS-422/485 serial interface. The modem is Bell 212A, Bell 103, CCITT V.21, and CCITT V.22 and V.22 bis compatible.

The auto dialer includes the capability for DTMF tone generation and call progress monitoring. Call progress monitoring capabilities allow the user's BASIC program to detect no dial tone, a busy signal, and incoming rings.

The modem can be programmed to auto answer calls based on the number of rings, the time and date or other application specific requirements.

Port 1 or Port 2 can be software configured to be the programming port thus allowing remote programming and simplified software development.

Direct connection to the telephone line is made via a standard RJ-12 PHONE jack.

BASIC statements and industry standard "AT" commands are used to control the modem and communicate with other modems over the public switched telephone network (PSTN).

All three ports have 255 character type-a-head input buffers for simultaneous communication with three or more external devices.

### **Modem Operation**

Command and on-line operating modes of the modem are enabled with the DTR2 statement.

- 10 DTR2 = 0 : REM Disable modem (Hang-up and exit on-line mode)
- 20 DTR2 = 1 : REM Enable modem (Enter command mode)

## Modem "AT" Commands

"AT" command strings are PRINTed at Port 2 to control modem operation. These commands are subdivided into three major groups:

- Configuration** Configuration commands affect the modem operation by changing the contents of "S-registers" (software registers). The B command which selects CCITT or BELL protocols is an example of this type of command. As a result of the B command, bit six of S-register 14 is set or cleared depending on which protocol is chosen.
- Action** Action commands instruct the modem to perform an action Immediately. Examples are the "A", go off hook in Answer mode, command and the "D", dial, command.
- Diagnostic** Diagnostic commands initiate Local Analog and Digital Loopback tests and Remote Digital Loopback test (Detailed information on diagnostic commands is available from FACTS Engineering).

The "AT" prefix begins every command string with the exception of "+++", escape, and the "A", repeat, commands. "AT" (attention code) allows the modem to determine the PORT 2 data rate and parity setting (see SETPORT statement in the FACTS Extended BASIC User's Reference). The modem will adopt these parameters until a new "AT" command is received.

Multiple commands can be included in a single PRINT statement. Space characters are allowed between commands to improve readability. A command string must be terminated with the ASCII carriage return character (default value in S-register 3). If a line feed character follows the carriage return character it is ignored. A result code is returned by the modem following execution of the command (see the RESULT CODES Table).

The command buffer can hold up to 40 characters before connection is made. It holds 10 characters after connection is established.

**Example** 10 PRINT2 "AT DT 1(234)567-8910" : REM Touch tone dialing

The punctuation symbols and spaces are optional and are ignored by the auto-dialer.

## Modem "AT" Commands Summary

AT	Precedes all command lines except "+++", escape, and "A/", repeat
A	Answer call without waiting for ring
A/	Repeat previous command line
B	CCITT V.22 and V.21 mode
B1	Bell 212A and 103 mode (default)
C/C0	Transmit carrier off
C1	Transmit carrier on (default)
D	Dial a number (0-9 ABCD*#)
E	Turn Echo off
E1	Turn Echo on (default)
H	Go on hook or hang up, PHONE jack connected to LINE (default)
H1	Go off hook
Q	Return result codes (default)
Q1	Do not return result codes
Sn=x	Write x in S-register n
Sn?	Read S-register n
V/V0	Enable short form numeric result codes (default)
V1	Enable full word result codes
X/X0	CONNECT result code enabled (default)
X1	CONNECT 1200/2400 result codes is enabled, no call progress monitoring
X2	Same as X1 except dial tone detection is enabled
X3	Same as X1 except busy signal detection is enabled
X4	ALL CONNECT result codes enabled including NO DIALTONE and BUSY
+++	The default escape code

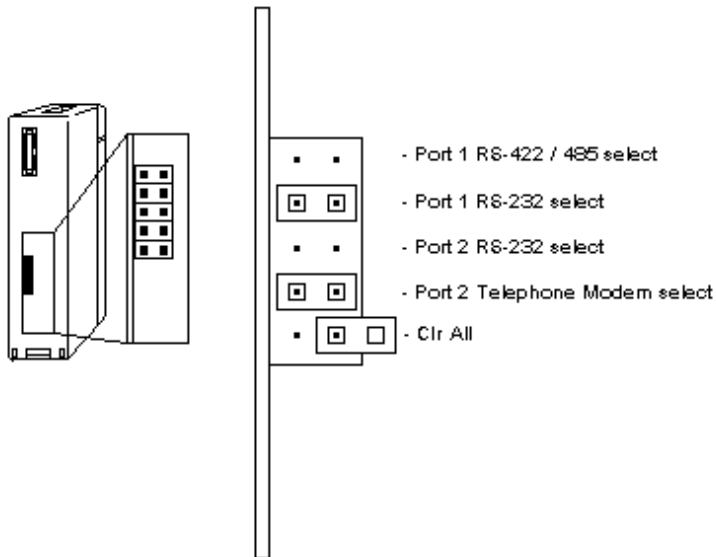
See APPENDIX D: TELEPHONE MODEM "AT" COMMAND SET for a detailed description of the AT command set.

## Result Codes

Result codes are strings returned by the modem in response to various "AT" commands and telephone line conditions.

Word Code	Result Code Description	Digit Code
OK	Command executed	0
CONNECT	Connected at 300 or 1200 bps	1
RING	Ring signal detected on telephone line	2
NO CARRIER	Carrier signal not detected or lost	3
ERROR	Illegal command or error in command line	4
CONNECT 1200	Connected at 1200 bps	5
NO DIALTONE	Dial tone was not detected	6
BUSY	Busy signal was detected	7
CONNECT 2400	Connected at 2400 bps	10

## F4-CP128-T JUMPER DESCRIPTIONS AND LOCATIONS



### PORT 1

The communication interface type for port 1 is selected by placing a jumper on one of the port 1 options, either RS422/485 or RS232. The RS232 selection is the default factory setting.

