PLC / Embedded computer

CUBLOC™

User Manual
Version 2.5

"Everything for Embedded Control"

COMFILE TECHNOLOGY

Comfile Technology Inc.
www.comfiletech.com

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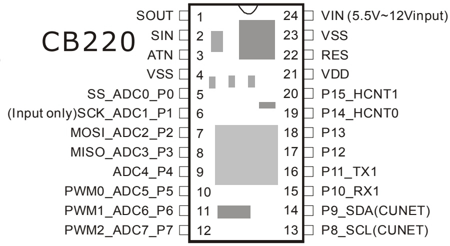
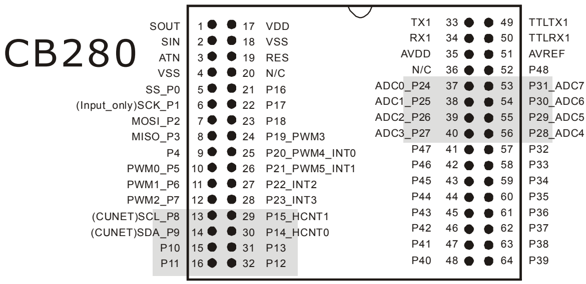
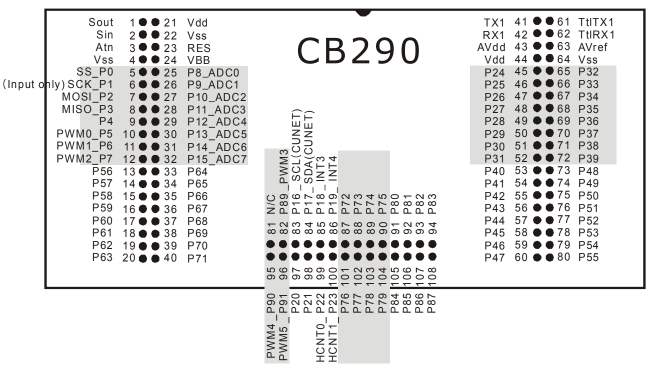
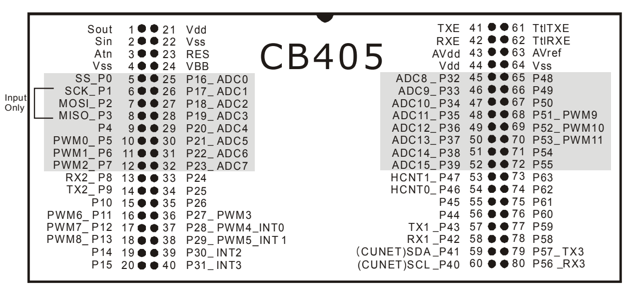
CUBLOC Core Module Pinout









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NEW in CublocStudio v.2.0.X

1. You can simple upgrade to CUBLOC STUDIO V2.X to use new features of CUBLOC and CUTOUCH.

New Functions	Syntax	Features
SET RS485	SET RS485 Channel, Port	Set Port Number for automatic control of TE (Transmit Enable) signal for RS485 converter (Comfile RS485 Converter)
GETCRC	GETCRC Variable, Array, Length	Calculate the CRC
VALHEX( )	Variable = VALHEX(String Variable)	Convert hexadecimal String number to a decimal variable.
FREEPIN	FREEPIN Port	Free I/O Port set to LADDER using Usepin back to BASIC
FP( )	FP(Single Variable, Whole Number Digits, Fractional Number Digits)	Convert Floating Point variable to a formatted String
COMPARE	COMPARE Channel, Set point, PortNumber, PortStatus	When high counter value reaches a set point, set an I/O Port to Low or High.
I2CREADNA	Variable = I2CREADNA(0)	I2CREAD command without acknowledgement

2. Modbus RTU Slave Mode

SET MODBUS   mode, slaveaddress, returninterval

mode : 0=ASCII, 1=RTU

slaveaddress : Slave Address (1 to 254)

returninterval : return interval value (1 to 255, default value is 1)

3. Pulse Control Command.

Function	Syntax	Features
STEPPULSE	STEPPULSE Channnel, PortNumber, Freqency, Number of Pulses	Output a set of number of pulses at a set frequency (up to 15kHz)
STEPSTOP	STEPSTOP Channel	Stop Pulse Output Channel immediately.
STEPSTAT( )	Variable = STEPSTAT(Channel)	Return number of pulses outputted since last STEPPULSE command

4. RS232 Receive and Send Commands Added.

Function	Syntax	Features
PUTA2	PUTA2 Channel, ArrayName, Length, StopChar	Same as PUTA command except it will stop transmission upto a set character in the array. (StopChar will be the last character to be send)
GETA2	GETA2 Channel, Array name, ByteLength, StopChar)	Same as GETA command except it will stop reading data at the StopChar even if there are data left to read set by the Length. If StopChar is not found, then it will operate just like a GETA command.
GETSTR2	String Variable = GETSTR2(Channel, Length, StopChar)	Same as GETSTR command except it will stop reading data at the StopChar even if there are data left to read set by the Length. If StopChar is not found, then it will operate just like a GETSTR command. (StopChar is read from the buffer, but not stored into the String Variable)

5. RTC using the system timer for CUBLOC without RTC.

This command will allow you to use the system timer of CUBLOC as an RTC. You can use TIME() and TIMESET functions to access the following addresses:

address	Returning Value	Range
10	Seconds	0 to 59
11	Minutes	0 to 59
12	Hours	0 to 65535
13	Continuous Seconds	0 to 65535

NEW CUBLOC Module - CB405

The new CUBLOC Module CB405 has more program and data memory with additional 2 RS232 serial channels over older CUBLOC modules.

Core Module	Features
CB405	200KB Program memory, 110KB Data memory, 64 I/Os, 4 RS232 Channels

To use the CUBLOC module CB405, you need to use CublocStudio v.2.0.X and above.

1. New functions for the CB405

New Functions	Commands
Use the following commands for RS232 Channel 0 through 3.	OPENCOM SET RS232 GET, GETA, GETSTR, PUT, PUTA, PUTSTR, BLEN, BFREE, CHECKBF, BCLR ON RECV, SET ONRECV, WAITTX
Use the AD commands from Channel 0 through 15.	ADIN, TADIN
Use PWM commands from Channel 0 through 11.	PWM, PWMOFF

2. Heap Access for the CB405

The HEAP memory access is a special feature only available on the CB405 module.

Function	Syntax	Feature
HEAPCLEAR	Heapclear	Erase the entire Heap memory.
HREAD	Variable = HREAD(Address, Length)	Read the designated number of bytes set by Length from the Heap memory address and store into a variable.
HWRITE	HWRITE Address, Variable, Length	Store the designated number of bytes set by Length to the Heap memory Address.
HEAPW	HEAPW Address, Variable	Store one byte to the Heap memory Address.
HEAP	Variable = HEAP(Address)	Read one byte from the Heap memory Address and store into a variable.

Preface

Comfile Technology has been developing PLC and BASIC controllers since 1997. With our past knowledge of this field, we are giving you a brand new product that is more powerful, flexible, and has the best features of both BASIC controllers and PLCs (Programmable Logic Controllers).

After experiences developing and selling TinyPLC and PicBASIC, which are chip based PLCs and BASIC controllers, we have been able to improve our engineering efforts every year. CUBLOC is able to adapt to the user's strengths, whether that be BASIC or LADDER. Unlike other products, you can simply use CUBLOC as a BASIC controller or as a PLC controller.

Ladder Logic, which is the traditional way of programming PLCs for its outstanding control sequence, is neither sufficient nor easy to use for graphic interface and other modern technology that require complex programming. In comparison, the BASIC language proves to be simple yet easy to implement those modern devices.

CUBLOC is able to handle both BASIC and Ladder Logic through on-chip multi-tasking. By sharing memory data, it's able to integrate both BASIC and LADDER efficiently and become a new type of controller by itself.

"CUBLOC" is created for beginners and advanced users in mind. Its basic purpose is to cut design time for those who are just entering the field of microcontrollers, engineers from other backgrounds such as Chemical or Mechanical, and anyone who would like to make something that they envision quickly and get a head start on their project.

With our Plug-N-Play displays, development boards, and relay boards, you will be able to put something together in matter or hours, instead of months.

Comfile Technology, Inc.

Notice

The Start Kit or Industrial Kit you receive comes with the latest version of Cubloc Studio.

- Please be aware that the software may be upgraded often.
- Please check www.comfiletech.com to download the latest version of CublocStudio.
- Please do Setup->Firmware Download after installing new version of CublocStudio as firmware of the modules is upgraded along with our software. (Firmware is comes automatically along w/ your new version of CublocStudio.
- Please check www.comfiletech.com often for latest Manual.
- Please make sure to insert the CUBLOC module correctly as inserting it upside-down can cause damage to the chip.
- Please be aware that our 1 Year Warranty only covers defective items.

Special thanks goes to:

Mr. Alexandre Braun & Lextronics for applications on the Forum
Mr. Batman for applications on the Forum
Mr. Mauro Russo & Uniplan Software srl, Italy for User Manual Revisions
Mr. Steve Yang & Mr. Bill Ebert for Modbus RTU
Mr. Spence for website links and website bugs

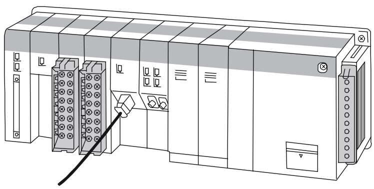
Table of Contents

Chapter 1 CUBLOC Getting started...

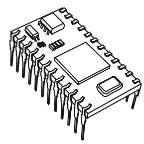
What is CUBLOC?

CUBLOC is different from the traditional PLCs that you may associate with. Traditional PLCs have cases and connections like the picture below but CUBLOC is an “On-Chip” PLC/Industrial Controller, meaning you have more freedom and flexibility to the final product size and design.

CUBLOC Modules are similar to traditional PLCs in that Ladder Logic can be used. But its small size allows developers to design custom PCBs just like a microcontroller.

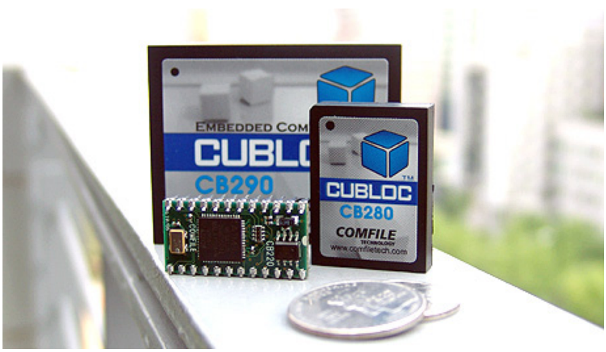


traditional PLC

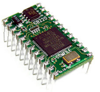


CUBLOC core module

There are different models, each with a unique program memory size and number of I/O ports. Please make a selection based on your product’s requirement.

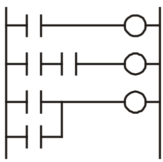


CUBLOC Specifications

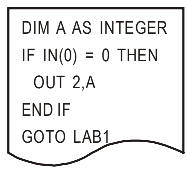
	CB220	CB280	CB290	CB405
Picture				
Program Memory	80KB	80KB	80KB	200KB
Data Memory	2KB(BASIC)+1KB(Ladder Logic)	2KB(BASIC)+1KB(Ladder Logic)	24KB(BASIC)+4KB(Ladder Logic)	51KB(BASIC)+4KB(Ladder Logic)+55KB(Heap)
EEPROM	4KB EEPROM	4KB EEPROM	4KB EEPROM	4KB EEPROM
Program Speed	36,000 inst./sec	36,000 inst./sec	36,000 inst./sec	36,000 inst./sec
General Purpose I/O	16 I/O lines (5V TTL) (input/output configurable)	49 I/O lines (5V TTL) (input/output configurable)	91 I/O lines (5V TTL) (33 input only + 32 output only + 26 input/output configurable)	64 I/O lines (5V TTL) (input/output configurable)
Serial Ports for Communication	2 serial ports (Channel 0: RS232C 12V, Channel 1: TTL 5V) - Configurable Baud rates: 2400bps to 230,400 bps	2 serial ports (Channel 0: RS232C 12V, Channel 1: RS232C 12V & TTL 5V) - Configurable Baud rates: 2400bps to 230,400 bps	2 serial ports (Channel 0: RS232C 12V, Channel 1: RS232C 12V & TTL 5V) - Configurable Baud rates: 2400bps to 230,400 bps	4 serial ports (Channel 0: RS232C 12V, Channel 1 to 3: RS232C TTL 5V) - Configurable Baud rates: 2400bps to 230,400 bps
Analog Inputs	8 Channel 10-bit ADCs	8 Channel 10-bit ADCs	8 channel 10-bit ADCs	16 channel 10-bit ADCs
Analog Outputs	- 3 Channel 16-bit PWMs (DACs) - Configurable Frequency: 35hz to 1.5Mhz	- 6 Channel 16-bit PWMs (DACs) - Configurable Frequency: 35hz to 1.5Mhz	- 6 Channel 16-bit PWMs (DACs) - Configurable Frequency: 35hz to 1.5Mhz	- 12 Channel 16-bit PWMs (DACs) - Configurable Frequency: 35hz to 1.5Mhz
External Interrupts	None	4 Channels	4 Channels	4 Channels
High Speed Counters	2 Channel 32-bit Counters (up to 2Mhz)	2 Channel 32-bit Counters (up to 2Mhz)	2 Channel 32-bit Counters (up to 2Mhz)	2 Channel 32-bit Counters (up to 2Mhz)
Power	5 to 12V, 40mA (ports unloaded)	5V, 40mA (ports unloaded)	5V, 70mA (ports unloaded)	5V, 50mA (ports unloaded)
RTC	No	No	Yes	No
Data Memory Back-up	None	None	Optional	Optional
Operating Temperature	-40 °C to 120 °C	-40 °C to 120 °C	-40 °C to 120 °C	-40 °C to 120 °C
Package	24-pin DIP 600mil	64-pin Module	108-pin Module	80-pin Module
Size	1.2"L x 0.6"W x 0.4"H (30 x 15.3 x 11 mm)	1.4"L x 1"W x 0.4"H (35 x 25.4 x 11 mm)	2.4"L x 1.9"W x 0.5"H (59.4 x 47.8 x 13 mm)	2.4"L x 1.9"W x 0.5"H (59.4 x 47.8 x 13 mm)

The main advantage of CUBLOC over other PLCs is that it fills Ladder Logic's weaknesses with BASIC language. Ladder Logic is good enough to replace sequence diagrams, but to collect data, print graphics, and process complex tasks is asking a little bit too much. That is why we added the BASIC language. You can now run both Ladder Logic and/or BASIC!

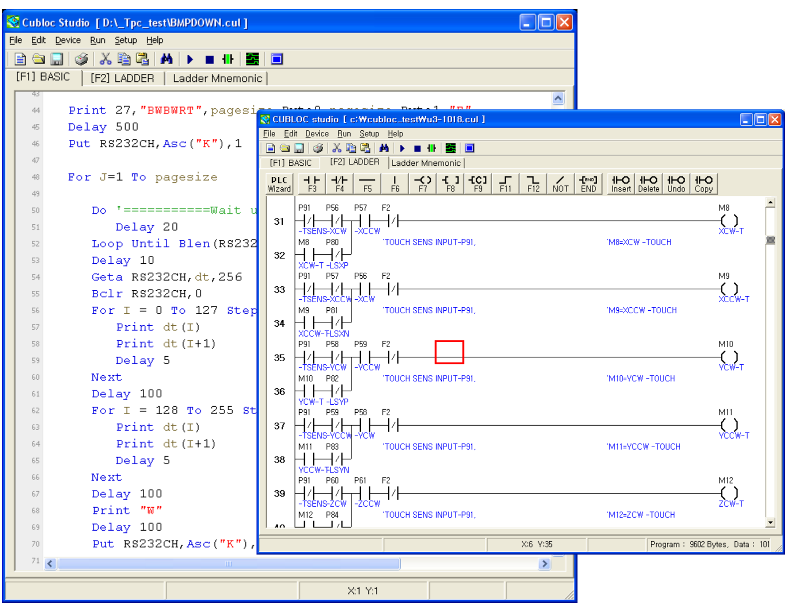
Another advantage over other BASIC processors is that CUBLOC is able to separate the amount of work and programming between Ladder Logic and BASIC as necessary. The user is able to debug easier by having two processes work together, instead of grudging through lines of BASIC codes.



LADDER LOGIC



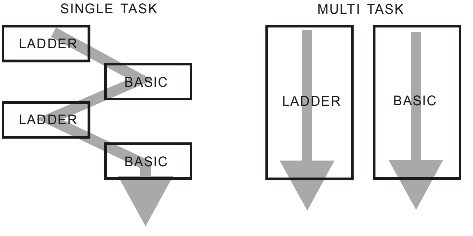
BASIC



Picture of "CUBLOC Studio" is shown above.

There are PLCs on the current market that supports both LADDER and BASIC. These PLCs do not multi-task and run "Single-task." BASIC is part of their Ladder Logic and does not run independently like CUBLOC or CUTOUCH. This can prove to be costly since BASIC is not real-time oriented and can affect the Ladder Logic of the program. CUBLOC covers these weaknesses through its multi-tasking features, guaranteeing accuracy and precision of timing. Unlike many BASIC processors on the market today, CUBLOC supports Ladder Logic and multi-tasking with BASIC language.

CUBLOC has a multi-tasking structure that runs BASIC and LADDER simultaneously that allows accurate LADDER scan timing and still process BASIC. You even have a choice of simply using BASIC or LADDER by itself.



CUBLOC is a brand new type of industrial controller. By being able to do things that traditional PLCs couldn't through BASIC language, we have expanded the horizons of both PLCs and BASIC micro-computers.

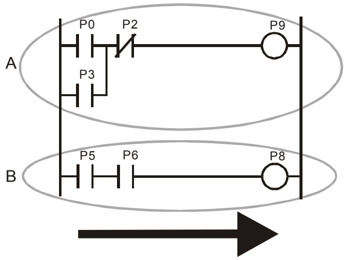
Unlike some BASIC controllers out on the market today, CUBLOC is fully backed by many Plug-N-Play peripherals such as our CuBASE industrial I/O Boards and Plug-N-Play Relay8 Boards. With these peripherals, controlling DC/AC devices becomes a walk in the park.

With 32-bit IEEE floating point math support and MODBUS ASCII/RTU support, the user will find that CUBLOC and CUTOUCH are one of the most versatile BASIC/PLC hybrid chip on the market today.

Another analogy to real life would be to automobiles. Do you have a very small fast car? Or do you have a monster truck? How would it be to use an SUV? Yes, CUBLOC is sort of like an SUV in the automobile world. You have the best of the worlds. Although it's not as fast as a raw MCU, you can take advantage over the overall savings in development cost and time using our Plug-N-Play peripherals.