### PORT 2

The communication interface type for port 2 is selected by placing a jumper on one of the port 2 options, either RS232 or

Telephone Modem. If the RS232 option is selected the RJ11 jack is disabled, If the Telephone Modem option is selected the RS232 port is disabled. The Telephone Modem selection is the default factory setting.

### CLR ALL

The CLR all jumper specifies the AUTOSTART mode that the module will use at reset. Placing the jumper on both posts disables AUTOSTART and waits for a space bar character in port 1. Placing the jumper on one post allows the module to use the last stored AUTOSTART parameters (this is the default factory setting).

**CAUTION:** Installing the CLR ALL jumper will erase program 0, all stored variables, cancel a COMMAND@2, remove LOCKOUT, and clear stored AUTOSTART information.



## F4-CP128-T PORT PINOUTS

F4-CP128-T Port Pinouts

PORT 1 - Programming / Communication		
Pin	Signal Name	Description
1	RXD1+	Data Input high, RS-422
2	TXD1	Data Output, RS-232
3	RXD1	Data Input, RS-232
4	RTS1 / <b>TXD3 *</b>	DTE has data to xmit, RS-232
5	CTS1 / <b>RXD3 *</b>	DTE may xmit data, RS-232
6	RXD1-	Data Input low, RS-422
7	GND	Signal ground
8	TXD1-	Data Output low, RS-422
9	TXD1+	Data Output high, RS-422

\* - the Port 3 TXD / RXD signals appear at unused hardware handshaking lines, RTS / CTS. If Port 3 is not used then the lines maybe used for hardware handshaking.

PORT 2 - Programming / Communication		
Pin	Signal Name	Description
1	RXD2+	Data Input high, RS-422
2	TXD2	Data Output, RS-232
3	RXD2	Data Input, RS-232
4	RTS2	DTE has data to xmit, RS-232
5	CTS2	DTE may xmit data, RS-232
6	RXD2-	Data Input low, RS-422
7	GND	Signal ground
8	TXD2-	Data Output low, RS-422
9	TXD2+	Data Output high, RS-422



## APPENDIX A: QUICK START

### INITIAL MODULE OPERATION USING ABM COMMANDER PLUS

1. Run ABM Commander for Windows.
2. Review the ABM Commander for Windows Help/Instructions.
3. Connect the cable from the computer to the 405 CoProcessor module.. See APPENDIX F for wiring diagrams.
4. Turn ON the power to the PLC.
5. Select 'COMMAND MODE Connect to BASIC Module' from the main window. Select 'SYstem\_Stats' from the COMMAND MODE menu. The 'SYstem\_Stats' button will send a SPACE BAR character so the BASIC CoProcessor can correctly calculate the baud rate.
6. The module will now respond with the sign on message.  
F A C T S E x t e n d e d B A S I C P l u s  
...  
READY  
> (">" character indicates BASIC is in COMMAND mode)  
  
If you do not receive the sign on message, please follow the trouble shooting procedure in APPENDIX B.
7. The BASIC CoProcessor is now ready for programming and program upload/download.

## EDITING A PROGRAM

User Action	Display Window
<p>Select 'Auto' from the menu bar. Select Mode 0, Program 0, and Click 'OK'.</p>	<pre>AUTOSTART 0,0 Mode = 0, Edit Program = 0 Port 1 Baud = 9600 Programming (Port 2 = 9600) (Port 3 = 9600) &gt;</pre>
<p>Enter the following on the 'Command Line' field 10 p. &lt;ENTER&gt; 65535 p. &lt;ENTER&gt;</p>	<pre>&gt;10 p. &gt;65535 p. &gt;</pre>
<p>Select 'Rese<u>I</u>' from the menu bar. Cycling the power to the PLC will also reset the BASIC CoProcessor.</p>	<pre>RESET  FACTS Extended BASIC Plus Series 405 OverDrive CoProcessor Version 2.12/HS (c)Copyright FACTS Engineering, Inc. 1988 - 1994  AUTOSTART Mode, Program, Baud Mode = 0, Edit Program = 0 Port 1 Baud = 9600 Programming (Port 2 = 9600) (Port 3 = 9600)  0 stored programs, 63297 program storage bytes free  PRM 0 READY &gt;</pre>
<p>Select '<u>L</u>ist' from the menu bar.</p> <p>Note that mode zero uses the stored baud rate. The program in the edit buffer, PROGRAM 0, is retained during loss of power in mode zero.</p>	<pre>list 10 PRINT1 65535 PRINT1  PRM 0 READY &gt;</pre>

## SAVING A PROGRAM

User Action	Display Window
Select 'Ne <u>W</u> ' from the menu bar.	NEW >
Enter the following on the 'Command Line' field: 10 P."MY FIRST PROGRAM" <ENTER>	>10 p. "MY FIRST PROGRAM" >
Select 'SaVe'  NOTE: The BASIC CoProcessor is shipped with a diagnostic program in PRM1 so the first SAVED program will go into PRM2.	SAVE  Saving program 2  2 stored programs, 63272 program storage bytes free  PRM 0 READY >
Enter the following on the 'Command Line' field: 10 P."MY SECOND PROGRAM" <ENTER>	>10 p. "MY SECOND PROGRAM" >
Select 'SaVe'	SAVE  Saving program 3  3 stored programs, 63246 program storage bytes free  PRM 0 READY >

## AUTO RUN MODE

User Action	Display Window
Select 'Auto' from the menu bar. Select Mode 1, Program 2, and Click 'OK'. This specifies that the BASIC CoProcessor will run program 2 after a reset.	AUTOSTART 1,2 Mode = 1, RUN (CLEAR) Program = 2 Port 1 Baud = 9600 Programming (Port 2 = 9600) (Port 3 = 9600) >
Select 'Rese <u>T</u> ' from the menu bar. Cycling the power to the PLC will also reset the BASIC CoProcessor.	RESET MY FIRST PROGRAM  PRM 2 READY >
Select ' <u>S</u> el' from the menu bar. Click the 'Program 0' radio button then 'OK'.	>
Select ' <u>L</u> ist' from the menu bar. Confirm that the program in the edit buffer (PRM0) is still present.	list 10 PRINT1 "MY SECOND PROGRAM"  PRM 0 READY >