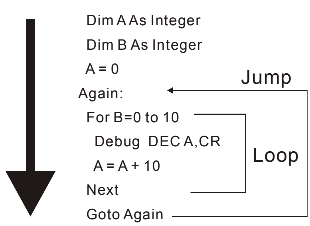
Ladder Logic and BASIC

The biggest advantage of Ladder Logic is that all circuits are processed in "Parallel," meaning they are all processed at the same time.



As you can see above, both A and B circuits are in a waiting state, ready to turn output On as soon as input is turned On. For example, if input P3 turned On, P9 would turn On.

In comparison, BASIC processes code in order, a type of "Sequential Processing."



These 2 types of programming languages have been used in different fields for a long time. Ladder Logic is used in automation controllers such as PLCs. On the other hand, BASIC and other programming languages such as C and Assembly have been used in PCs and MCUs.

Whether you are an experienced MCU or PLC user, you will be able to benefit by integrating both BASIC and Ladder Logic in your designs.

The biggest advantage that Ladder Logic possesses is the ability to process input within a guaranteed slot of time. No matter how complex the circuit becomes, Ladder Logic is always ready to output when it receives input. This is the main reason why it's used for machine control and other automation fields.

Ladder Logic is more logic oriented, not a complete programming language. To do complex processes, it has its limits. For example, to receive input from a keypad, display to 7 Segment or LCD, and process user's input is a daring task for Ladder Logic.

But these things are rarely a problem for programming languages such as BASIC. BASIC is able to process floating point numbers, data communications, and other things beyond the scope of what Ladder Logic can do alone. Another advantage that BASIC has is that its language is very similar to the English language (IF, GOTO, etc…), allowing the beginners and the developers to learn in matter of hours, instead having to deal with months of learning curves.

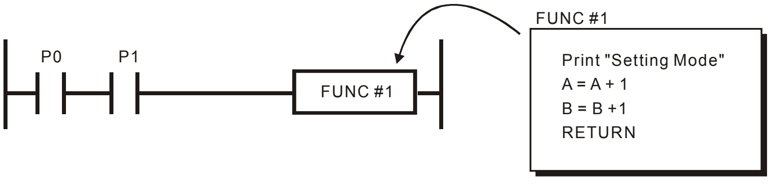
	Ladder Logic	Programming Languages (BASIC, C, ASM)
Device	PLC	PC or Micro-Computer
Application	Automation, Machine-Control	General Computing
Advantages	Sequencer, Bit Logic, Timers, Counters	Complex Math, Data Communication, Data Collection & Process, Analysis, Graphic Interface
Basic Mechanism	Parallel	Sequential

<u>Ladder Logic's parallelism and BASIC sequential language both have its advantages over each other.</u> Ladder Logic is able to process what couldn't be done with BASIC. On the other hand, BASIC can easily process what is either hard to do or couldn't be done in Ladder Logic.

That is why we created "CUBLOC," which the user is free to use both Ladder Logic and/or BASIC based on the application being created. After understanding the advantages of both Ladder Logic and BASIC, the user will be able to create more efficient final products while saving development time and costs.

Multi-tasking of Ladder Logic and BASIC

There are many ways to implement both BASIC and Ladder Logic in one processor. The current products on the market use BASIC as part of Ladder Logic. These products support BASIC and Ladder Logic but there is one clear weakness.



The first weakness is that based on the execution time of BASIC, Ladder Logic also gets affected. If the BASIC code is made up of an infinite loop, Ladder Logic will also stop.
Ladder Logic's main advantage is that it can process input in a guaranteed scan-time. If Ladder Logic cannot process within this guaranteed scan-time because of BASIC, it might be better to not include BASIC capabilities.

The second weakness is that BASIC can only be used as part of Ladder Logic. BASIC is a powerful language by being able to process complex algorithms. But if we can only use BASIC as part of Ladder Logic, we are not fully using BASIC to its maximum performance.

The third point has to do with I/Os. BASIC language's execution of I/Os can create unwanted collisions with LADDER. The reason is that Ladder Logic I/Os are updated while in BASIC, I/Os are directly accessed.

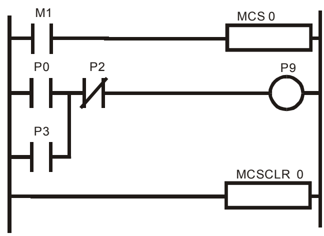
After solving these problems, we have created a BASIC and Ladder Logic processor that supports real-time "multi-tasking." BASIC runs BASIC and LADDER runs LADDER, simultaneously without causing collision between the each other.

With just BASIC, you will be able to create many devices. In comparison to other BASIC processor on the market today, CUBLOC's BASIC clearly has faster processing speed and the upper hand on the main features. If Ladder Logic is not necessary, the user may use just BASIC.

In the case of I/Os, the user can specifically control the I/Os used by BASIC and LADDER, thereby eliminating I/O collision problems.

CUBLOC uses BASIC as its main language. We recommend controlling LADDER from BASIC.
For example, there is a MASTER CONTROL feature in Ladder Logic, allowing the user to set Control Zones. Control Zones are sections within the Ladder Logic that the user can set entire sections of the control circuit. With the MASTER CONTROL feature, the user can enable/disable Ladder Logic's Control Zones easily.

```
If A=1 THEN _M(1) = 1
If B=1 THEN _M(1) = 0
```

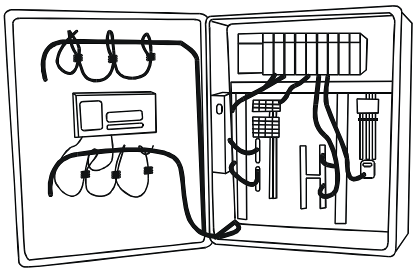


In BASIC, the user may read or write to Ladder Logic's data memory.
In the above example, you can access Register M1 as _M(1) and write to it from BASIC.

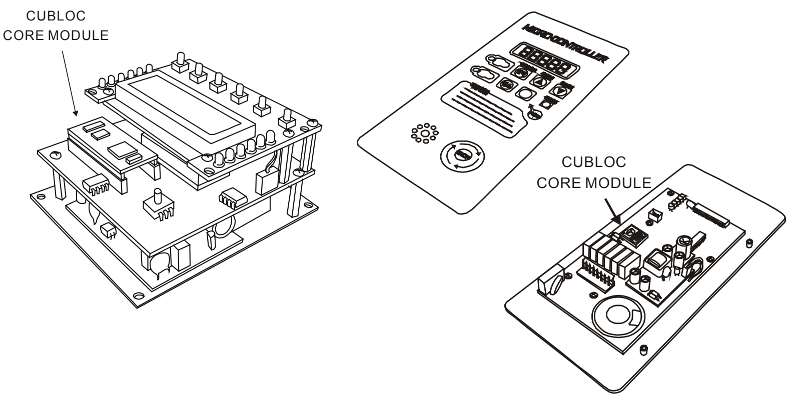
As you can see, CUBLOC supports BASIC and LADDER multi-tasking simultaneously through "data memory sharing."

Advantages of "On-Chip" PLC/Embedded Computer

One of the main advantages of CUBLOC is that it is an "On-Chip" PLC. Normally, we think of PLC as a block type case with input and output lines. When using these PLCs, an external case, and cabinet must be used in addition to other mind-bogging wiring requirements

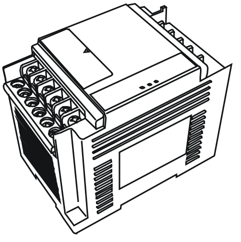
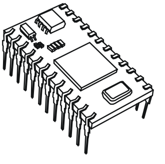


When using just a couple of sets, this might not present a big problem. But when mass-producing such PLCs, labor cost for assembling the PLCs and faulty parts could lead to many problems. Most importantly, the overall design of you final product will be bigger and will cost more to produce.



CUBLOC is an “On-Chip” PLC, allowing easy fit on a PCB. You may use the PLC almost like an MCU. You can design a customized PCB for the desired product which reduces the cost and size of your final product, and most importantly, allow the product to be one-of-a-kind.

The following table shows differences between a traditional PLC and “On-Chip” PLC/Micro-computer, CUBLOC.

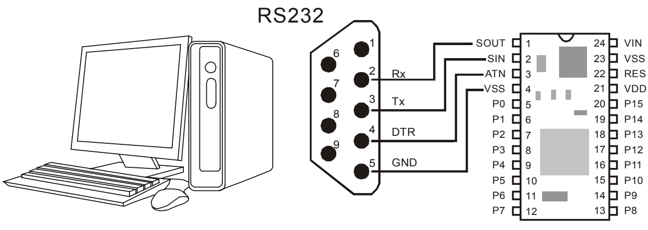
	Traditional PLC	CUBLOC
Picture		
Production	Din Rail Attachment	Din Rail or PCB
Labor Costs	High	Low
Mass-Production	Difficult	Easy
Final Product Cost	High	Low
Final Size	Large	Compact

If you are currently using a traditional PLC, please review our product and compare the costs if you change it to a PCB type. We believe that you will have much more satisfactory final product at a fractional cost.

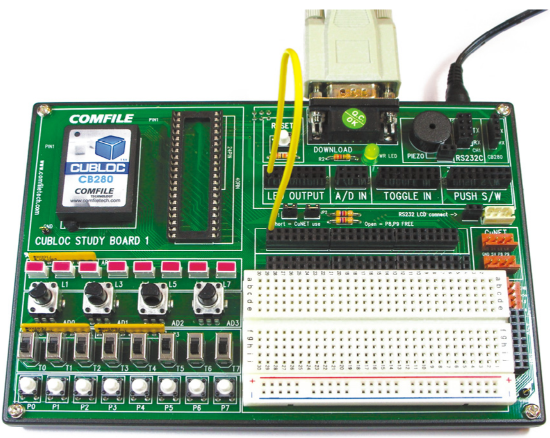
Development Environment

To use CUBLOC, the user may use a Windows XP, 2000, or 98 operating system equipped computer. If you would like to use it in Linux/Unix/Macintosh environment, you will need to install a virtual machine software of some type (such as VMware, etc…) that allows Windows operating system to run on it.

An RS232 port is also required or you may use a USB-to-RS232C converter. Download and Monitoring is possible when connected with the PC.



When CUBLOC is disconnected from the PC, it goes into a STAND-ALONE state. The main program is stored in CUBLOC's flash memory, and will be retained even with no power. The user may download new programs and erase them as many times as he or she wishes.



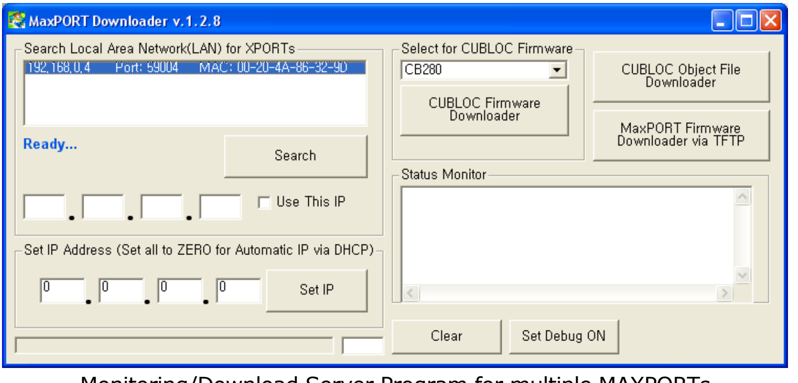
Cubloc core module with Study board

Download and Monitoring through the Internet

XPORT is an internet module that converts RS232 signals into TCP or UDP packets. You can use XPORT and CUBLOC to download and monitor programs through the internet.

By using this feature, you will be able to update and provide customer service for your products even if it's located in other parts of the world. We provide custom MAXPORT firmware, Downloading/Monitoring Server programs and embeddable applets for downloading and monitoring your CUBLOC module. You may use this program to manage thousands of devices.

MAXPORT module



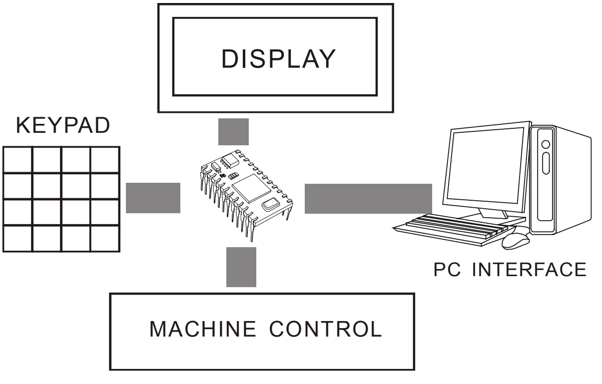
Monitoring/Download Server Program for multiple MAXPORTs

Hints for traditional PLC User

For users with much experience in traditional PLCs, they will find BASIC a completely new language. CUBLOC is a PLC with BASIC language capabilities added. The user may program only using the ladder language. By having the option of using the BASIC language, even the PLC user may be able to incorporate new features to the final product by making use of BASIC, which has much powerful capability and flexibility in communicating with other devices than PLCs.

To use CUBLOC, the user does not have to know BASIC. He/She may simply use only LADDER for development. If the user does not require LCD display or keypad usage, he or she does not need to use BASIC at all.

As you can realize, more emphasis on user interface is becoming apparent in our industrial world. CUBLOC is able to overcome the deficiencies and disadvantages of traditional PLCs by being able to use both BASIC and LADDER language.



We provide many BASIC libraries for user interfaces which you can simply copy & paste to achieve the user interface structure desired.

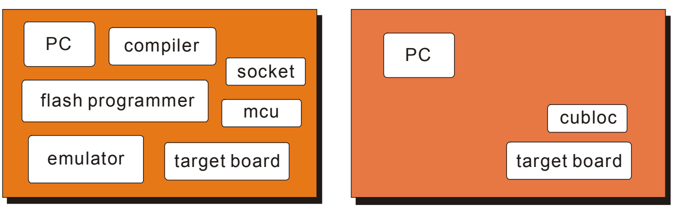
Hints for Micro Controller User

MCU, Micro Controller Unit, is programmable micro-computers such as PIC, AVR, and 8051. For mass-production, MCUs can cut costs and reduce the overall product size. But the main disadvantage of MCUs is that it is hard to develop and takes a long time. For simple projects, this might be a good route.

Even those experienced engineers feel that MCU programming is time-consuming and not a simple task. To make a final product, it takes many hours programming and debugging with an MCU. Even after development, if bugs arise, it becomes almost impossible to update the MCU.

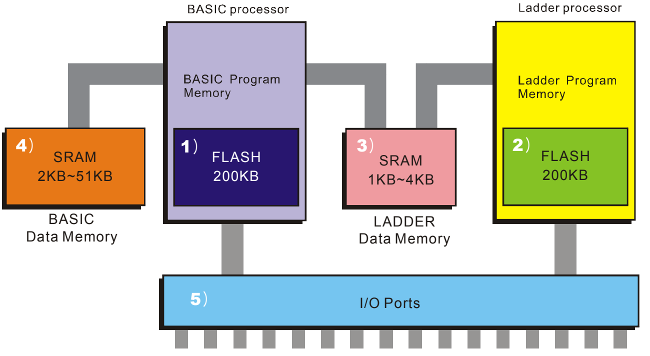
In comparison, Comfile's CUBLOC will cut the users development time as much as 20 times and provide a MCU-like chip that is upgradeable through RS232 cable or even through the internet by using an XPORT. By being able to provide a way to upgrade the final product, the value of your final product is much more than what you thought.

If you have experience programming with MCUs, we guarantee you that development of your final product will be much easier. You will be able to spend more time designing the features of your final product, instead of spending hours and hours in front of a computer.



MCU engineer's desk   CUBLOC engineer's desk

CUBLOC's Internal Structure



The BASIC interpreter contains a "Flash memory" for user's BASIC programs. LADDER processor also has a "Flash memory" for user's LADDER program. I/O ports are shared among BASIC and LADDER, allowing free access to both.

BASIC data Memory can only be accessed by BASIC interpreter while LADDER data memory can be accessed by both BASIC Interpreter and LADDER Processor.

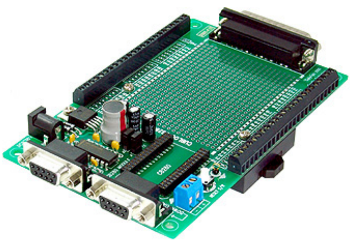
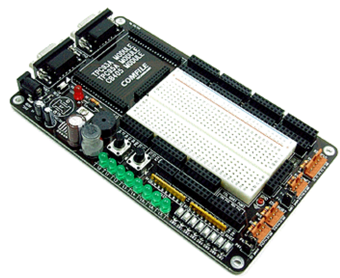
BASIC program memory(1) and LADDER(2) share the same Flash Memory. The total available memory space is 80KB. BASIC can use the whole memory or LADDER may use the whole memory. As long as the BASIC and LADDER program total is within 200KB, the user is free to program as he/she wills. (CB2XX series allow 80KB)

I/O ports (5) can be used both by BASIC and LADDER. The user must specify I/O ports to use in LADDER and BASIC. All I/O ports can be used in LADDER or BASIC.

CUBLOC Peripherals

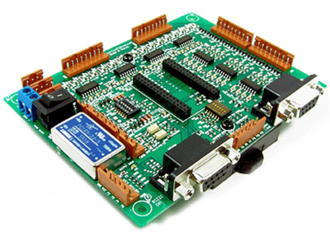
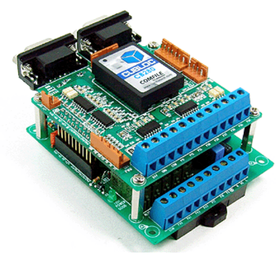
PROTO BOARD Series

Proto-boards for CUBLOC can be used for testing and debugging your future products before starting PCB artwork or production. These proto-boards all include basic power and interface circuits.

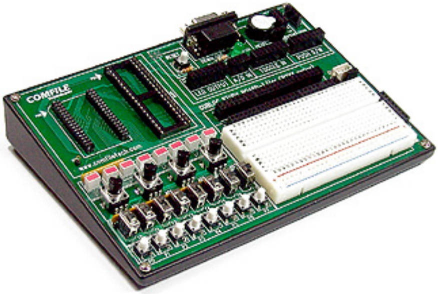
BASE BOARD / SB Series

Base-boards for CUBLOC, SB series, are especially geared for the industrial field applications. Simply attach our **Plug-N-Play** relays to the output ports for implementing solenoids, magnetic switches, and etc… With 24V input ports and DIN-RAIL Mount Brackets, the user does not have to re-invent the wheel by using CUBASE.

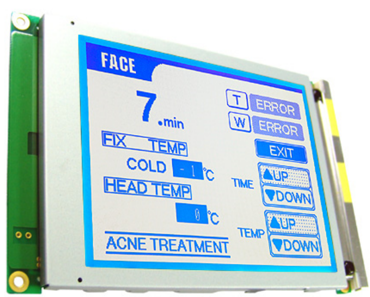
STUDY BOARD

Study board is geared for first timers and experienced developers to CUBLOC. Peripherals for simple experiments including switches, LED, RS232 communication, I2C, piezo, ADC, toggle switches, and LCDs are included.
We recommend the Start Kit for first-timers, which includes this study board, a CUBLOC module, necessary cables, and a manual.



LCD DISPLAY Module (CLCD, GHLCD Series)

Various LCD displays are provided for use with CUBLOC using CUNET (I2C) protocol. With one line commands (PRINT, CLS, etc…), you can easily start printing to the LCD without hassling with complex lines and commands.



CUNET is especially engineered for CUBLOC displays, therefore, we recommend to use CUNET supported LCDs for quick and easy development.
Our Graphic Display GHLCD allows you to download Black and White BMP images from your computer and store it in its memory.

7 Segment Display Modules (CSG Series)

7 Segment display, modules can be easily implemented using CUBLOC's I2C protocol and native commands.

CUTOUCH Series

CUTOUCH is an integration of our graphic LCD, touch panel, and CUBLOC core module. With BASIC, you can control the GHLCD, touch panel. With Ladder Logic, I/O ports can be controlled in real-time.

We are constantly upgrading and developing new peripherals for CUBLOC core modules. Please check out our website www.comfiletech.com often for these updates.

MEMO

Chapter 2
Hardware

Hardware Features

CUBLOC have the following features:

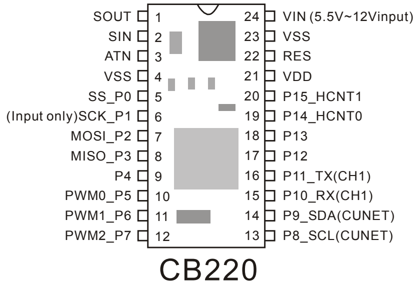
- (BASIC and Ladder Logic) 80KB or 200KB Flash Memory
- BASIC Execution Speed : 36,000 Instr./sec
- LADDER Execution Speed : 10ms Scan time
  (Turbo Mode ~= 100 Micro Second)
- Data Memory for BASIC: 2 to 51KB
- Data Memory for LADDER: 1 to 4KB
- EEPROM Memory: 4KB
- 16 to 91 I/O pins (Ports)
- 10 bit, 16 Channel ADC
- 8 to 16bit, 3 to 12 Channel PWM (DAC)
- UART (H/W RS232C ports) 4 Channels
- RS232C port PC interface
- RTC chip included (CB290)

Model Comparison Chart

Feature	CB220	CB280	CB290	CB405
Program Memory	80KB	80KB	80KB	200KB
Data Memory	BASIC 2KB LADDER 1KB	BASIC 2KB LADDER 1KB	BASIC 24KB LADDER 4KB	BASIC 51KB LADDER 4KB HEAP 55KB
Battery Backup	N/A	N/A	Available	Available
EEPROM	4KB	4KB	4KB	4KB
I/O ports	16	49 + 2	91 + 2	64 + 2
Package	24 pin DIP	64 pin Module	108 pin Module	80 pin Module
ADC	8 Channel	8 Channel	8 Channel	16 Channel
PWM	3 Channel	6 Channel	6 Channel	12 Channel
RS232	2 Channel	2 Channel	2 Channel	4 Channel
External Interrupt	None	4	4	4
HIGH COUNT INPUT	2 Channel	2 Channel	2 Channel	2 Channel
RTC	None	None	Yes	None

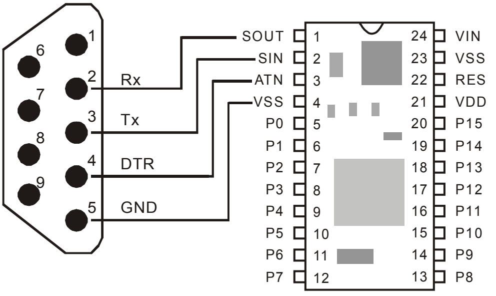
CB220

CB220 is comes as a 24pin DIP type package. It has 16 I/O ports and an internal 5V power regulator.



Port	Pin	I/O	Port Block	Explanation
SOUT	1	OUT		DOWNLOAD SERIAL OUTPUT
SIN	2	IN		DOWNLOAD SERIAL INPUT
ATN	3	IN		DOWNLOAD SERIAL INPUT
VSS	4	POWER		GROUND
P0	5	I/O		ADC0 / SPI SS
P1	6	Input		ADC1 / SPI SCK
P2	7	I/O		ADC2 / SPI MOSI
P3	8	I/O	Block 0	ADC3 / SPI MISO
P4	9	I/O		ADC4
P5	10	I/O		PWM0 / ADC5
P6	11	I/O		PWM1 / ADC6
P7	12	I/O		PWM2 / ADC7
P8	13	I/O		CuNET SCL
P9	14	I/O		CuNET SDA
P10	15	I/O		RS232C Channel 1 RX
P11	16	I/O	Block 1	RS232C Channel 1 TX
P12	17	I/O		
P13	18	I/O		
P14	19	I/O		High Count channel 0
P15	20	I/O		High Count channel 1
VDD	21	I/O		5V Output/Input
RES	22	IN		RESET Input (LOW signal resets!)
VSS	23	IN		GROUND
VIN	24	IN		5.5V to 12V Input Power

SIN, SOUT, ATN are connection pins to the PC/XPORT for DOWNLOAD, DEBUG, and MONITORING. All CUBLOC models have SOUT, SIN, ATN pins and you can connect to the PC serial cable as shown below.



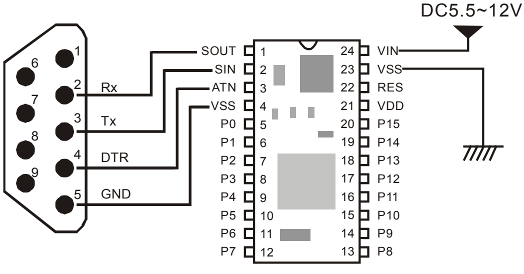
Other pins are mostly I/O ports. The user may select which ports (pins) to use as INPUT or OUTPUT. When set to INPUT, the pin enters a HIGH impedance state whereas when set to OUTPUT, the pin ether outputs LOW or HIGH. The maximum current coming out of the output ports is 25mA. The user is free to choose which I/O ports he/she will use for which purpose (such as AD, PWM, etc…).

Supplying power to the CB220

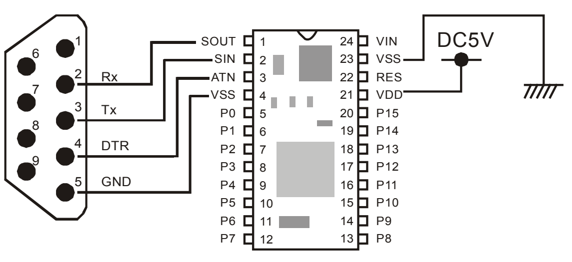
CB220 has an internal 5V power regulator that accepts anything between 5.5 to 12V of power.

It will produce a stable 100mA 5V. When using the internal regulator, voltage can be inputted to pin 24 and 5V will output on pin 21. If 5V is used for power, the user may simply connect to pin 21. If your application requires more than 100mA of current that can be supplied by the internal regulator, please use a separate power supply.

Method 1

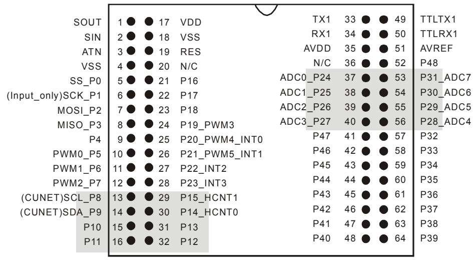


Method 2



CB280

CB280 is in a 64 pin module package and 49 of those pins can be used for I/O. The CB280 does not have a 5V internal regulator.



CB280

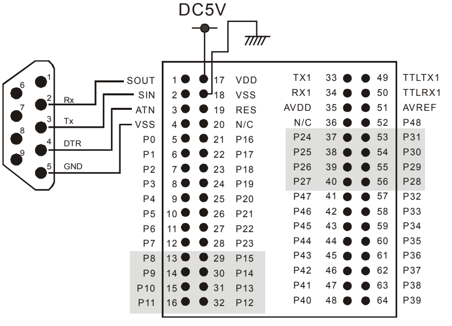
The pin numbers below are categorized by features, not by pin numbers.

Port	Pin	I/O	Port Block	Explanation
SOUT	1	OUT		DOWNLOAD SERIAL OUTPUT
SIN	2	IN		DOWNLOAD SERIAL INPUT
ATN	3	IN		DOWNLOAD SERIAL INPUT
VSS	4	POWER		GROUND
P0	5	I/O	Block 0	SPI SS
P1	6	Input		SPI SCK
P2	7	I/O		SPI MOSI
P3	8	I/O		SP MISO
P4	9	I/O		
P5	10	I/O		PWM Channel 0
P6	11	I/O		PWM Channel 1
P7	12	I/O		PWM Channel 2
P8	13	I/O	Block 1	CuNET SCL
P9	14	I/O		CuNET SDA
P10	15	I/O		
P11	16	I/O		
P12	32	I/O		
P13	31	I/O		
P14	30	I/O		High Count Channel 0
P15	29	I/O		High Count Channel 1
P16	21	I/O	Block 2	
P17	22	I/O		
P18	23	I/O		
P19	24	I/O		PWM Channel 3
P20	25	I/O		PWM Channel 4 / INT Channel 0
P21	26	I/O		PWM Channel 5 / INT Channel 1
P22	27	I/O		INT Channel 2
P23	28	I/O		INT Channel 3

P24	37	I/O	Block 3	ADC0 : AD Channel 0
P25	38	I/O		ADC1 : AD Channel 1
P26	39	I/O		ADC2 : AD Channel 2
P27	40	I/O		ADC3 : AD Channel 3
P28	56	I/O		ADC4 : AD Channel 4
P29	55	I/O		ADC5 : AD Channel 5
P30	54	I/O		ADC6 : AD Channel 6
P31	53	I/O		ADC7 : AD Channel 7
P32	57	I/O	Block 4	
P33	58	I/O		
P34	59	I/O		
P35	60	I/O		
P36	61	I/O		
P37	62	I/O		
P38	63	I/O		
P39	64	I/O		
P40	48	I/O	Block 5	
P41	47	I/O		
P42	46	I/O		
P43	45	I/O		
P44	44	I/O		
P45	43	I/O		
P46	42	I/O		
P47	41	I/O		
P48	52	I/O		
VDD	17	IN		Power, 4.5V to 5.5V
VSS	18	IN		GROUND
RES	19	IN		RESET Input (LOW signal resets!), Normally HIGH or OPEN
TX1	33			RS232 Channel 1, +/- 12V Data Output
RX1	34			RS232 Channel 1, +/- 12V Data Input
AVDD	35			ADC Power
TTLTX1	49			RS232 Channel 1, 5V (TTL level) Data Output
TTLRX1	50			RS232 Channel 1, 5V (TTL level) Data Input
AVREF	51			ADC Reference Voltage

How to supply power to the CB280

The CB280 does not have a 5V regulator; you must provide your own 5V power like shown below.

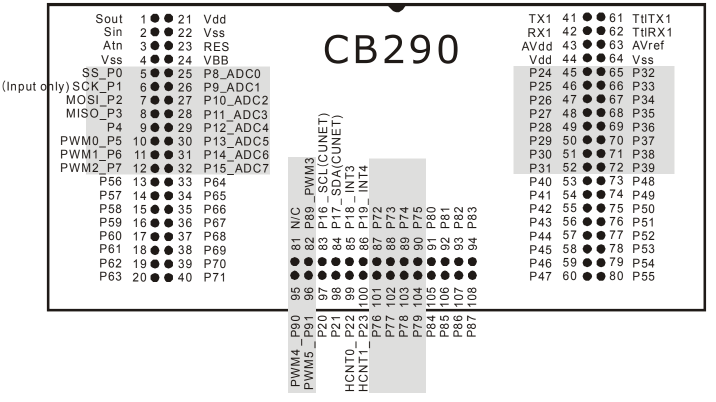


* Pin 20 and 36 are not used, please DO NOT CONNECT anything.

CB290

CB290 is in a 108 pin module package, of which 91 pins can be used as I/O ports.

It has a battery backup-able 28KB of data memory and RTC. CB290 does not have an internal 5V regulator. Of the I/O ports, 32 ports are Output only, 32 ports are Input only, and rest can be set as desired by the user.



The pin numbers below are categorized by features, not by pin numbers.

Port	Pin	I/O	Port Block	Explanation
SOUT	1	OUT		DOWNLOAD SERIAL OUTPUT
SIN	2	IN		DOWNLOAD SERIAL INPUT
ATN	3	IN		DOWNLOAD SERIAL INPUT
VSS	4	POWER		GROUND
P0	5	I/O	Block 0	SPI SS
P1	6	Input		SPI SCK
P2	7	I/O		SPI MOSI
P3	8	I/O		SPI MISO
P4	9	I/O		
P5	10	I/O		PWM Channel 0
P6	11	I/O		PWM Channel 1
P7	12	I/O		PWM Channel 2
P8	25	I/O	Block 1	ADC0 : AD Channel 0
P9	26	I/O		ADC1 : AD Channel 1
P10	27	I/O		ADC2 : AD Channel 2
P11	28	I/O		ADC3 : AD Channel 3
P12	29	I/O		ADC4 : AD Channel 4
P13	30	I/O		ADC5 : AD Channel 5
P14	31	I/O		ADC6 : AD Channel 6
P15	32	I/O		ADC7 : AD Channel 7

P16	83	I/O	Block 2	CUNET SCL
P17	84	I/O		CUNET SDA
P18	85	I/O		INT Channel 2
P19	86	I/O		INT Channel 3
P20	97	I/O		
P21	98	I/O		
P22	99	I/O		High Count Channel 0
P23	100	I/O		High Count Channel 1
P24	45	Output	Block 3	
P25	46	Output		
P26	47	Output		
P27	48	Output		
P28	49	Output		
P29	50	Output		
P30	51	Output		
P31	52	Output		
P32	65	Output	Block 4	
P33	66	Output		
P34	67	Output		
P35	68	Output		
P36	69	Output		
P37	70	Output		
P38	71	Output		
P39	72	Output		
P40	53	Output	Block 5	
P41	54	Output		
P42	55	Output		
P43	56	Output		
P44	57	Output		
P45	58	Output		
P46	59	Output		
P47	60	Output		
P48	73	Output	Block 6	
P49	74	Output		
P50	75	Output		
P51	76	Output		
P52	77	Output		
P53	78	Output		
P54	79	Output		
P55	80	Output		
P56	13	Input	Block 7	
P57	14	Input		
P58	15	Input		
P59	16	Input		
P60	17	Input		
P61	18	Input		
P62	19	Input		
P63	20	Input		

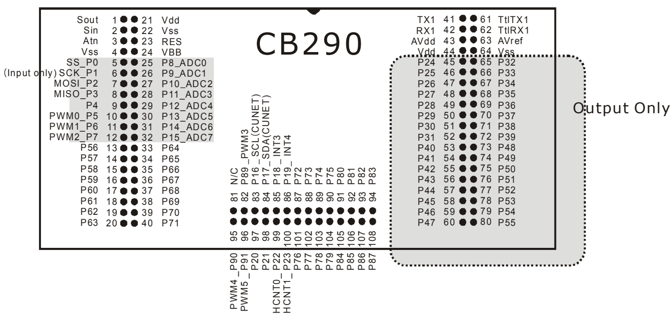
P64	33	Input	Block 8	
P65	34	Input		
P66	35	Input		
P67	36	Input		
P68	37	Input		
P69	38	Input		
P70	39	Input		
P71	40	Input		
P72	87	Input	Block 9	
P73	88	Input		
P74	89	Input		
P75	90	Input		
P76	101	Input		
P77	102	Input		
P78	103	Input		
P79	104	Input		
P80	91	Input	Block 10	
P81	92	Input		
P82	93	Input		
P83	94	Input		
P84	105	Input		
P85	106	Input		
P86	107	Input		
P87	108	Input		
P88	81	N/C	Block 11	N/C (Do not use this I/O number)
P89	82	I/O		PWM Channel 3
P90	95	I/O		PWM Channel 4 / INT Channel 0
P91	96	I/O		PWM Channel 5 / INT Channel 1
VDD	21,44	IN		Power, 4.5V to 5.5V
VSS	22,64	IN		GROUND
RES	23	IN		RESET Input (LOW signal resets!), Normally HIGH or OPEN
VBB	24	IN		Battery Backup
TX1	41			RS232 Channel 1, +/- 12V Data Output
RX1	42			RS232 Channel 1, +/- 12V Data Input
AVDD	43			ADC Power
TTLTX1	61			RS232 Channel 1, 5V (TTL level) Data Output
TTLRX1	62			RS232 Channel 1, 5V (TTL level) Data Input
AVREF	63			ADC Reference Voltage

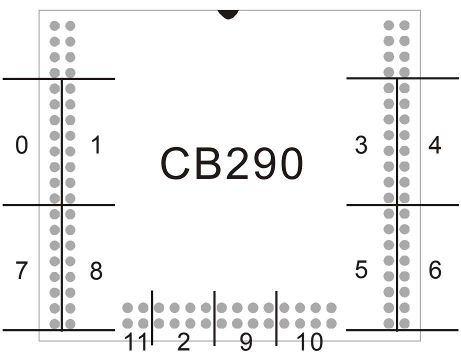
The CB290 output-only pins P24 to P55 are in high impedance state(High-Z) at power ON. You can use "Set Outonly On" to set them all to output states.

```
Set Outonly On
```

This command only works with CB290 rev B. The revision number is written on the bottom side of the CB290 module.

A fake port 88 was made to make the Set OUTOnly command, which is same as LOW 88. Therefore, when using the CB290 Rev B, you may not use port 88 (P88) for other purposes. Please do not use USEPIN 88 when using with LADDER.

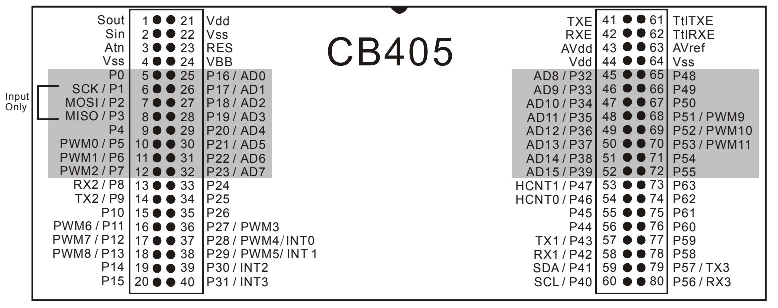




Port Blocks

CB405

CB405 is in a 80 pin module package, of which 64 pins can be used as I/O ports. It has a battery backup-able 55KB of data memory. CB405 does not have an internal 5V regulator.