## DELETING A PROGRAM

User Action	Display Window
Select ' <u>D</u> el' from the menu bar.  Enter '2' then click 'OK'. Click 'Yes' on the confirmation dialog.	DELPRM2  2 stored programs, 63271program storage bytes free >
Select 'Rese <u>T</u> ' from the menu bar. Cycling the power to the PLC will also reset the BASIC CoProcessor.	RESET MY SECOND PROGRAM  PRM 2 READY >

### CANCEL AUTO RUN MODE

User Action	Display Window
Select 'Auto' from the menu bar. Select Mode 0, Program 0, and Click 'OK'. This specifies that the BASIC CoProcessor will start up in edit mode after a reset.	AUTOSTART 0,0 Mode = 0, Edit Program = 0 Port 1 Baud = 9600 Programming (Port 2 = 9600) (Port 3 = 9600) >

### CHANGING THE PROGRAMMING PORT

When interfacing to a RS-422 or RS-485 device or when communicating with two or three external devices, you can change the RS-232 programming port from Port 1 to Port 2. This is done as shown below.

User Action	Display Window
In the 'Port Select' field (Bottom Left of the Command Window) select the 'Port 2' radio button.	No Change
In the 'Port Select' field click on the 'Command Port (ABM)' button. Click 'Yes' on the confirmation dialog.	No Change
Move cable from Port 1 to Port 2 then click 'OK' on the dialog prompting the cable change.	No Change
Select 'S <u>Y</u> stem_Stats' from the menu bar.	>





## APPENDIX B: TROUBLE SHOOTING

### UNABLE TO ESTABLISH COMMUNICATION WITH BASIC COPROCESSOR

1. If the Port 1 RXD LED flashes when data is entered on the terminal then go to step 2. If the LED does not flash then use a RS-232 break-out box to determine if the problem is in the cable or the computer.
2. Power off the base, remove the module, and place the "CLR ALL" jumper on both posts.  
  
CAUTION: Installing the CLR ALL jumper will erase program 0, all stored data, cancel a COMMAND@2, remove LOCKOUT, and clear stored AUTOSTART information.
3. Run ABM Commander for Windows.
4. Review the ABM Commander for Windows Help/Instructions.
5. Connect the cable from the computer to the 205 CoProcessor module. See APPENDIX C for wiring diagrams.
6. Turn ON the power to the PLC.
7. Select 'COMMAND MODE Connect to BASIC Module' from the main window. Select 'SYstem\_Stats' from the COMMAND MODE menu. The 'SYstem\_Stats' button will send a SPACE BAR character so the BASIC CoProcessor can correctly calculate the baud rate.
8. The module will now respond with the sign on message.  
FACTS Extended BASIC Plus  
...  
READY  
> (">" character indicates BASIC is in COMMAND mode)
9. Type the following command and press return.  
>AUTOSTART 0,0
10. Power off the base and remove the module. Place the "CLR ALL" jumper on a single post.

11. Install the module and power up the base. The module will now respond with the sign on message.

FACTS Extended BASIC Plus

...

READY

> ("**>**" prompt character indicates BASIC is in COMMAND mode)

# APPENDIX C: TELEPHONE MODEM SPECIFICATIONS

**TRANSMITTER SPECIFICATIONS**

Description	Min	Typ	Max	Units
Carrier Output Level		-10	-9	dBm
Frequency Deviation	.01		.01	%

**RECEIVER SPECIFICATIONS**

Description	Min	Typ	Max	Units
Received Signal Range, OFF to ON	-45		0	dBm
Received Signal Range, ON to OFF	-48		0	dBm
Frequency Deviation Tolerance	-7		12	Hz

**FREQUENCY PARAMETERS**

300 Baud Modes

Modem Mode	Baud Rate	Transmit Frequency		Receive Frequency	
		Space Hz	Mark Hz	Space Hz	Mark Hz
Bell 103 Origin	300	1070	1270	2025	2225
Bell 103 Answer	300	2025	2225	1070	1270
CCITT V.21 Origin	300	1180	980	1850	1650
CCITT V.21 Answer	300	1850	1650	1180	980

1200/2400 Baud Modes

Description	Bell 212A	CCITT V.22
Baud Rate (bps)	1200/2400	1200/2400
Answer Band (Hz)	2400	2400
Originate Band (Hz)	1200	1200
Answer Tone (Hz)	2225	2100
Guard Tone (Hz)	--	1800



## APPENDIX D: TELEPHONE MODEM AT COMMAND SET

### DESCRIPTION OF MODEM AT COMMANDS

A Answer command

"A" command causes the modem to immediately go off-hook, answer the call and go into data transmission mode. Alternately the modem will automatically answer a call after the number of rings specified in S-register 0. By default, the modem will answer a call after 1 ring.

A/ Repeat command

"A/" command must be used without "AT" prefix and carriage return character at the end of the line. After receiving the "A/" command the modem repeats the execution of the last command stored in the command buffer. This command is normally not used.

Bn Bell/CCITT Protocol Compatibility

B/B0 Selects CCITT V.22 and V.21 modes of operation.

B1 Selects Bell 212A and 103 modes of operation (default).

Cn Enable carrier signal

C/C0 Turns the transmit carrier off.

C1 Enables the carrier signal (default).

D Dial telephone number

The "D" command causes the modem to go to the auto-dial mode. The parameters of the command include ASCII characters A to D, digits 0 to 9, \*, and #. The dial modifiers are:

- T Touch-tone dial
- P Pulse dial
- R Reverse mode (change from originate mode to answer mode)
- W Wait for a dial tone
- , Pause before executing the next command in the dial string. waiting time is specified in S-register 8. Default is 2 seconds.
- ; Go to command state after dialing. The line will be held for further commands. No connection will be made to another modem.
- ! Go on-hook for 1/2 second (flash).
- @ Wait for a ring back, followed by 5 seconds of silence before processing the next symbol in the dialing string. The waiting time is specified in S-register 7. Default is 30 seconds.

En Echo command

- E1 Enables the modem to echo back to the BASIC module input buffer the characters transmitted out Port 2 (default).
- E0 Disables local echo.

Hn Switch hook control

- H0 Causes the modem to go on-hook or hang up (default).
- H1 Causes the modem to go off-hook

Qn Result codes

- Q0 Enables result codes (default).
- Q1 Disables result codes.

**Sn** Direct register commands

Instead of stepping through a sequence of "AT" commands, the S-registers may be written directly. This reduces the time needed to configure the modem.

**Sn?** Returns decimal value stored in S-register n.

**Sn=x** Stores decimal equivalent of a binary number in S-register n (the range of x from 0 to 255)

**Vn** Select type of result code, verbal or numeric

**V0** Selects the short numeric form of the result code (one or two decimal digits) .

**V1** Selects a long verbal form of the result codes. Long form codes are preceded and terminated with both carriage return and line feed characters.

**Xn** Enable extended result code

**X/X0** Requests the modem to send a CONNECT message when connection is established with the remote modem. In this mode, the modem dials regardless of the presence or absence of the dial tone. Dialing begins after waiting for the number of seconds specified in S-register 6 (default is 2 seconds). The modem does not recognize the dial tone or busy signal in this mode. This is the default.

**X1** Requests the modem to send a full CONNECT 1200 message once connection is established at 1200 bps or a CONNECT message when both modems are operating at 300 bps. In this mode, the modem dials regardless of the presence or absence of the dial tone. Dialing begins after waiting for the number of seconds specified in S-register 6 (default is 2 seconds). The modem does not detect the dial tone or busy signal.

**X2** Requests the modem to send a full CONNECT message (Connect 300 , or CONNECT 1200) once connection is established. The modem waits for the dial tone before it dials. If the dial tone is not detected within five seconds, the NO DIALTONE result code is returned. The busy signal is not detected.

- X3 Requests the modem to send a full CONNECT message (CONNECT 300, or CONNECT 1200) once connection is established. In this mode, the modem dials regardless of the presence or absence of the dial tone. Dialing begins after waiting for the number of seconds specified in S-register 6 (default is 2 seconds). If busy signal is detected, the BUSY result code is returned.
- X4 Requests the modem to send a full CONNECT message (CONNECT 300, or CONNECT 1200) once connection is established. The modem waits for the dial tone before it dials. If the dial tone is not detected within five seconds, the NO DIALTONE result code is returned. If busy signal is detected, the BUSY result code is returned.

#### &Dn Data Terminal Ready Option

- D0 Modem ignores BASIC DTR2 statements (default).
- D1 Modem assumes command state when DTR2 goes from 0 to 1.
- D2 Modem hangs up, assumes command state and disables auto answer with the BASIC line DTR2=0 : DELAY 3000 : DTR2=1.
- D3 Modem assumes software reset state when DTR2 goes from 0 to 1.

#### +++ The escape code

The escape code, preceded and followed by guard time intervals, returns the modem to the command mode from the on-line state without releasing the telephone line.



## APPENDIX E: RADIO MODEM/LEASED LINE MODEM SPECIFICATIONS

### TRANSMITTER SPECIFICATIONS

Description	Min	Typ	Max	Units
Fixed Carrier Output Level		-10	-9	dBm
Adjustable Carrier Output Level	-40		0	dBm
Frequency Accuracy (Except 202)	-0.4		0.4	Hz
Frequency Accuracy (202 Mark)	-1.0		1.0	Hz
Request to Send (RTS) to Clear to Send (CTS) ON Delay (std.)		25 8		ms @ 300 bps ms @ 1200 bps
Request to Send (RTS) to Clear to Send (CTS) OFF Delay (std.)		.5		msec

### RECEIVER SPECIFICATIONS

Description	Min	Typ	Max	Units
Received Signal Range	-45		0	dBm
Carrier Detect ON Level		-42		dBm
Carrier Detect Hysteresis		5.5		dB
Frequency Deviation Tolerance	-16		16	Hz
Carrier Detect ON Delay	10 3		16 5	ms @ 300 bps ms @ 1200 bps
Carrier Detect OFF Delay	7 2		20 8.5	ms @ 300 bps ms @ 1200 bps

### FREQUENCY PARAMETERS

Modem Mode	Baud Rate	Transmit Frequency		Receive Frequency	
		Space Hz	Mark Hz	Space Hz	Mark Hz
Bell 103 Origin	300	1070	1270	2025	2225
Bell 103 Answer	300	2025	2225	1070	1270
CCITT V.23 Mode 1	600	1700	1300	1700	1300
CCITT V.23 Mode 2	1200	2100	1300	2100	1300
CCITT V.23 Mode 2 Equalized	1200	2100	1300	2100	1300
Bell 202	1200	2200	1200	2200	1200
Bell 202 Equalized	1200	2200	1200	2200	1200



## APPENDIX F: RS232 AND 422/485 WIRING DIAGRAMS

### RS-232 STANDARD

RS-232-C (RS-232) is an interface standard from the Electronic Industries Association (EIA). The standard names and defines 20 communication signals, assigned to separate pins in a 25-pin connector. The five unassigned pins may carry nonstandard signals required by any individual system.

Each signal is transmitted as a positive or negative electric current between 3 and 15 volts (usually 12 volts). The signal assigned to each pin flows in one direction only. Signals output, for example, from a computer must input to a terminal, and vice versa.