The pin numbers below are categorized by features, not by pin numbers.

Name	Pin #	I/O	Explanation
SOUT	1	OUT	DOWNLOAD SERIAL OUTPUT
SIN	2	IN	DOWNLOAD SERIAL INPUT
ATN	3	IN	DOWNLOAD SERIAL INPUT
VSS	4, 22, 64	POWER IN	GROUND
VDD	21, 44	POWER IN	4.5V to 5.5V Power Supply
AVDD	43	POWER IN	ADC power
AVREF	63	IN	ADC Reference Voltage
VBB	24	POWER IN	Battery Backup
RES	23	IN	RESET pin
TTLTXE	61	OUT	RS232 to TTL232 curcuit, TX contact
TTLRXE	62	IN	RS232 to TTL232 curcuit, RX contact
TXE	41	OUT	RS232 Output, +/- 12V
RXE	42	IN	RS232 Input, +/- 12V

The following is I/O Ports explained in PortBlocks.

Block	Name	Pin#	I/O	Function	Explanation
0	P0	5	I/O	SPI SS	
	P1	6	Input	SPI SCK	Input Only
	P2	7	Input	SPI MOSI	Input Only
	P3	8	Input	SPI MISO	Input Only
	P4	9	I/O		
	P5	10	I/O	PWM CHANNEL 0	
	P6	11	I/O	PWM CHANNEL 1	
	P7	12	I/O	PWM CHANNEL 2	

1	P8	13	I/O	TTL232 RX2	TTLRX channel 2
	P9	14	I/O	TTL232 TX2	TTLTX channel 2
	P10	15	I/O		
	P11	16	I/O	PWM CHANNEL 6	
	P12	17	I/O	PWM CHANNEL 7	
	P13	18	I/O	PWM CHANNEL 8	
	P14	19	I/O		
	P15	20	I/O		

2	P16	25	I/O	AD CHANNEL 0	
	P17	26	I/O	AD CHANNEL 1	
	P18	27	I/O	AD CHANNEL 2	
	P19	28	I/O	AD CHANNEL 3	
	P20	29	I/O	AD CHANNEL 4	
	P21	30	I/O	AD CHANNEL 5	
	P22	31	I/O	AD CHANNEL 6	
	P23	32	I/O	AD CHANNEL 7	

3	P24	33	I/O	Co-processor SCL	1)
	P25	34	I/O	Co-processor SDA	1)
	P26	35	I/O	Co-processor INT	1)
	P27	36	I/O	PWM3	
	P28	37	I/O	PWM4 / INT0	
	P29	38	I/O	PWM5 / INT1	
	P30	39	I/O	INT2	
	P31	40	I/O	INT3	

1) Communication line for connecting to co-processor (Please try to save these pins for future co-processor communication ports.)

Block	Name	Pin#	I/O	Function	Explanation
4	P32	45	I/O	AD CHANNEL 8	
	P33	46	I/O	AD CHANNEL 9	
	P34	47	I/O	AD CHANNEL 10	
	P35	48	I/O	AD CHANNEL 11	
	P36	49	I/O	AD CHANNEL 12	
	P37	50	I/O	AD CHANNEL 13	
	P38	51	I/O	AD CHANNEL 14	
	P39	52	I/O	AD CHANNEL 15	

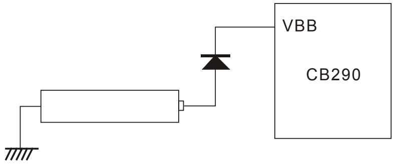
5	P40	60	I/O	SCL	CUNET clock pin
	P41	59	I/O	SDA	CUNET data pin
	P42	58	I/O	RX1	TTLRX channel 1
	P43	57	I/O	TX1	TTLTX channel 1
	P44	56	I/O		
	P45	55	I/O		
	P46	54	I/O	HCNT0	High Counter 0
	P47	53	I/O	HCNT1	High Counter 1

6	P48	65	I/O		
	P49	66	I/O		
	P50	67	I/O		
	P51	68	I/O	PWM CANNEL 9	
	P52	69	I/O	PWM CANNEL 10	
	P53	70	I/O	PWM CANNEL 11	
	P54	71	I/O		
	P55	72	I/O		

7	P56	80	I/O	RX3	TTLRX channel 3
	P57	79	I/O	TX3	TTLTX channel 3
	P58	78	I/O		
	P59	77	I/O		
	P60	76	I/O		
	P61	75	I/O		
	P62	74	I/O		
	P63	73	I/O		

How to connect Battery to CB290/CB405

When a super capacitor is used for VBB of CB290 /CB405, a length of couple days to couple weeks can be backed up once powered OFF. CB290 /CB405 consumes about 15-20mA of current when idling. For longer backup period, a battery can be used. Using a battery with large capacity could yield up to 1 year of data backup. Make sure to use a diode as shown below for using batteries.



Power Features

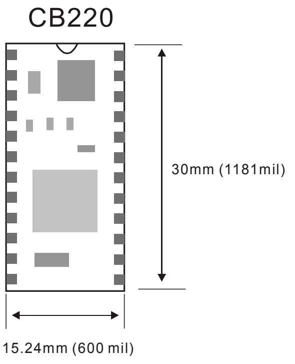
- Operating Voltage : 4.5V to 5.5V
- Operating Clock : 18.432MHz
- I/O Port Source Current : 20mA
- I/O Port Sink Current : 25mA
- Operating Temperature : -40 to 125 Degrees(Celcius)
- Maintenance Temperature: -60 to 140 Degrees(Celcius)
- Operating Humidity : 5 to 95% RH

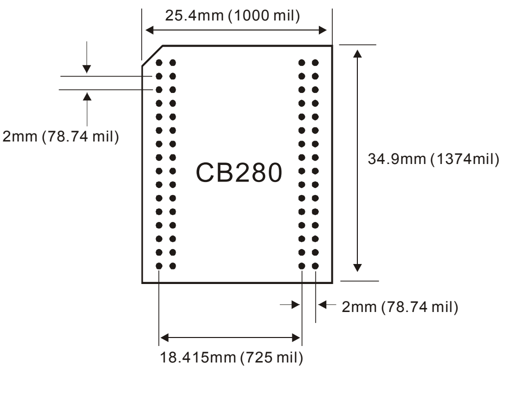
  (Keep the board's surface dry when testing and/or operating)

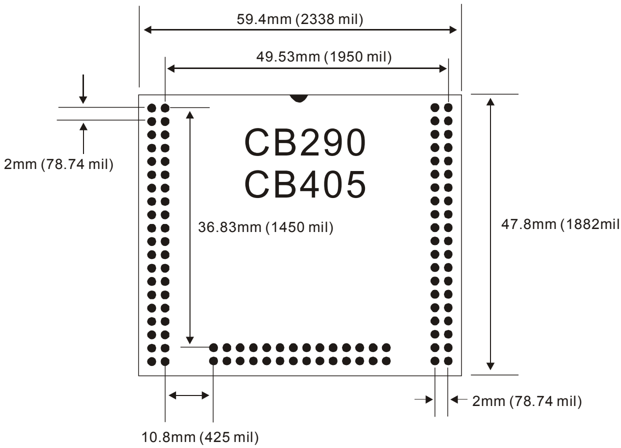
Additional Information

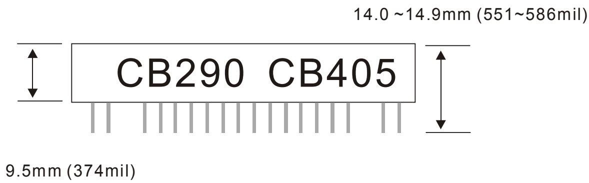
If CUBLOC module is supplied with power above recommended voltage, the chip can be destroyed. Please be careful of static electricity that could damage the chip. Please be aware that P1 is an input-only pin.
To block noise, please set all pins not used to input and set all outputs to Low when not being used. All I/Os are set to input as default at power-ON.
When not using SIN, SOUT, and ATN pins, please do not connect them to anything.

Dimensions

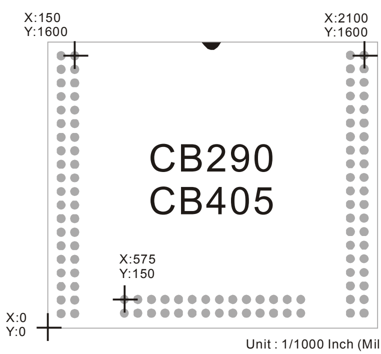

CB220
30mm (1181mil)
15.24mm (600 mil)


25.4mm (1000 mil)
2mm (78.74 mil)
CB280
34.9mm (1374mil)
2mm (78.74 mil)
18.415mm (725 mil)





Please refer to the above picture for PCB design. The numbers are Offsets based on location 0, 0.

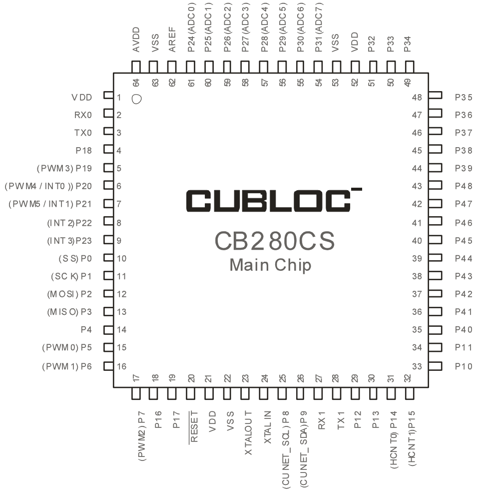


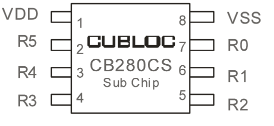
CUBLOC Chipset : CB280CS

The CB280CS has exactly the same features as a regular CB280 chip except it's in a chipset format. By using the CB280CS, the user is able to solder the chipset directly on to their PCB. This will lower your overall production cost while integrating CB280 into your product seamlessly.

Since this chipset has same features as a regular CB280, we recommend you develop your applications on the CB280 before going into production with the chipset version.

*The CB280CS includes: Main Chip, Sub Chip





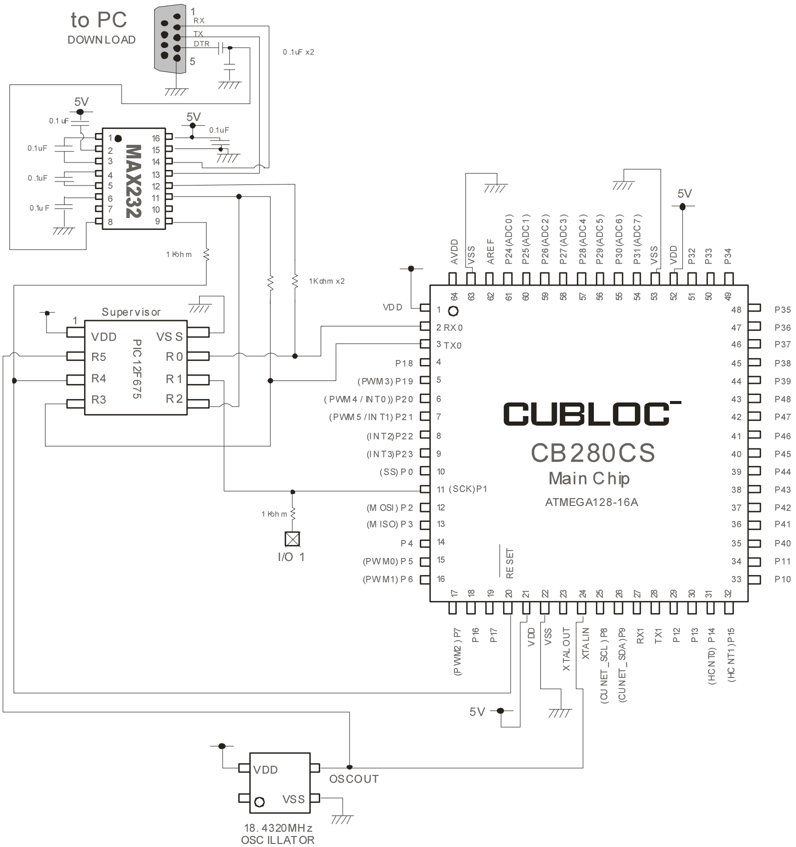
Main chip pin out

Pin #	Port	Function	Desc.
1	VDD		Power Supply
2	RX0	DOWNLOAD RX	RS232-RX
3	TX0	DOWNLOAD TX	RS232-TX
4	P18		I/O port
5	P19	PWM3	I/O port
6	P20	PWM4 / INT0	I/O port
7	P21	PWM5 / INT1	I/O port
8	P22	INT2	I/O port
9	P23	INT3	I/O port
10	P0	SS	I/O port
11	P1	SCK	I/O port
12	P2	MOSI	I/O port
13	P3	MISO	I/O port
14	P4		I/O port

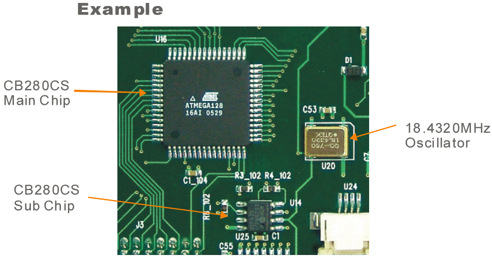
15	P5	PWM0	I/O port
16	P6	PWM1	I/O port
17	P7	PWM2	I/O port
18	P16		I/O port
19	P17		I/O port
20	/RESET		Reset (Low active)
21	VDD		Power supply
22	VSS		Ground
23	XTALOUT		Xtal output
24	XTALIN		Xtal input
25	P8	CUNET_SCL	I/O port
26	P9	CUNET_SDA	I/O port
27	RX1	RS232 CH1 RX	RS232 Channel 1 Rx
28	TX1	RS232 CH1 TX	RS232 Channel 1 Tx
29	P12		I/O port
30	P13		I/O port
31	P14	HCOUNT0	I/O port
32	P15	HCOUNT1	I/O port
33	P10		I/O port
34	P11		I/O port
35	P40		I/O port
36	P41		I/O port
37	P42		I/O port
38	P43		I/O port
39	P44		I/O port
40	P45		I/O port
41	P46		I/O port
42	P47		I/O port
43	P48		I/O port
44	P39		I/O port
45	P38		I/O port
46	P37		I/O port
47	P36		I/O port
48	P35		I/O port
49	P34		I/O port
50	P33		I/O port
51	P32		I/O port
52	VDD		Power supply
53	VSS		Ground
54	P31	ADC7	I/O port
55	P30	ADC6	I/O port
56	P29	ADC5	I/O port
57	P28	ADC4	I/O port
58	P27	ADC3	I/O port
59	P26	ADC2	I/O port
60	P25	ADC1	I/O port
61	P24	ADC0	I/O port
62	AREF		Ref. for ADC
63	VSS		Ground
64	AVDD		Power supply for ADC

Please refer to Appendix F for detailed CB280CS specification.

CB280CS Application Schematic



Example

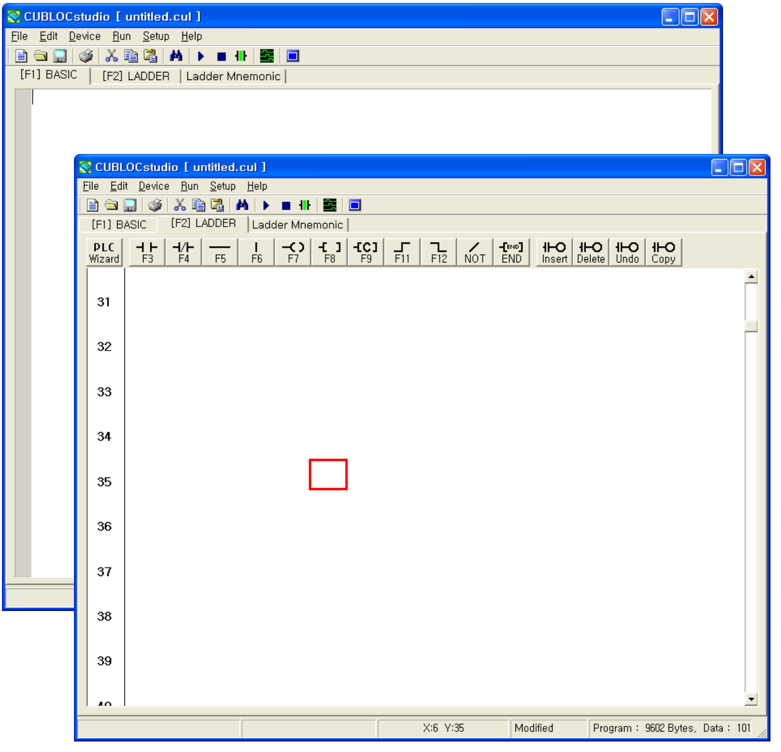


MEMO

Chapter 3 CUBLOC STUDIO Editor/ Compiler

CUBLOC STUDIO Basics

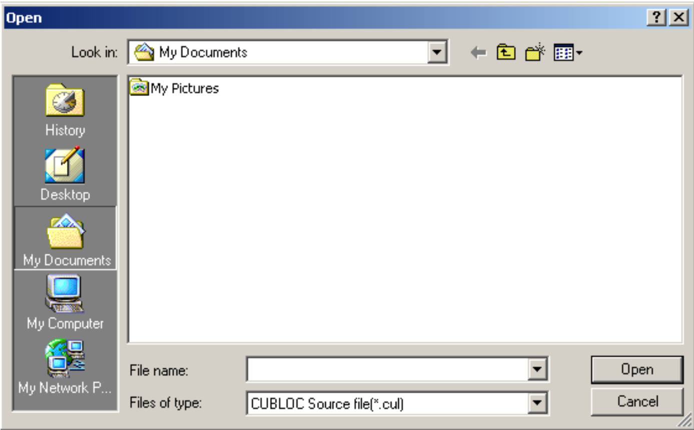
After installing CUBLOC STUDIO and executing it, you will see the following screen.



You will see that at first CUBLOC STUDIO will be in TEXT EDITOR Mode.

If you press F2, the screen will change to LADDER EDITOR Mode and if you press F1, it will switch back to TEXT EDITOR Mode.

Source files are saved under file extensions .CUL and .CUB, as TWO FILES. If you need to backup or move source files, you must save BOTH of these files.



When opening a file, you will only see .CUL files. (.CUB files are not displayed, but they are in the same folder). When you open .CUL file, CUBLOC STUDIO automatically opens CUB file.

The source code can only be saved on the PC. Source code downloaded to the CUBLOC module can not be recovered.