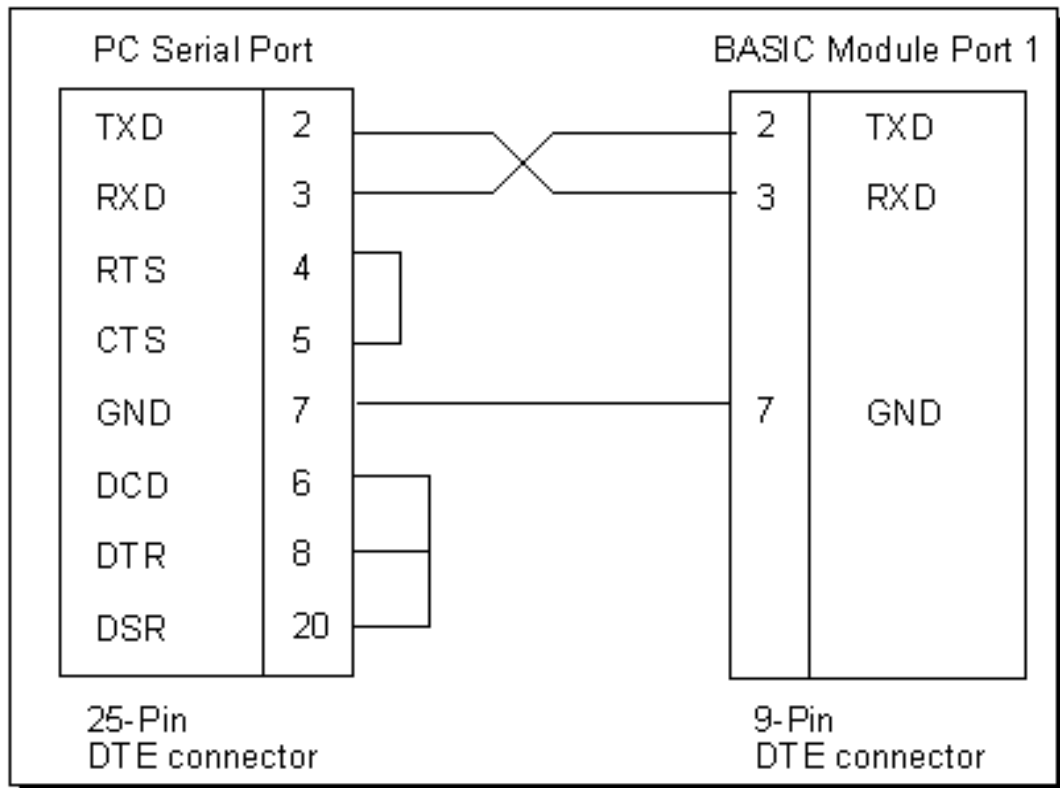
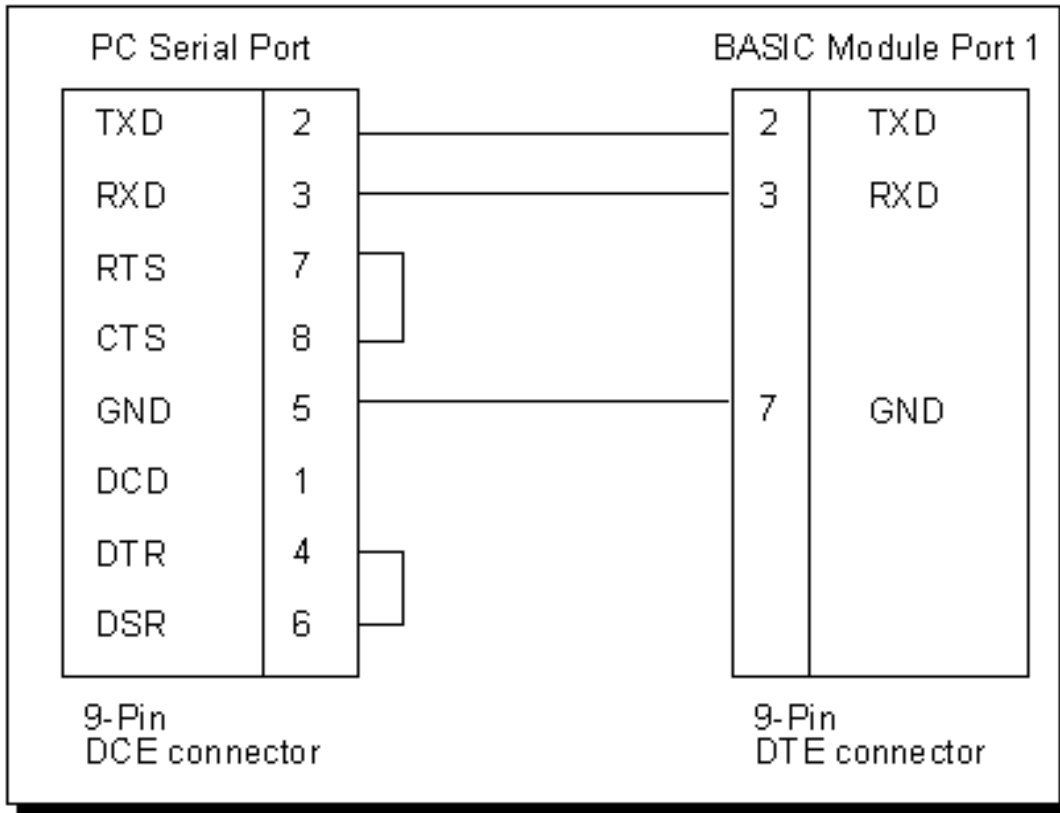
RS-232 signals travel over a serial interface cable that may have up to 25 wires. Since most signals are not required for simple communication, cables have as few as 2 or 3 wires. As shown in the following cabling diagrams, jumpers often are installed at one or both of the connectors to ensure that flow control signals are satisfied.

The signals flow between two types of interface ports, data communication equipment (DCE) and data terminal equipment (DTE). The pin names are the same for both DCE and DTE equipment, however, the direction of signal flow is reversed.