IMPORTANT

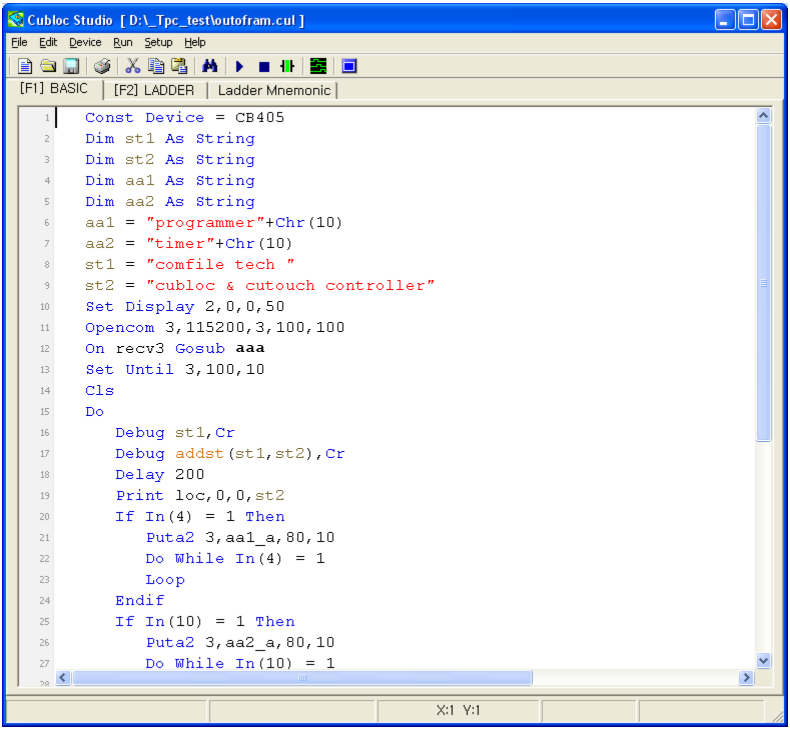
CUBLOC module supports "Code-protection." By encrypting download data, others can not simply read part of the chip's memory to access the source code.

When you press the RUN button (or CTRL-R), Save**->** **Compile->** **Download->** **Execute** are automatically processed.

LADDER and BASIC both are compiled with one RUN button. If error is found during compilation, the screen will move to where the error occurs.

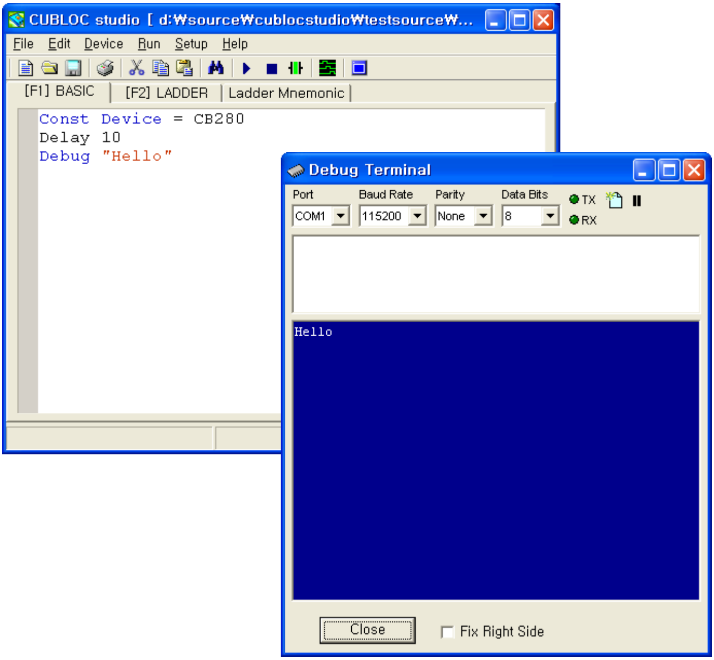
Creating BASIC

You can create BASIC code as shown below. CUBLOC Text Editor is similar to most text editors and supports Coloring of certain commands.



Short-Cut	Explanation
CTRL-Z	UNDO
CTRL-O	OPEN
CTRL-S	SAVE
CTRL-C	COPY
CTRL-X	CUT
CTRL-V	PASTE
CTRL-F	FIND
CTRL-HOME	Go to the very beginning
CTRL-END	Go to the very end
CTRL-Y	REDO

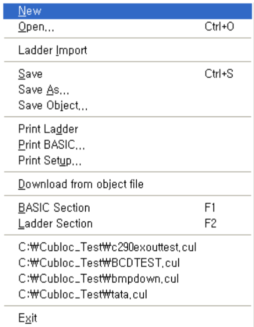
Debugging



As you can see in the above example, DEBUG command can be used to debug your BASIC program while it's running. Be aware that you are not allowed to use both Debugging and LADDER Monitoring at the same time. You must remove Debug commands or comment them out with an apostrophe to use LADDER Monitoring. Another option is to use the command "Set Debug Off," which will turn OFF the DEBUG feature.

Menus

File Menu

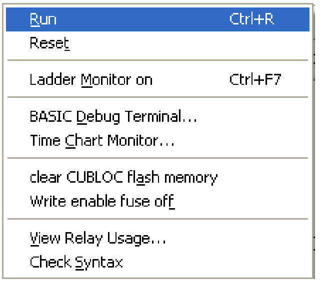


Menu	Explanation
New	Create new file.
Open	Open file.
Ladder Import	Import Ladder Logic part of a CUBLOC program.
Save	Save current file.
Save As	Save current file under different name.
Save Object	Save current program as an object file. Use this to protect your source code. Object file is strictly binary format file so others cannot reverse engineer it. You can use "Download from Object File" to download your object file to CUBLOC. Create object files for internet-downloading with CuMAX or CuMAX Server.
Print Ladder	Print Ladder Logic Section only.
Print Basic	Print Basic Section only.
Print Setup	Setup Printer for printing Ladder Logic Section.
Download from Object file	Download an Object file to the CUBLOC module.
Basic Section	Switch to Basic Section for editing. (Or press F1).
Ladder Section	Switch to Ladder Logic Section for editing. (Or press F2).
Last 4 Files Edited	View last 4 files edited.
Exit	Exit CUBLOC Studio

Device Menu

If Const device statement does not exist in your source code, Device Menu will create a Const device statement at the very beginning of your source code. If it exists already, the Const device statement will simply be replaced.

Run Menu



Menu	Explanation
Run	Compile Basic and Ladder, download to CUBLOC module if there are no errors, and restart the program automatically. To disable automatic restart, please go to **Setup->Studio Option** to change.
Reset	Reset CUBLOC Module.
Ladder Monitor on	Start Ladder Monitoring
BASIC Debug Terminal	Open BASIC Debug Terminal Window. This window opens automatically when there's a DEBUG command in the source code.
Time Chart Monitor	View Time chart monitor window
Clear CUBLOC's Flash Memory	Clear CUBLOC's Flash Memory.
Write enable fuse off	This will turn off download function for a CUBLOC Core module to protect against noisy environments where the flash memory can be affected. Once you choose this menu, you will be unable to download new programs to your CUBLOC module. BUT, you will be able to download again after a new Firmware Download.
View Register Usage	(After Compiling) View Register usage of Ladder Logic.
Check Syntax	Check Syntax

Setup Menu

Menu	Explanation
PLC Setup Wizard	Automatic BASIC source code generation for Ladder Logic
PC Interface Setup	Setup the RS232 COM PORT for Download/Monitor. Select COM1 through COM4.
Editor Environment Setup	Setup Editor Environment options for BASIC text editor.
Environment Options	CUBLOC Studio Options.
Firmware Download	Download Firmware to CUBLOC CORE. Please use this to download firmware to CUBLOC CORE manually.

MEMO

Chapter 4 CUBLOC BASIC Language

IMPORTANT

You must declare the device being used before using BASIC or LADDER. Below is an example of declaring CUBLOC CB220 module.

```
CONST DEVICE = CB220  ' Use CB220.
```

This should be the first line at the start of your program. When this command is not used, CB220 model will be chosen as default.

```
CONST DEVICE = CT1720 ' Use CT1720.
CONST DEVICE = CB280  ' Use CB280.
```

CUBLOC BASIC Features

Interface PC with RS232C Port

CUBLOC uses RS232 port to interface with the PC. You also have option of using it to connect to MAXPORT and use monitoring/downloading via the internet.

CUBLOC BASIC supports functions and sub routines.

Like C language, the user is able to create sub-routines and functions to lessen the complexities of their programs. By being able to use sub-routines and functions, it is now possible to simple copy & paste for new programs, instead of starting everything from scratch.

```
Function  SUM( A As Integer,  B As Integer) As Integer
        Dim RES As Integer
        RES = A + B
        SUM = RES
End Function
```

Calculations can be done within conditional statements such as If, While, etc...

```
IF ((A + 1) = 100) THEN GOTO ABC

IF ((A + 1) = 100) AND (B / 100 = 20) OR C = 3 THEN GOTO ABC
```

Multi-dimension arrays are supported.

CUBLOC supports multi-dimension arrays including character arrays. Maximum of 8-D arrays are supported and only 1 dimensional array is allowed for character arrays.

```
DIM A(100,10,20) AS BYTE
```

Hardware RS232 Communication are Supported

CUBLOC supports hardware RS232 communication, meaning it does not conflict with real-time processing.

Conditional Statements are supported.

CUBLOC BASIC supports SELECT CASE and DO…LOOP conditional statements.

A graphic LCD library is provided.

CUBLOC provides a complete graphic LCD library for GHLCD. Drawing boxes, lines, circles, and graphic commands are easily implemented in few lines of code.

Various Communication Protocols are supported.

CUNET : Display Peripherals such as LCD
RS232 : 4 channel
MODBUS : HMI and Touch screen Protocol
I2C : I2C commands supported (I2CREAD, I2CWRITE)
SPI : SPI commands supported (SHIFTIN, SHIFTOUT)
PAD: Keypad, touchpad supported.

Advanced Basic Language is Comparable to C Language.

#include support
#define support
#if..#ifdef..#endif conditional compile support
Incr, Decr commands: same function as C's + +, - -
Pointers allowed (PEEK, POKE, and MEMADR)
String Arrays (1-Dimension)

Simple BASIC program

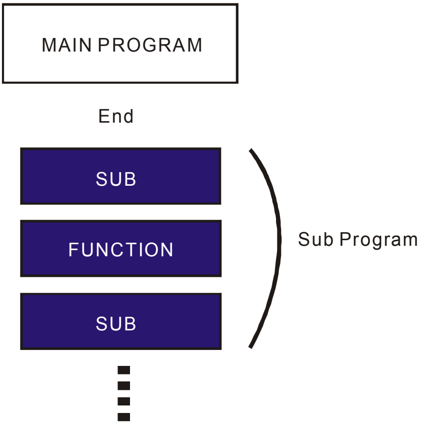
Below is an example of simple BASIC program with Do…Loop statement.

```
Dim A As Byte
Do
      Byteout 0, A
      A=A+1
Loop
```

This program outputs to Port P0-P7 an increasing value of A. The next program uses a function to accomplish the same task:

```
Dim A As Byte
Do
      Byteout 0, A
      A=ADD_VALUE(A)
Loop
End

Function ADD_VALUE(B As Byte) As Byte
      ADD_VALUE = B + 1
End Function
```

By separating A=A+1 to a function, the user will be able to separate one big program into small chunks. As you can see here, the main program ends when "END" comes and functions are added afterwards.



Sub and Function

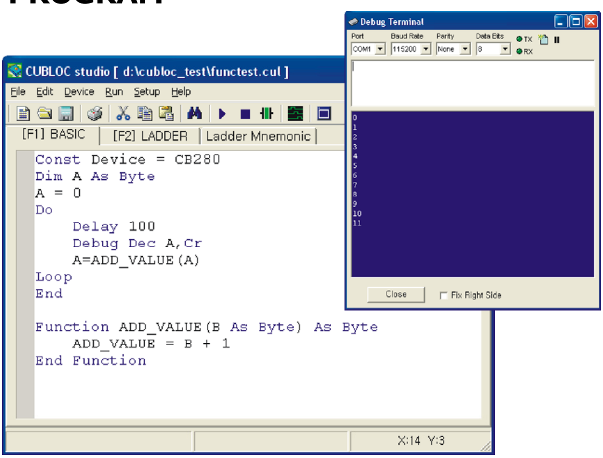
For sub-routines, you can either use Sub or Function. Sub does not return any values whereas Function does return values.

```
Sub SubName (Param1 As DataType [,ParamX As DataType][,…])
      Statements
      [Exit sub] ` Exit during sub-routine
End Sub

Function FunctionName (Param1 As DataType [,…])[As ReturnDataType]
      Statements
     [Exit Function] ` Exit during sub-routine
End Function
```

To return values using Function, simply store the final value as the name of the Function like shown here:

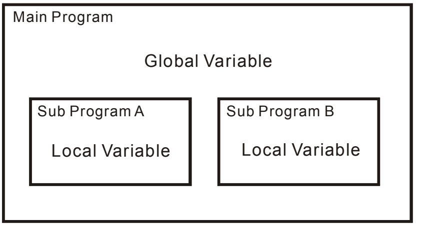
```
Function ADD_VALUE(B As Byte) As Byte
     ADD_VALUE = B + 1 ` Return B+1.
End Function
```

DEMO PROGRAM



Global and Local Variables

When you declare variables inside a Sub or Function, it is considered to be a "Local" variable. The Local Variables are created upon call of the Sub or Function and removed at exit. This means that the Local Variables will use the Data Memory and then free it for other resources. Local Variables may only be referred to or used inside the Sub or Function.
On the other hand, Global variables may be used in all parts of your code.




```
Dim  A  As  Integer       ` Declare A as Global Variable
LOOP1:
    A = A + 1
    Debug  Dp(A),CR       ` Display A on Debug screen
    DELAYTIME             ` Call Sub DELAYTIME
    Goto LOOP1
    End                   ` End of Main Program

Sub  DELAYTIME()
    Dim  K  As  Integer   ` Declare K as Local Variable
    For K=0 To 10
    Next
End Sub
```

In the program above, "A" is declared as Global Variable and "K" is declared as Local Variable. A can be used anywhere in your code but K may only be used inside the subroutine DELAYTIME().

Arrays may not be used for Local Variables. **Arrays must be declared as Global Variables.**

Calling subroutines

Once the subroutine is created, you can use them like a regular command. For Sub, you do not need parenthesis around the parameters. For multiple parameters, use a comma to separate them.

The example shows how this is done:

```
DELAYTIME 100           ` Call subroutine
End

Sub  DELAYTIME(DL As Integer)
     Dim  K  As  Integer  ` Declare K as Local Variable
     For K=0 To DL
     Next
End Sub
```

For Function, you need parenthesis around the parameters. Parenthesis is required even when there is no parameters.

```
Dim K As Integer
K = SUMAB(100,200) `Call subroutine and store return value in K
Debug Dec K,cr
End

Function  SUMAB(A AS INTEGER, B AS INTEGER) As Integer
     SUMAB = A + B
End Function
```

Subroutine Position

Subroutines must be created after the main program. To do this, simply put "End" at the end of your main program like shown here:
("End" is only required if you have subroutines)

```
Dim  A  As  Integer
LOOP1:
     A = A + 1
     Debug  DP(A),CR
     DELAYTIME
     Goto Loop1

     End           ' End of main program

Sub  DELAYTIME()
     Dim  K  As  Integer
     For K=0 To 10
     Next
End Sub
```

Sub and Function subroutines come after the "End." Gosub subroutines must be within the main program like shown here:

```
 Dim A As Integer
   :
   :
 Gosub ABC
   :
ABC:
   :
 End
```

```
Sub  DEF(B as Byte)
   :
   :
End Sub
```

```
Function  GHI(C as Byte)
   :
   :
End Function
```

* End command is used to differentiate between BASIC main program and the subroutines. END command used in Ladder Logic is to indicate the end of Ladder Logic.

Subroutine Parameters and Return Values

Function may use any data type as parameters and return values.

```
Dim A(10) As Integer

Function ABC(A AS Single) as Single    ` Return Single value
End Function

Function ABC(A AS String * 12) as String *12 ` Return String value
End Function

Function ABC(A AS long)  ` Long value as a parameter
End Function             ` When return value is not declared, Long
                         ` will be used as return value.
```

Exceptions includes using arrays as parameters.

```
Function ARRAYUSING(A(10) AS Integer) ` Arrays may not be used as
                                      ` parameters.
End Function
```

But you may use one element of an array as a parameter.

```
Dim b(10) as integer
K = ARRAYUSING(b(10)) ` Use 10th element of array b as a parameter.

Function ARRAYUSING(A AS Integer) as integer
End Function
```

All subroutines' parameters are "Call by value," meaning the values are only used as reference. Even if the parameter value is changed within a subroutine, it will not affect the actual variable used as a parameter like shown here:

```
Dim  A  As  Integer
Dim  K  As  Integer
A = 100
K = ADDATEN(A)
Debug Dec? A, Dec? K,CR ` A is 100 and K is 110
End

Sub ADDATEN(V As Integer)
    V = V + 10          ` A does not change when V is changed.
    ADDATEN = V
End Sub
```

In contrast, there is "Reference by Address," in which the actual Data Memory address is passed to the subroutine. **CUBLOC only supports "Call by Value."**

Too many characters in one line?

If you run out of room, you can use an underscore character (_) to go to the next line like shown here:

```
ST = "COMFILE TECHNOLOGY"
ST = "COMFILE _
     TECHNOLOGY"
```

Comments

Use an apostrophe (‘) to add comments. Comments are discarded during compile, meaning it will not take up extra Program Memory.

```
ADD_VALUE = B + 1   ‘ Add 1 to B.(Comment)
```

Nested subroutines

Nested subroutines are supported in CUBLOC.

```
A=FLOOR(SQR(F)) ‘ Do Floor() on SQR(F).
```

Colons

Colons may not be used to put append commands in CUBLOC BASIC.

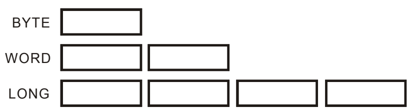
```
A=1: B=1 : C=1  ‘ Incorrect.

A=1         ‘ Correct.
B=1
C=1
```

Variables

There are 5 types of variables in CUBLOC BASIC.

- BYTE 8 bit Positive Number, 0 to 255
- INTEGER 16 bit Positive Number, 0 to 65535
- LONG 32 bit Positive/Negative Number, (-2147483648 to +2147483647)
- SINGLE 32 bit Floating Point Number, (-3.402823E+38 to 3.402823E+38)
- STRING String, 0 TO 127 bytes

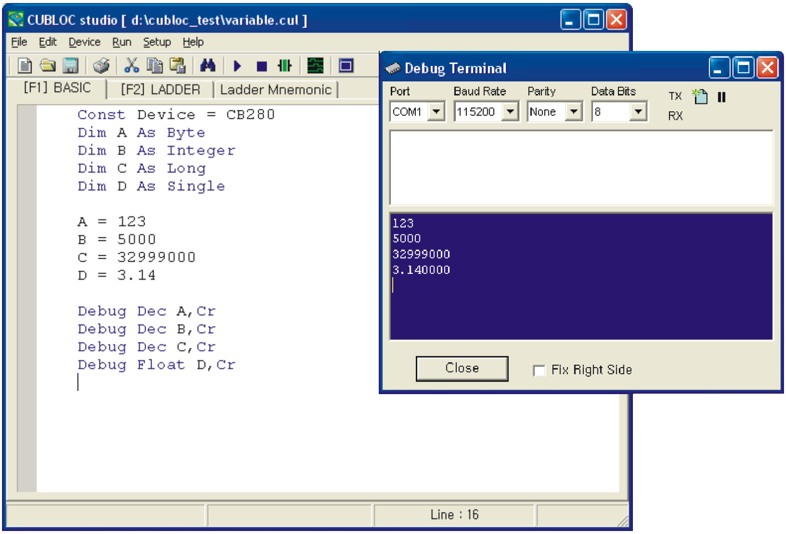
A Byte is an 8 bit positive number representing 0 to 255.
An Integer is a 16 bit positive number representing 0 to 65535.
A Long is a 32 bit positive or negative number representing -2,147,483,648 to 2,147,483,647.
A Single is a 32 bit positive or negative floating point number representing -3.402823×10^{38} to 3.402823×10^{38}.



*For storing negative numbers, please use LONG or SINGLE.
Use DIM command for declaring variables as shown below:

```
Dim  A  As  Byte                    'Declare A as BYTE.
Dim  B  As  Integer, C As Byte      'Comma may NOT be used.
Dim  ST1  As String * 12            'Set String size for String.
Dim  ST2  As String                 'Set as 64 bytes (default).
Dim  AR(10) As Byte                 'Declare as Byte Array.
Dim  AK(10,20) As Integer           'Declare as 2D Array
Dim  ST(10) As String*10            'Declare a String Array
```

DEMO PROGRAM



VAR Command (Same function as DIM)

VAR can be used in place of DIM to declare variables. Below are examples of how to use VAR:

```
A       Var     Byte            ' Declare A as BYTE.
ST1     Var     String * 12     ' Declare ST1 as String of 12 bytes.
AR      Var     Byte(10)                ' Declare AR as Byte Array of 10.
AK      Var     Integer(10,20)          ' Declare AK as 2-D Integer Array
ST      Var     String *12  (10)        ' Declare String Array
```

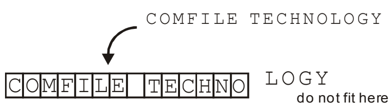
String

A String size can be set up to 127 bytes. When size is not set, default value of 64 bytes will be used as the String size.

```
Dim  ST  As  String * 14    ' For maximum usage of 14 bytes
Dim  ST2  As  String        ' Set as 64 byte String variable
```

When setting a String as 14 bytes, another byte is allocated by the processor to store NULL. When storing “COMFILE TECHNOLOGY” in a 14 byte String, the last 4 characters (bytes) will not be stored.

```
Dim  ST  As  String * 14
ST = “COMFILE TECHNOLOGY” ‘  “LOGY” is not stored
```



In CUBLOC BASIC, (“) must be used for String. An apostrophe (‘) may not be used.

```
ST = “COMFILE “ TECHNOLOGY” ‘ (“) can not be used inside the String.
ST = “COMFILE ‘ TECHNOLOGY” ‘ (‘) can not be used inside the String.
ST = “COMFILE , TECHNOLOGY” ‘ (,) can not be used inside the String.
```

You can use CHR(&H22) to express (“) and CHR(&H27) to express (‘) and CHR(&H2C) to express (,).

Example for printing to LCD:

```
Print Chr(&H22),“COMFILE “ TECHNOLOGY”,Chr(&H22) ‘ (“)
Print Chr(&H27),“COMFILE “ TECHNOLOGY”,Chr(&H27) ‘ (‘) Apostrophe
```

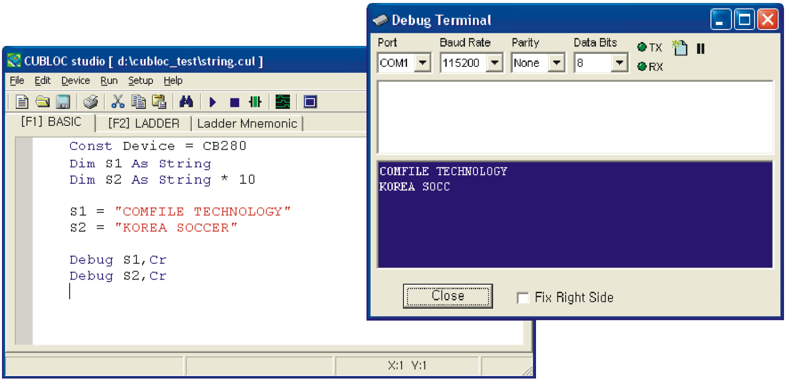
To connect multiple Strings, you can use a comma as shown below:

```
Print "ABC","DEF","GHI"  ' Same as PRINT "ABCDEFGHI".
```

Use CR for Carriage Return (Next Line).

```
Print "California",CR  ' Print California and go to the next line.
```

DEMO PROGRAM



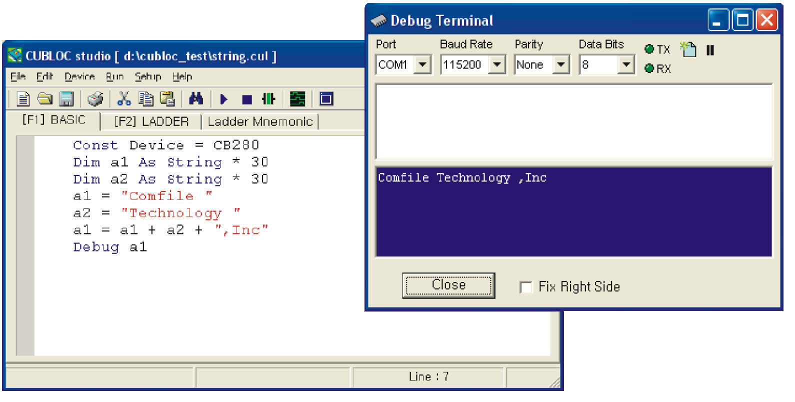
Merge Multiple Strings

To merge multiple strings together, use & as shown below:

```
Dim a1 As String * 30
Dim a2 As String * 30
a1 = "Comfile "
a2 = "Technology "
a1 = a1 + a2 + ",Inc"
Debug a1,cr
```

The above program will show "Comfile Technology, Inc" on the debug screen.

DEMO PROGRAM



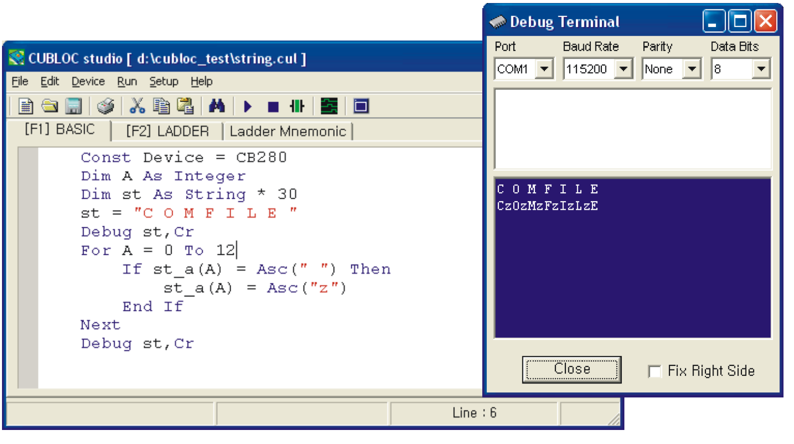
How to Access Individual Characters within a String

You can use strings like an array. Simply append "_A" after the name of your string variable like shown here:

```
DIM ST1 AS STRING * 12      ` ST1_A Array is created at the same time.
ST1 = "123"
ST1_A(0) = ASC("A")         ` Store A in the first character of ST1.
```

When you declare Dim St1 as String * 12, St1_A(12) is also declared automatically by the RTOS. The string and the array use the same memory space. Whether you use the string or the array, you are still accessing same memory location.

The example below shows how to convert blank characters to z.



With string arrays, you may not use this feature.

```
Dim st(10) As String * 3
```

About Variable Memory Space

In the case of CB220 and CB280, 2KB (2048 bytes) of data memory is available. You may not use the whole data memory for variables. Part of the data memory space is reserved for use by peripherals such as DISPLAY and the RS232 buffers. The 80 bytes are used for DEBUG command.

Sub and Function routines and interrupt routines use up data memory space. Of the available 2048 bytes, about 1800 bytes can be used for global variables. The more Sub/Function routines you use, you will have less memory available for variables and constants.

When the user uses buffers with command SET DISPLAY or OPENCOM, the data memory will lose that much amount of memory space to use for variables.

Initializing Memory

CUBLOC BASIC data memory is not cleared at POWER UP. The user must initialize variables to zero or use RAMCLEAR command to clear the whole memory.

```
Ramclear
```

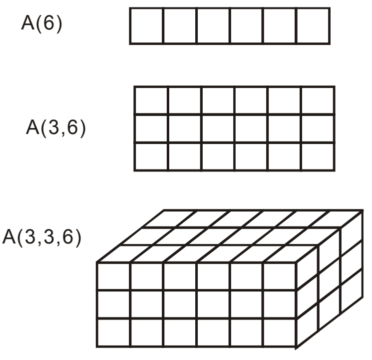
The data memory will contain garbage values at POWER UP.

In the case of Battery-backed up modules, the variables will remember their values after a Power-cycle (powering Off and On).

Arrays

CUBLOC BASIC supports up to 8 dimensional arrays, each dimension allowed up to 65535 members.

```
DIM   A(20)  AS  BYTE       ` Declare A's array size as 20
DIM   B(200)  AS   INTEGER  ` Declare Integer array
DIM   C(200)  AS   LONG     ` Declare Long array
DIM   D(20,10)  AS   SINGLE   ` 2-dimensional Single array
DIM  ST1(10) AS STRING * 12  ` Declare String array
```



CUBLOC supports multi-dimension arrays including character arrays. Up to 8-D arrays are supported. Please make note of how much memory is used when using multi-dimensional arrays.

```
` 13 * 10 = 130 Bytes of Data Memory
DIM   ST1(10) AS STRING * 12

 ` 4*10 * 20 = 800 Bytes of Data Memory
DIM   D(20,10)  AS   SINGLE
```

Bits and Bytes modifiers

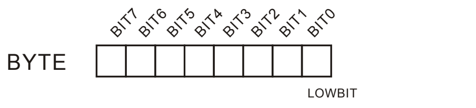
A variable’s bits and bytes can individually be accessed by using the commands shown below.

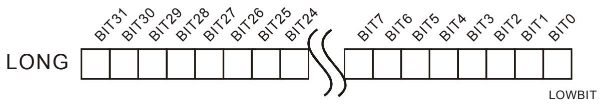
```
DIM  A  AS INTEGER
DIM  B  AS BYTE
A.LOWBYTE = &H12   ‘ Store &H12 at A’s lowest byte
```

Bit

LOWBIT	Variable’s bit 0
BIT0 to 31	Variable’s bit 0 through 31

```
A.BIT2 = 1 ‘Make bit 2 of A 1.
```



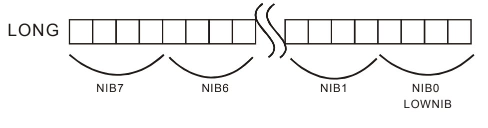


Nibble

A Nibble is for 4 bits. By using Nibbles, the user has more flexibility to manipulate the data.

LOWNIB	Variable’s NIBBLE 0
NIB0 to 7	Variable’s NIBBLE 0 to 7

```
A.NIB3 = 7 ‘ Store 7 in Nibble 3 of A
```



Byte

To specify certain bytes of a variable, the below names can be used.
(A Byte is 8 bits)

LOWBYTE, BYTE0	BYTE 0 of Variable
BYTE1	BYTE 1 of Variable
BYTE2	BYTE 2 of Variable
BYTE3	BYTE 3 of Variable

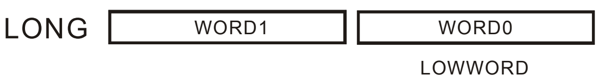
```
A.BYTE1 = &HAB 'Store &hab in byte 1 of A
```

Word

To specify certain Word of a variable, the below names can be used:
(A Word is 16 bits)

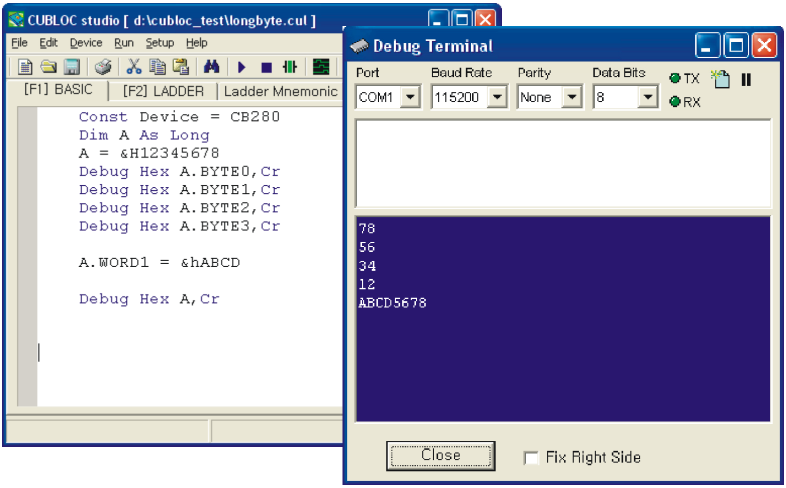
LOWWORD, WORD0	Word 0 of variable
WORD1	Word 1 of variable

```
A.WORD1 = &HABCD 'Store &habcd in word 1 of A
```



* Tips: Need to access 5 bits of a variable?
Try **NewVariable = Variable and 0x1F.**
This will mask the last 5 bits of the variable.

DEMO PROGRAM



Constants

Constants can be used to declare a fixed value at the beginning of the program. By doing this, readability and debuggability of the source code will be easier.
The command CONST can be used to declare constants in CUBLOC.

```
CONST  PI  AS  SINGLE = 3.14159
CONST  WRTTIME  AS  BYTE  = 10
CONST  MSG1 AS STRING = "ACCESS PORT"
```

When the constant is not given a type, the compiler will find an appropriate type for it as shown below:

```
CONST  PI = 3.14159          ' Declare as SINGLE
CONST  WRTTIME  = 10                ' Declare as Byte
CONST  MYROOM  = 310                ' Declare as Integer since it's over 
255.
CONST  MSG1 = "ACCESS PORT"         ' Declare as String
```

CON (Another way of CONST)

The Command CON can be used also used to declare constants in the following way:

```
PI          CON    3.14159       ' Declare as SINGLE.
WRTTIME     CON    10            ' Declare as Byte
MYROOM      CON    310                  ' Declare as Integer
MSG1        CON    "ACCESS PORT"        ' Declare as String
```

Constant Arrays...

By using constant arrays, the user is able to store a list of numbers before the program begins. By using constant arrays, the program can be simplified as shown below:

```
Const Byte DATA1 = (31, 25, 102, 34, 1, 0, 0, 0, 0, 0, 65, 64, 34)
I = 0
A = DATA1(I)   ' Store 31 in A.
I = I + 1
A = DATA1(I)   ' Store 25 in A.
Const Byte DATA1 = ("CUBLOC SYSTEMS")
```

String data can be store in Byte constant arrays. The ASCII code of the character is returned.
If DATA1(0) is read, ASCII code of 'C' is returned. Likewise if DATA1(1) is read, ASCII code of 'U' is returned.

Whole and floating point numbers can be used as shown next:

```
CONST INTEGER DATA1 = (6000, 3000, 65500, 0, 3200)
CONST LONG DATA2 = (12345678, 356789, 165500, 0, 0)
CONST SINGLE DATA3 = (3.14, 0.12345, 1.5443, 0.0, 32.0)
```

For multi-lines of constants, following ways can be used:
1)

```
CONST BYTE DATA1 = (31, 25, 102, 34, 1, 0, 0, 0, 0, 0, 65, 64, 34,
                    12, 123, 94, 200, 0, 123, 44, 39, 120, 239,
                    132, 13, 34, 20, 101, 123, 44, 39, 12, 39)
```

2)

```
CONST BYTE DATA2 = (31, 25, 102, 34, 1, 0, 65, 64, 34,_
                         101, 123, 44, 39, 12, 39)
```

Strings can be used as shown next:

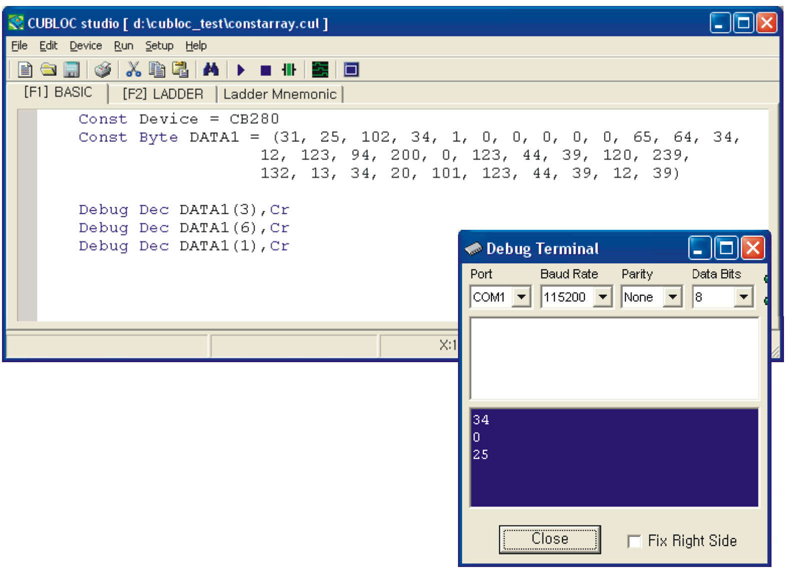
```
CONST STRING * 6 STRTBL = ("COMFILE", "BASIC", "ERROR", "PICTURE")
```

Please set the size of the String to be greater than any of the members of the constants.

Only 1 dimensional array is allowed for constants.

Comparison	Array	Constant Array
Storage	Data Memory (SRAM)	Program Memory (FLASH)
Stored Time	During Program run	During Download
Can be Changed	Yes	No
Purpose	Changing Values	Unchanging values
Power OFF	Disappear	Kept

DEMO PROGRAM



Operators

When using many logical operators, the below priority table is used to determine which operator is operated on first.