#### RS-232 DTE and DCE Pin Names and Signal Flow

Pin	Abrev.	Name	Signal Direction		Description
			DCE	DTE	
1	FG	Frame Ground	None	None	
2	TXD	Transmit Data	Input	Output	DTE Output Data Path
3	RXD	Receive Data	Output	Input	DCE Output Data Path
4	RTS	Request to Send	Input	Output	DTE has data to XMIT
5	CTS	Clear to Send	Output	Input	DTE may XMIT data
6	DSR	Data Set Ready	Output	Input	DCE has data to XMIT
7	SG	Signal Ground	Input	Output	
8	DCD	Data Carrier Detect	Output	Input	Modem has carrier
20	DTR	Data Terminal Ready	Input	Output	DCE may XMIT data
22	RI	Ring Indicator	Output	Input	

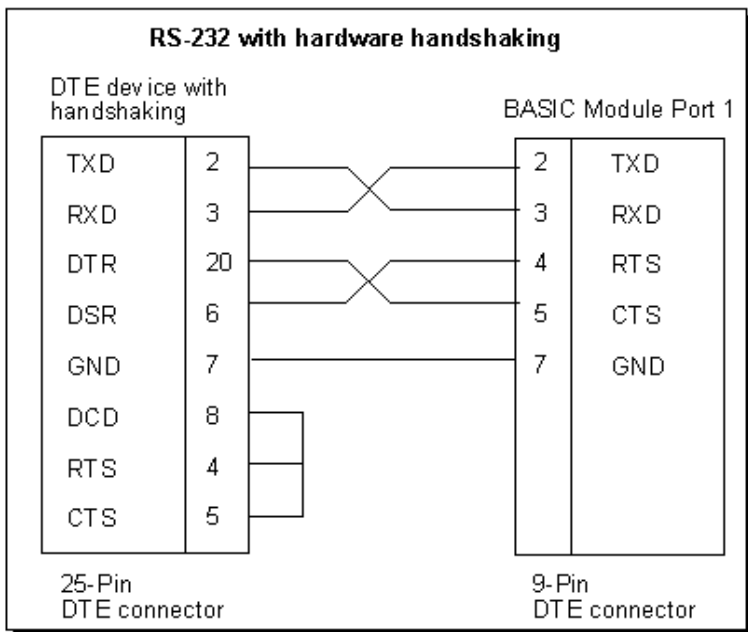
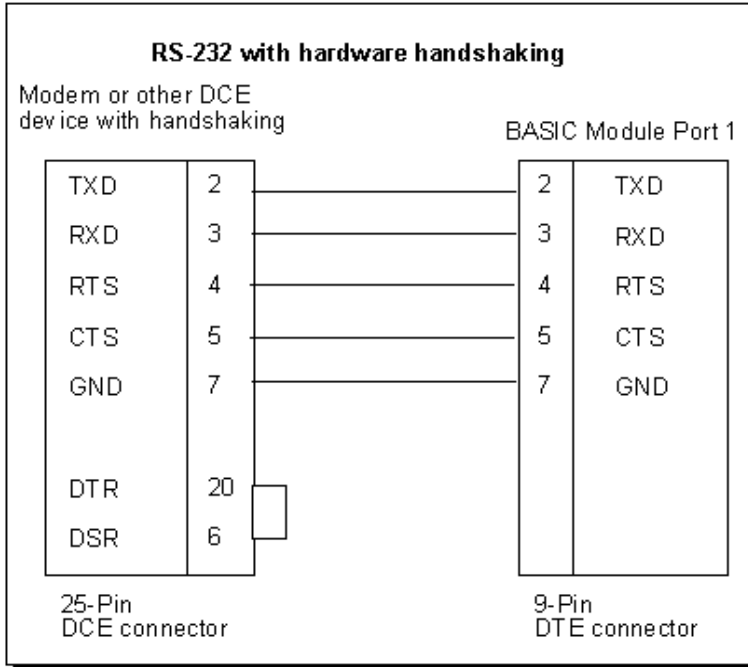
**IBM COMPUTER CABLES**



## IDENTIFYING A COMMUNICATION PORT AS DCE OR DTE

With an unknown RS-232 port powered, measure the dc voltage between pin-2 and ground (pin-7) and pin-3 and ground. If the most negative pin is pin-2 then the port is DTE. If the most negative pin is pin-3 then the port is DCE. Improper connection of pins 2 and 3 will not damage the interface.

## RS-232 WITH HARDWARE HANDSHAKE



## RS-422/485 STANDARD

The RS-485 transceivers on CoProcessor's so equipped are compatible with both RS-422 and RS-485 signals.

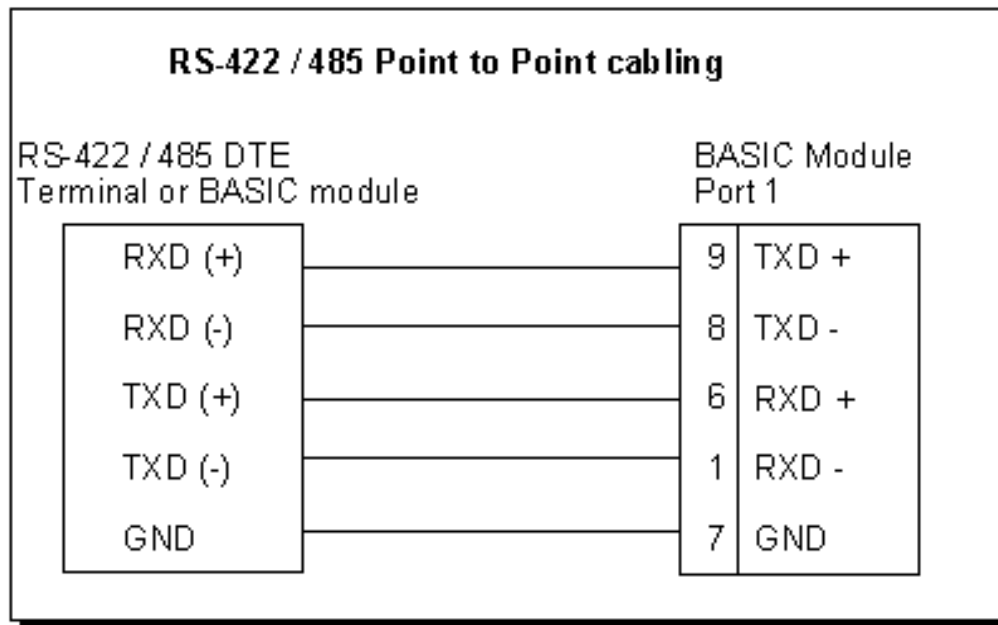
RS-422 uses high current differential outputs and is specified to 4000 feet at 10 Megabaud. Lower speed communications, such as 19.2K baud, may use substantially longer cables.