Operator	Explanation	Type	Priority
^	To the power of	Math	Highest
*,/,MOD	Multiply, Divide, MOD	Math	
+,-	Add, Subtract	Math	
<<, >>	Left Shift, Right Shift	Logic	
<, >, <=, >=	Less than, Larger than, Less or Equal to , Larger or Equal to.	Compare	
=, <>	Same, Different	Compare	
AND, XOR, OR	AND,XOR,OR	Logic	Lowest

Please refer to the above table for checking priority of operator used. In the rows, the highest priority is calculated from the left to right.

You can use operators as conditions like below:

```
IF A+1 = 10 THEN GOTO ABC
```

Whole numbers and floating point numbers can be mixed. The final result follows the type of variable it will be stored in.

```
DIM F1 AS SINGLE
DIM A AS LONG
F1 = 1.1234
A = F1 * 3.14  ' A gets 3 even though result is 3.525456.
```

Please make sure to include a period(.) when using floating point numbers.

```
F1 = 3.0/4.0        ' Write 3/4 as 3.0/4.0 for floating values
F1 = 200.0 + FLOOR(A) * 12.0 + SQR(B) '200 as 200.0, 12 as 12.0…
```

AND, XOR, OR is used for logical operations and as Bit operators.

```
IF A=1 AND B=1 THEN C=1 ' if A=1 and B=1 …(Logical Operation)
IF A=1 OR B=1 THEN C=1  ' if A=1 or B=1…(Logical Operation)

A = B AND &HF        'Set the upper 4 bits to zero. (Bit Operation)
A = B XOR &HF        'Invert the lower 4 bits. (Bit Operation)
A = B OR &HF         'Set the lower 4 bits to 1. (Bit Operation).
```

Strings can be compared with the "=" sign. ASCII values are compared for Strings.

```
DIM ST1 AS STRING * 12
DIM ST2 AS STRING * 12
ST1 = "COMFILE"
ST2 = "CUBLOC"
IF ST1=ST2 THEN ST2 = "OK"   ' Check if ST1 is same as ST2.
```

Operators used in our BASIC language may slightly differ with actual Math operators. Please refer to the below table:

Operator	Math	Basic	Example
Add	+	+	3+4+5, 6+A
Subtract	-	-	10-3, 63-B
Multiply	X	*	2 * 4, A * 5
Division	÷	/	1234/3, 3843/A
To the power of	5^3	^	5^3, A^2
MOD	Remainder of	mod	102 mod 3

In CUBLOC BASIC, a slash (/) is used in place of division sign.
Please make sure to use parenthesis appropriately for correct calculations.

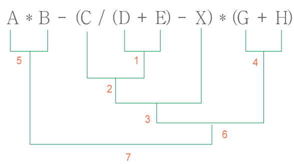
$$\frac{1}{2} \blacktriangleright 1/2 \qquad \frac{5}{3+4} \blacktriangleright 5/(3+4)$$

$$\frac{2+6}{3+4} \blacktriangleright (2+6)/(3+4)$$

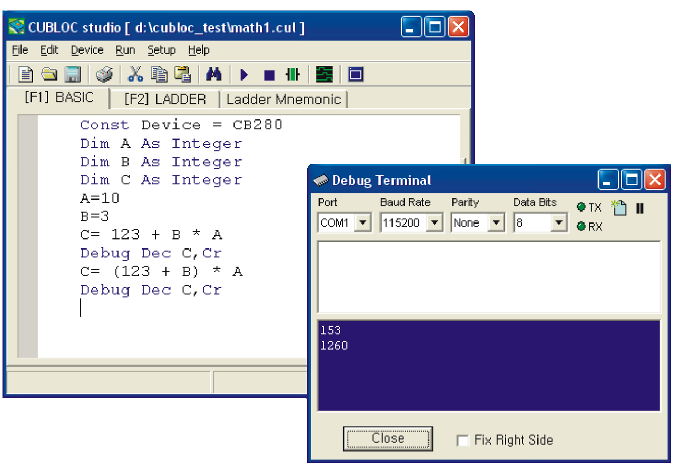
Operator Priority

When multiple operators are used, the following operator priority is used:

1) Operator inside parenthesis
2) Negative Sign (–)
3) (^)
4) Multiplication, Division, Remainder (*, /, MOD)
5) Addition/Subtraction (+,-)
6) Left Shift, Right Shift (<<, >>)



DEMO PROGRAM



Expressing Numbers in Bits

3 ways of bit representation of numbers are possible with CUBLOC. Binary (2 bit), Decimal (10 bit), and Hexadecimal (16 bit) can be used.

Examples of how-to:

```
Binary :      &B10001010, &B10101,
              0b1001001, 0b1100

Decimal :     10, 20, 32, 1234

Hexadecimal : &HA, &H1234, &HABCD
              0xABCD, 0x1234      ← Similar to C
              $1234, $ABCD        ← Similar to Assembly Language
```

The BASIC Preprocessor

The BASIC preprocessor is a macro processor that is used automatically by the compiler to transform your program before compilation. It is called a macro processor because it allows you to define macros, which are brief abbreviations for longer constructs.

In CUBLOC BASIC, a Preprocessor similar to C language can be used.
Preprocessor directives like #include and #define can be used to include files and process code before compiling.

#include "filename"

Include file in the source code. For files in the same directory as the source file, you can do the following:

```
#INCLUDE "MYLIB.cub"
```

For files in other directories, you will need to include the full path name like shown here:

```
#INCLUDE "c:\mysource\CUBLOC\lib\mylib.cub"
```

By using include files, you can store all of your sub-routines in a separate file.
Please make sure to use pre-processor directive #include at the very end of your program. (After "End" for subroutines)

#define name constants

By using #define, you can define constants before compiling.

```
#define motorport 4
low motorport
```

For the example above, motorport will be compiled as 4. You can also just use CONST for such examples like this:

```
CONST motorport = 4
low motorport
```

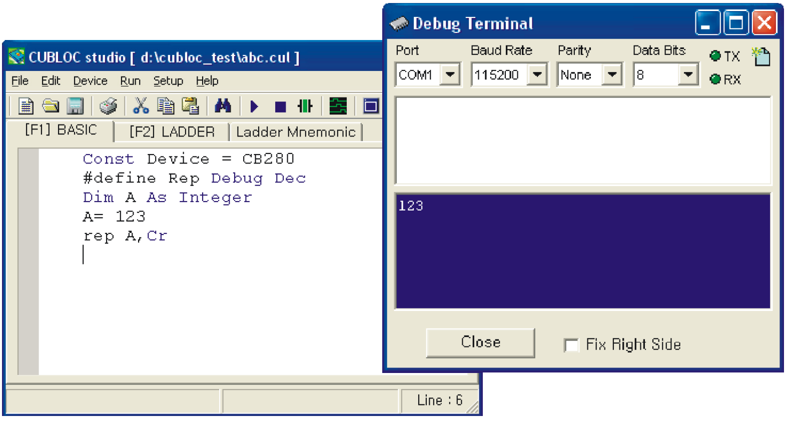
The following example uses #define for replacing a line of command:

```
#define FLAGREG1 2
#define f_led FLAGREG1.BIT0
#define calc (4+i)*256
f_led = 1                         ` Set FLAGREG1's bit zero to 1.
IF f_led = 1 then f_led = 0        ` Make it easier to read.
j = calc                          `Calculations can be simplified
```

NOTE

#define will not differentiate uppercase and lowercase letters. They will all be processed as uppercase character. For example, #define ALPHA 0 and #define alpha 0 are both considered the same.

DEMO PROGRAM



Conditional

A *conditional* is a directive that instructs the preprocessor to select whether or not to include a part of code before compilation. Preprocessor conditionals can test arithmetic expressions, or whether a name is defined as a macro, or both simultaneously using the special defined operator.

Here are some reasons to use a conditional.

- A program may need to use different code depending on the module it is to run on. In some cases the code for one module may be different on another module. With a preprocessing conditional, a BASIC program may be programmed to compile on any of CUBLOC/CUTOUCH modules without making changes to the source code.
- If you want to be able to compile the same source file into two different programs. One version might print the values of data for debugging, and the other not.

#if constant
#endif

The preprocessor directive #if will compare a constant declared with CONST to another constant. If the #if statement is true, the statements inside the #if…#endif block will be compiled, otherwise statements will be discarded.

```
Const Device = CB280

Delay 500
` Device only returns the decimal number
#If Device = 220
 Debug "CB220 module used!"
#endif
```

The above example shows how depending on the module of CUBLOC/CUTOUCH, you can decided to include a command in the final compilation of your program. By using conditional directives, you will be able to manage multiple modules of your CUBLOC/CUTOUCH with just one source code.

By using preprocessor directive #elseif or #else, you can create more complex #if…#endif blocks.

```
Const Device = CB220

Delay 500
` Device only returns the decimal number

#If Device = 220
 Debug "CB220 module used!"
#elseif device = 280
Debug "CB220 module used!"
#elseif device = 290
Debug "CB290 module used!"
#elseif device = 1720
Debug "CT1720 module used!"
#endif
```

#else may only be used ONCE in a #if statement. You may only compare constants declared with CONST command for the #if statements.

#ifdef name
#endif

When using #if to compare constants, you can use #ifdef to see if a constant has been defined previously using #define or CONST.
If the constant has been defined previously, the statements inside the #if…#endif block will be compiled, otherwise it will be discarded.

```
#define  LOWMODEL 0
#ifdef LOWMODEL
      LOW 0
#endif
```

In the above example, since LOWMODEL is defined, the statement LOW 0 is compiled.
#else #elseifdef may be used for more complex blocks like shown here:

```
#ifdef LOWMODEL
      LOW 0
#elseifdef HIGHMODEL
      HIGH 0
#else
      LOW 1
#endif
```

#ifndef name
#endif

#ifndef is exactly the opposite of #ifdef directive. If a constant has not been defined, the statements inside #if…#endif block will be compiled, otherwise statements are discarded.

```
#define  LOWMODEL 0
#ifndef LOWMODEL
      LOW 0
#endif
```

#elseifndef and #else may be used for more complex blocks like shown here:

```
#ifndef LOWMODEL
      LOW 0
#elseifndef HIGHMODEL
      HIGH 0
#else
      LOW 1
#endif
```

Finally, the directives may be mixed as shown below:

```
#if MODELNO = 0
      LOW 0
#elseifdef HIGHMODEL
      HIGH 0
#else
      LOW 1
#endif
```

An exception is that #if may not be used inside another #if.

To use LADDER ONLY

If you do not need to use BASIC, you can just program in LADDER. But you will need the most basic BASIC-code as shown below:

```
Const Device = CB280       'Select device

Usepin 0,In,START          'Declare pins to use
Usepin 1,Out,RELAY

Alias M0 = MOTORSTATE      'Set Aliases
Alias M1 = RELAY1STATE

Set Ladder On              'Start Ladder.
```

Device model, aliases, and pin input and output status must be set in BASIC. Ladder must be started in BASIC with SET LADDER ON command.

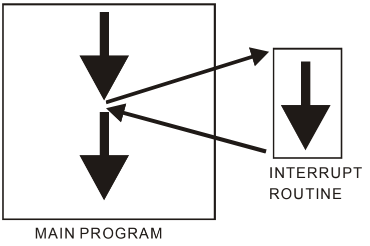
To use BASIC ONLY

Simply use BASIC! Ladder is off as default

```
Set Ladder On       ` Just don't use this command.
Ladderscan          ` And this one too.
```

Interrupt

An interrupt can occur during the main program to process immediate needs of some sort. ON…GOSUB command can be used to set a new interrupt. When that interrupt occurs, the main program stops execution and jumps to the label designated by the previous ON…GOSUB command. Once the interrupt routine in the label is finished, RETURN command is used to return back to the main program.



External Key input can be pressed and RS232 serial data can be received at any moment. Since the main program cannot wait forever to receive these inputs, we need interrupts. If a key is pressed or serial data is received while the Main program is running, an interrupt occurs and the Main program jumps to an interrupt routine.

CUBLOC possesses one of the most flexible interrupts in the world. While an interrupt routine is running, another **interrupt request of the same type** is ignored. If an RS232 RECV interrupt occurs during execution of an RS232 RECV interrupt routine, it will be ignored. On the other hand, if an INT Edge interrupt occurs during execution of an RS232 RECV interrupt routine, it will be executed immediately before returning to the RS232 RECV interrupt routine.

Interrupt Type	Explanation
On Timer	Create interrupt within the set interval
On Int	Create interrupt when external input is received.
On Recv	Create interrupt when RS232 receives data
On LadderInt	Create interrupt when Ladder Logic requests for an interrupt
On Pad	Create interrupt when Pad receives data

More about Interrupts…

The CUBLOC and CUTOUCH have RTOS which controls interrupt events. This is slightly different from microcontroller's hardware interrupts.

1. When an interrupt A occurs, during the interrupt A, another interrupt A cannot occur. But a different interrupt B can occur. Here A and B are different types of interrupts. (e.g. On Timer and On Recv)

2. When an interrupt B occurs during the interrupt A, interrupt B will be executed immediately and the Main Program will return to interrupt A to finish.

3. At the end of your interrupt routine, please make sure to include a **Return** command. Otherwise, your program can mal-function.

4. There is no limit on the number of interrupts and how long an interrupt routine may be.

5. **Delay, Pulsout** commands can be used during an interrupt. BUT, **Delay** and **Pulsout** time may be affected by other interrupts that occur during its execution. To protect against such situations, please use **Set Onglobal Off** before calling **Delay** or **Pulsout** command like shown here:

```
Set Onglobal Off
Delay 100                 ' Delay  command not affected
Set Onglobal On
```

6. If no interrupt is required for your program, you can actual increase the execution speed of CUBLOC or CUTOUCH by setting all interrupt off using the command, **Set Onglobal Off**.
*By Default, **Set Onglobal** is set to On.

7. In case of On Recv, data received during an On Recv routine will simply be stored in the receive buffer. Therefore the data will not be lost. After the current On Recv interrupt routine is finished, if there's new data in the receive buffer, another On Recv interrupt will be called immediately. **Bclr** command can be used in case the user does not want to process another On Recv Interrupt.

8. If you declare an interrupt twice, the last one called will be in effect.

Pointers using Peek, Poke, and Memadr

Following is an example that uses EEWRITE command and EEREAD command to read floating point data:

```
Const Device = CB280
Dim f1 As Single, f2 As Single
f1 = 3.14
Eewrite 0,f1,4
f2 = Eeread(0,4)
Debug Float f2,cr
```

When you run this code, the debug window will show 3.00000 instead of 3.14. The reason is that EEWRITE command automatically converts floating point values to whole numbers.

In order to store floating point values, we can use Peek and Poke to read the data directly. The following is how we would accomplish that:

```
Const Device = CB280
Dim F1 As Single, F2 As Single
F1 = 3.14
Eewrite 10,Peek(Memadr(F1),4),4
Poke Memadr(F2),Eeread(10,4),4

Debug Float F2,CR
```

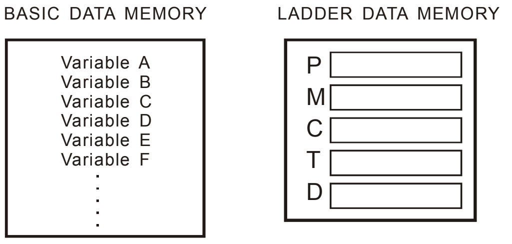
The Debug Window will now show 3.14.

We use Memadr(F1) to find the memory address of F1 and then use Peek command to directly access the memory and write 4 bytes. We store that value in EEPOM. Conversely, we use Memadr(F2) and Poke to read 4 bytes directly.

Warning : Please use caution when using this command as pointers can affect the whole program. Peek and Poke may only access data memory SRAM.

Sharing Data

CUBLOC has individual BASIC and LADDER data memory.



LADDER data memory can be accessed from BASIC easily by using system variables. By using these system variables, data can easily be read or written from and to LADDER.

System Variable (Array)	Access Units	LADDER Register
_P	Bits _P(0) to _P(127)	P Register
_M	Bits _M(0) to _M(511)	M Register
_WP	Words _WP(0) to _WP(7)	P Register (Word Access)
_WM	Words _WM(0) to _WM(31)	M Register (Word Access)
_T	Words _T(0) to _T(99)	T Register (Timer)
_C	Words _C(0) to _C(49)	C Register (Counter)
_D	Words _D(0) to _D(99)	D Register (Data)

Registers P and M can be accessed in units of bits and the rest of the Registers C, T, and D can be accessed in units of Words. To access P and M Registers in units of Words, use _WP and _WD. For example, _WP(0) represents P0 through P15.

The following is an example program :

```
_D(0) = 1234
_D(1) = 3456
_D(2) = 100
FOR I = 0 TO 99
      _M(I) = 0
NEXT
IF _P(3) = 1 THEN _M(127) = 1
```

Reversely, accessing BASIC variables from Ladder is not possible but you can use Ladder interrupts to get around this.

Use Ladder pins in BASIC using ALIAS command

ALIAS command can be used to set aliases for Registers (**all except D**) used in LADDER. Both BASIC and LADDER may freely use these set aliases.

```
Usepin 0,In,START
Usepin 1,Out,RELAY
Alias M0 = MOTORSTATE
Alias M1 = RELAY1STATE
Alias T1 = SUBTIMER

RELAY = 0          ' Set port 1 to LOW
MOTORSTATE = 1     ' Set M0 to 1.  Same as _M(0) = 1.

A = RELAY1STATE    ' Store M1 status in variable A.
B = SUBTIMER       ' Store T1 status in variable B.
```

MEMO

Chapter 5 CUBLOC BASIC functions

Math Functions

SIN, COS, TAN

Return Sine, Cosine, and Tangent values. CUBLOC uses radians as units. Use SINGLE for most precise results.

```
A=SIN B               ` Return Sine value.
A=COS B               ` Return Cosine value.
A=TAN B               ` Return Tangent value.
```

ASIN, ACOS, ATAN

Return Arc Sine, Arc Cosine, and Arc Tangent values. CUBLOC uses radians as units. Use SINGLE for most precise results.

```
A=ASIN B              ` Return Arc Sine value.
A=ACOS B              ` Return Arc Cosine value.
A=ATAN B              ` Return Arc Tangent value.
```

SINH, COSH, TANH

Return Hyperbolic Sine, Hyperbolic Cosine, and Hyperbolic Tangent values.

```
A=SINH B              ` Return Hyperbolic Sine value of B.
A=COSH B              ` Return Hyperbolic Cosine value of B.
A=TANH B              ` Return Hyperbolic Tangent value of B.
```

SQR   Return Square Root value.

```
A=SQR B               ` Return square root value of B
```

EXP   Return E^X.

```
A=EXP X               `Return E^X.
```

LOG, LOG10   Return LOG or LOG10 value.

```
A=LOG B  or  A=LOG10 B
```

Tips

"For natural logarithm (Ln), simply do: A= Log(B)/Log(Exp(1))"

ABS Return Absolute value.(for long type)

```
Dim A As Long, B As Long
B = -1234
A=ABS B       `Return |B|.
Debug Dec A   `Print 1234
```

FABS Return Absolute value.(for Single type)

```
Dim A As Single, B As Single
B = -1234.0
A=FABS B      `Return |B|.
Debug Float A `Print 1234.00
```

FLOOR Round down to the whole number.

```
Dim A As Single, B As Single
B = 3.14
A=FLOOR B     `FLOOR 3.14 gives 3.
Debug Float A       `Print 3.0
```

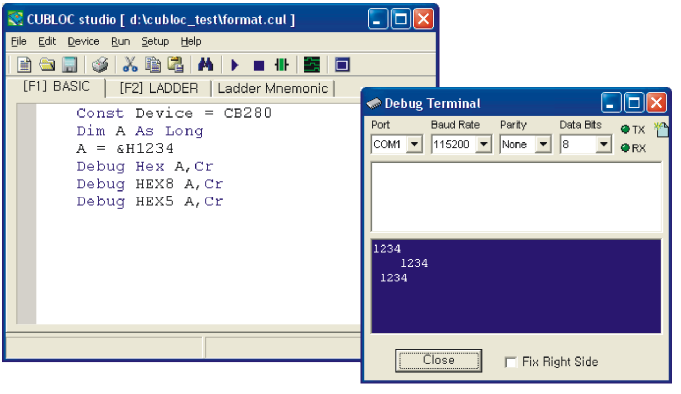
Type Conversion

Type conversion can be used to convert the variable to desired bit representation.