RS-485 is an upgraded version of EIA RS-422-A and offers higher current tri-state drivers which are internally protected from bus contentions caused by multiple drivers on the same line. RS-485 drivers will also withstand higher voltages on their outputs when disabled (high impedance state). RS-485 is specified for multiple transmitter and multiple receiver systems as well as single and multi-drop RS-422 applications. The RS-422 specification permits only one driver and 10 receivers on a line. The RS-485 standard allows up to 32 drivers and receivers on the same transmission line.

## RS-422/485 COMMUNICATION

Most CoProcessors have one RS-422/485 communication interface some have two. To select a port for RS232 or RS422/485 data reception mode, please refer to "JUMPER DESCRIPTIONS AND LOCATIONS" in the chapter for the CoProcessor module that you are using. Transmissions from a selectable port are always available at RS-232 and RS-422/485 signal levels simultaneously.

## RS-422/485 POINT-TO-POINT CABLING



## **RS-422/485 MULTI-DROP MADE EASY**

Four wire RS-422 multiple transmitter multi-drop networks and all 2 wire RS-485 connections require that the transmitters float when not in use.

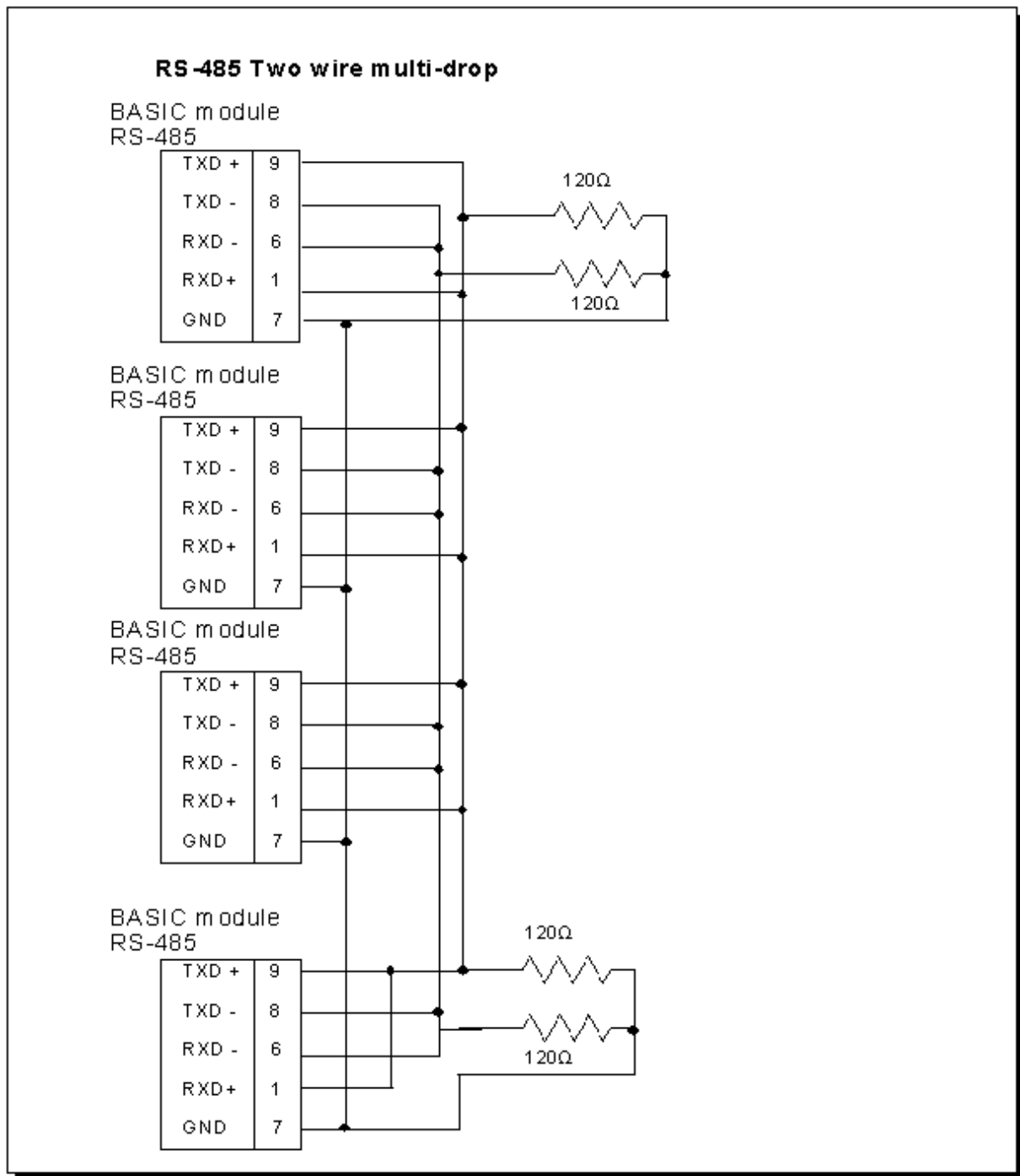
To enable the RS-422/485 transmitters only when PRINTing, use SETPORT to select multi-drop mode "M". Use the multi-drop option when the CoProcessor is a slave in a master/slave configuration or when a peer to peer configuration is required.

To leave the RS-422/485 transmitters ON even when not PRINTing, use SETPORT to select point to point mode "P". Use the point to point option when the CoProcessor is a single master in a master/slave or point to point configuration. This configuration provides the greatest noise immunity because the RS-422/485 drivers remain enabled and prevent noise from being received by the slave devices on the network.

Example:       Configure Port 1 for 9600 baud, no parity, 8 bit word, 1 stop bit, software XON/XOFF handshaking, and multi-drop RS-422/485 mode.

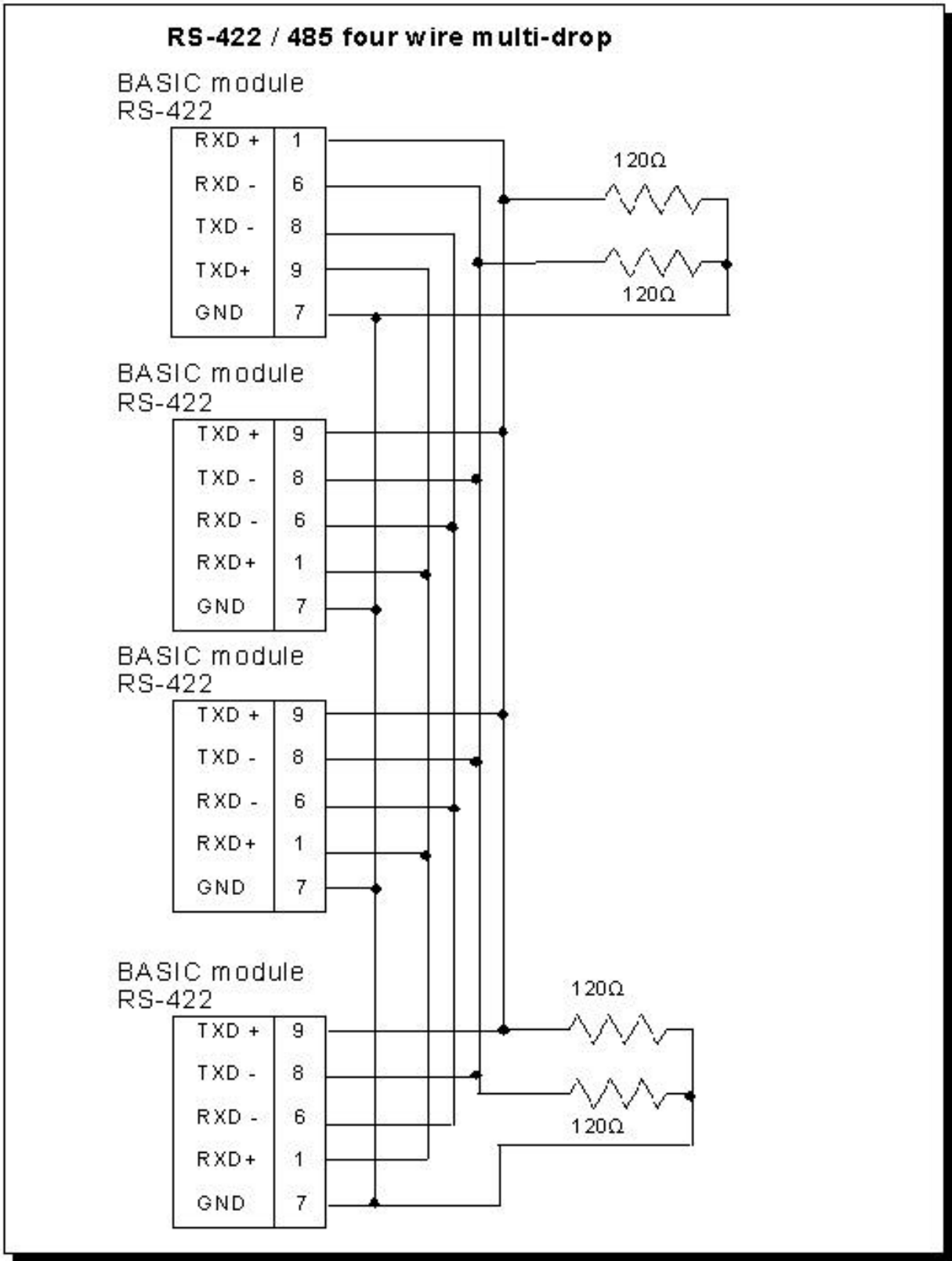
```
SETPORT 1, 9600, N, 8, 1, S, M
```

## RS-485 TWO WIRE MULTI-DROP





# RS-422 FOUR WIRE MULTI-DROP



## Cable Shielding

Shielding improves noise immunity (magnetic field protection). It is important to ground the shield at the receiver end only. Grounding the receiver end only provides the least high frequency signal attenuation and the best rejection of unwanted signals. Grounding both ends of the shield will cause magnetic field induced noised currents to flow through ground. Noise may then appear on the data lines due to transformer like coupling with the shield. If the cable shield is used as the system ground conductor then placing a 100  $\Omega$  resistor in series with the shield and the ground connection will reduce noise producing ground currents.

### **Connecting Cables and Line Termination**

A dual twisted pair plus ground connection is recommended for 4-wire RS-422 networks. Proper termination of the balanced transmission line is required to prevent data errors. A typical AWG 22 solid wire with .060 inch plastic cover, twisted 4.5 times per foot has a characteristic impedance of about 120  $\Omega$ . Thus the selection of the two 62  $\Omega$  line-to-ground terminating resistors. Line-to-ground termination is preferred to the often shown line-to-line 120  $\Omega$  termination. In noisy or long line applications the much better line-to-ground common-mode rejection capability is particularly important. In multidrop networks, the line must be terminated at the extreme ends only as shown in the two previous diagrams. Addition of intermediate terminations will adversely load the line. If both the transmit and receive ends of the same twisted pair are terminated, double the value of the termination resistors.

### **Floating Data Lines Noise Prevention**

The RS-422/485 drivers at the host should remain enabled to prevent noise from being received by the slave devices on the network. To prevent noise reception at the host when there is no slave transmitting, add a pair of network biasing resistors to the host as shown in the two previous diagrams. This will pull-up the floating transmit line from the slaves to the RS-422/485 idle state (RXD+ to RXD- > .45 V). The equivalent of this can be done in a CoProcessor using the "P" parameter in the SETPORT statement.