HEX

Converts the variable to hex (16 bit). HEX8 means to convert to 8 decimal places. (1 to 8 can be used for decimal places)

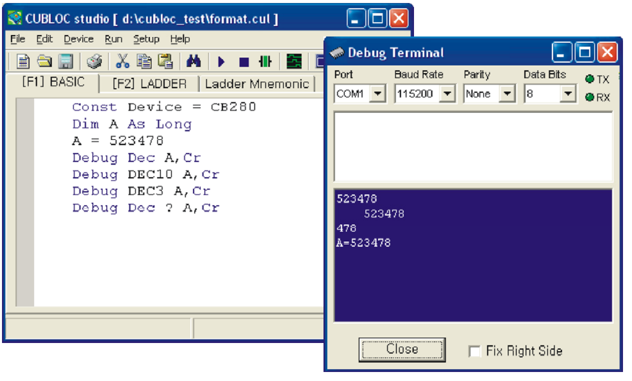
```
DEBUG HEX A   `if A is 123ABC, 123ABC is printed
DEBUG HEX8 A  `if A is 123ABC, bb123ABC is printed,
              `  b is a blank space in this case.
DEBUG HEX5 A  `if A is 123ABC, 23ABC is printed, first character
              `is cut.
```



DEC

Converts the variable to a decimal (10 bit). DEC8 means to convert to 8 decimal places. (1 to 11 can be used for decimal places)

```
DEBUG DEC A         ` If A is 1234, 1234 is printed.
DEBUG DEC10 A       ` If A is 1234, bbbbbb1234 is printed,
                    `  b is a blank space in this case.
DEBUG DEC3 A        ` If A is 1234, 234 is printed, first
                    ` character is cut
```



?

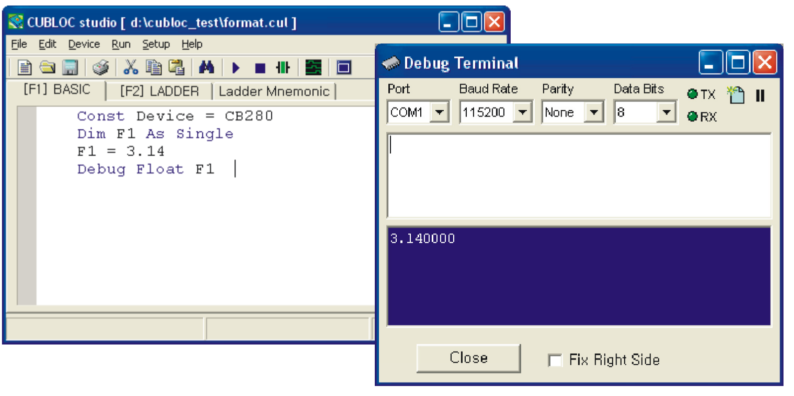
Include the name of the variable by using question mark (?). This question mark can only be used with HEX or DEC.

```
DEBUG DEC ? A       ` If A is 1234, "A=1234" will be printed.
DEBUG HEX ? A       ` If A is ABCD, "A=ABCD" will be printed.
DEBUG HEX ? B       ` If B is a sub-routine variable let's say of
                    ` sub-routine CONV, "B_@_CONV=ABCD"
                    ` will be printed. (B is in CONV)
```

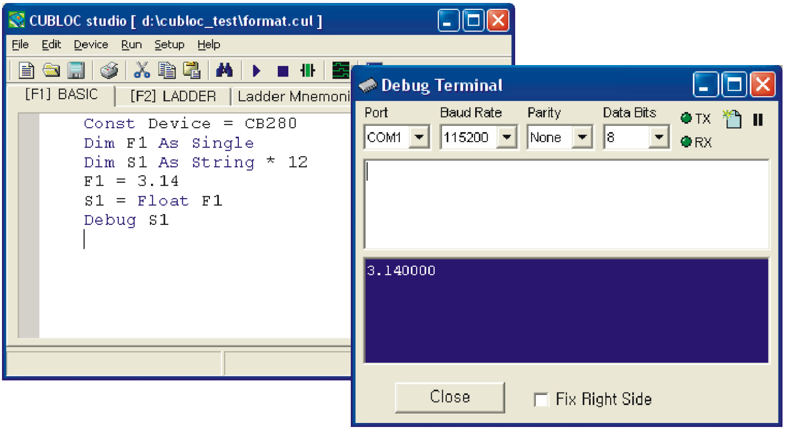
FLOAT

Use FLOAT to convert floating point values to String.

```
Const Device = cb280
Dim F1 As Single
F1 = 3.14
Debug Float F1,cr            ' Print "3.14000".

Dim ST As String * 15
ST = Float F1                ' First store in a String.
ST = Left(ST,3)              ' Convert to 3 decimal places
Debug ST                     ' Print "3.14".
```



You can also store into a string before printing debug statements or displaying to the LCD.



String Functions

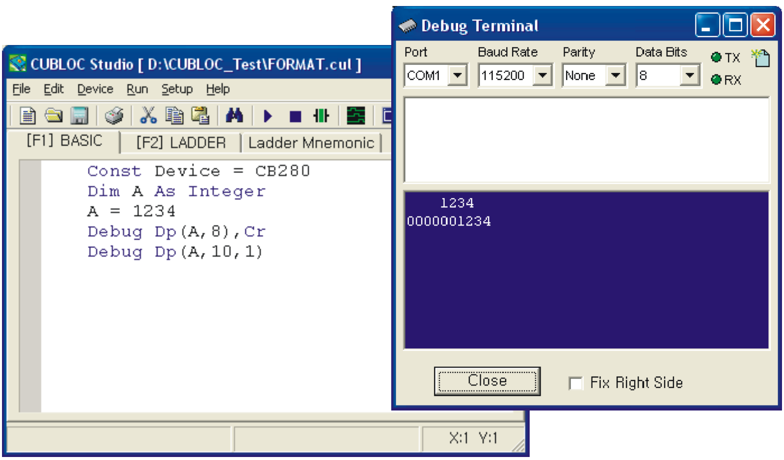
String Ructions are provided to assist the user in accessing data within the String.

DP(Variable, Decimal Places, ZeroPrint)

The command DP converts Variable into decimal String representation.

If ZeroPrint is set to 1, zeros are substituted for blank spaces.

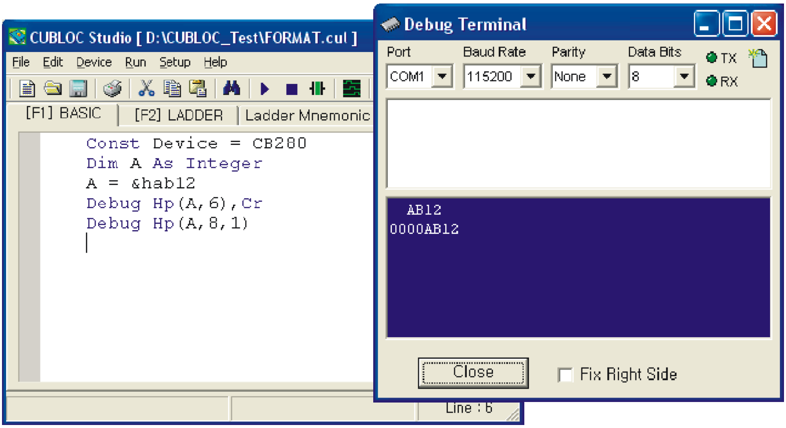
```
Dim A as Integer
DEBUG DP(A,10,0)      ` Convert A into decimal String representation.
                      ` Set display decimal places to 10.
                      ` If A is 1234, bbbbb1234 will be displayed.
                      ` (b stands for blank spaces.)

DEBUG DP(A,10,1)      ` If A is 1234, 0000001234 will be displayed.
```



HP(Variable, Decimal Places, ZeroPrint)

This command HP converts Variable into hexadecimal String representation. If ZeroPrint is set to 1, zeroes are substituted for blank spaces.

```
DEBUG HP(A,4,0)        ' Convert A into HEX String representation
                       ' Set display decimal places to 4.
                       ' If A is ABC, bABC will be displayed.
                       ' (b stand for blank spaces.)

DEBUG HP(A,4,1)        ' If A is ABC, 0ABC will be displayed.
```

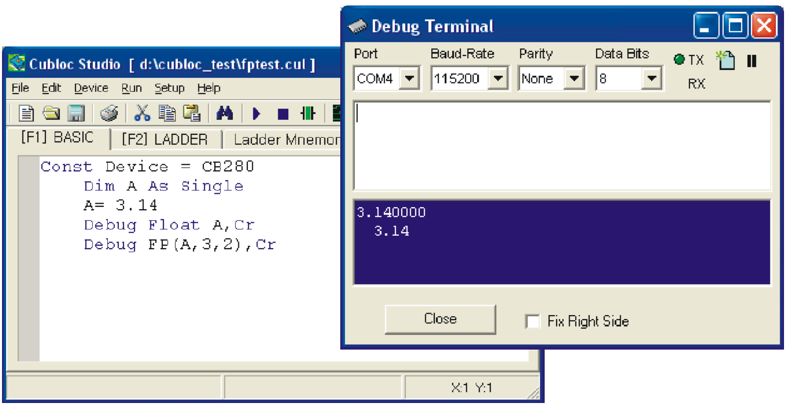


FP(Value, Whole Number Digits, Fractional Number Digits)

Convert Floating Point variables into a formatted String with user defined whole and fractional number digits.

```
Dim A as Single
A = 3.14
DEBUG Float A          ` 3.1400000 Prints all digits.
DEBUG FP(A,3,2)        `  3.14 Print user defined digits.
```

By using FP function, the user can control the number of digits to be used for string data when using Debug commands or displaying to an LCD.



CUBLOC Floating Point Values are in accordance with the IEEE724 format. The values of FP() and Float may differ but the value stored in the variable will be the same.

LEFT(Variable, Decimal Places)

Cut specified decimal places of the String from the left side and return the value.

```
DIM ST1 AS STRING * 12
ST1 = "CUBLOC"
DEBUG LEFT(ST1,4)  ' "CUBL" is printed.
```

RIGHT(Variable, Decimal Places)

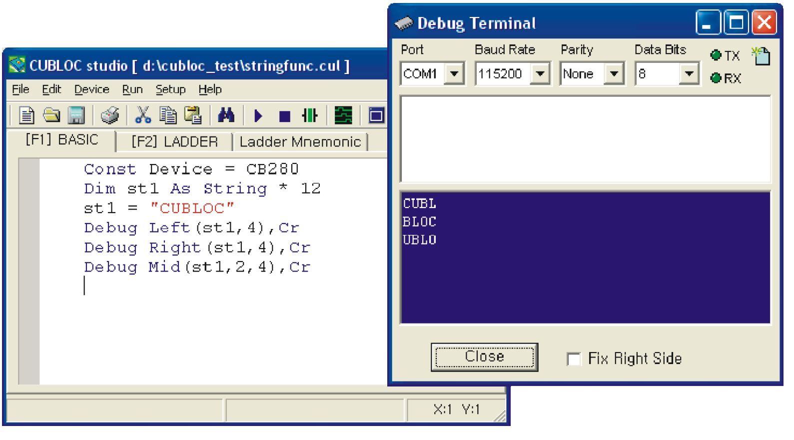
Cut specified decimal places of the String from the right side and return the value.

```
DIM ST1 AS STRING * 12
ST1 = "CUBLOC"
DEBUG RIGHT(ST1,4)  ' "BLOC" is printed.
```

MID(Variable, Location, Decimal Places)

Cut specified decimal places starting from the Location specified and return the value.

```
DIM ST1 AS STRING * 12
ST1 = "CUBLOC"
DEBUG MID(ST1,2,4)  ' "UBLO" is printed.
```



LEN(Variable)

Return the length of the String specified.

```
DIM ST1 AS STRING * 12
ST1 = "CUBLOC"
DEBUG DEC LEN(ST1) '6 is printed since there are 6 characters in ST1.
```

STRING(ASCII code, length)

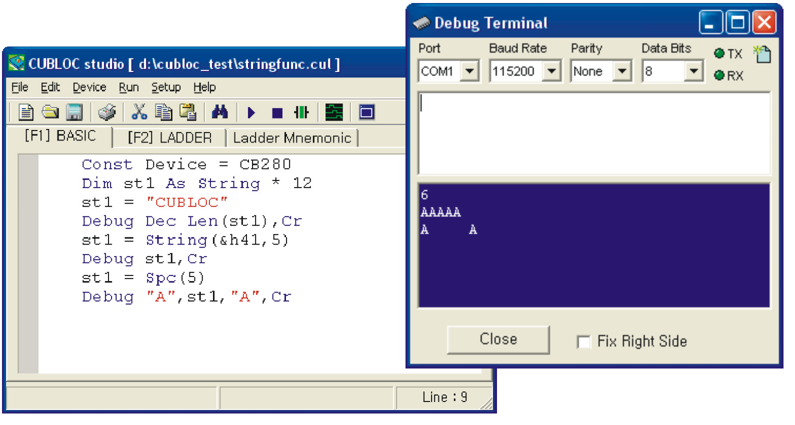
Create a specified length String with specified ASCII code value.

```
DIM ST1 AS STRING * 12
ST1 = STRING(&H41,5)
DEBUG ST1 'AAAAA is printed.  &H41 is ASCII code for character A.
```

SPC(decimal places)

Create specified amount of blank space

```
DIM ST1 AS STRING * 12
ST1 = SPC(5)
DEBUG "A",ST1,"A" 'AbbbbbA is printed.  Here, b is for blank space.
```



LTRIM(String variable)

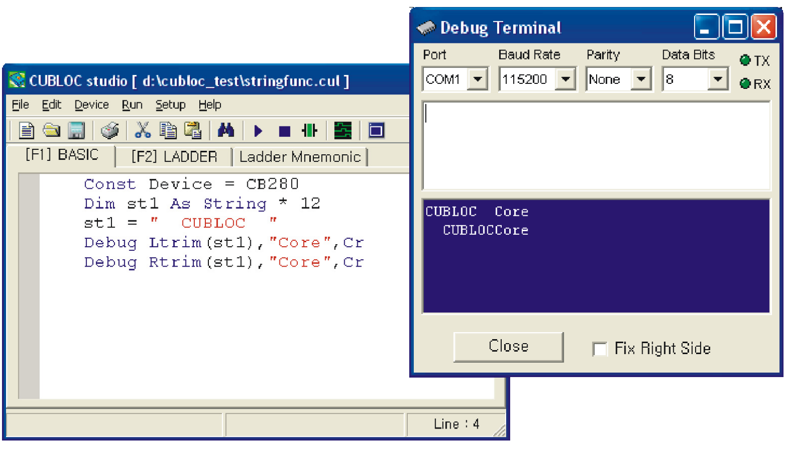
Cut all blank spaces on the left side of the String and return the value.

```
DIM ST1 AS STRING * 12
ST1 = "  COMFILE"
ST1 = LTRIM(ST1)
DEBUG "AAA",ST1  ' AAACOMFILE is printed.
```

RTRIM(String variable)

Cut all blank spaces on the right side of the String and return the value.

```
DIM ST1 AS STRING * 12
ST1 = "COMFILE  "
ST1 = RTRIM(ST1)
DEBUG ST1,"TECH"     ' COMFILETECH is printed.
                     ' Blank spaces on the right are removed.
```



VAL(String variable)

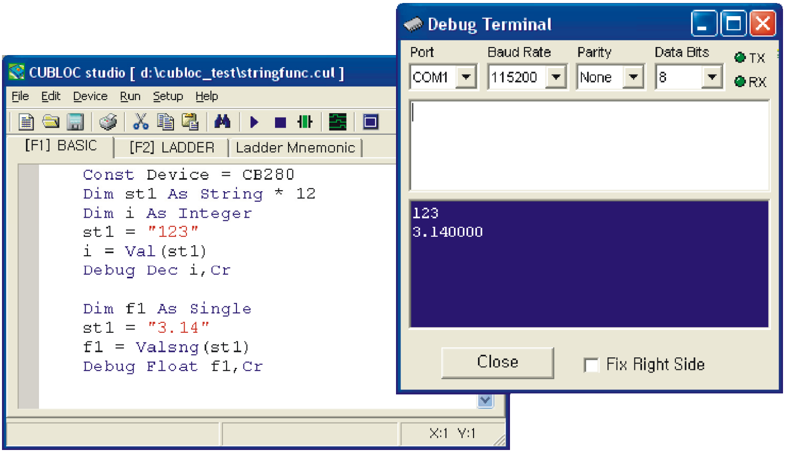
Return a converted numerical value of the String.

```
DIM ST1 AS STRING * 12
DIM I AS INTEGER
ST1 = "123"
I = VAL(ST1)   ` 123 is stored in variable I as a number.
```

VALSNG(String variable)

Return a converted floating point numerical value of the String.

```
DIM ST1 AS STRING * 12
DIM F AS SINGLE
ST1 = "3.14"
F = VALSNG(ST1)       ` 3.14 is stored in variable F as a floating
                      ` point number.
```



VALHEX(String variable)

Return a converted hexadecimal value of the String.

```
DIM ST1 AS STRING * 12
DIM I AS LONG
ST1 = "ABCD123"
I = VALHEX(ST1) `&HABCD123 is stored in variable I
```

CHR(ASCII code)

Return the character of desired ASCII code.

```
DIM ST1 AS STRING * 12
ST1 = CHR(&H41)
DEBUG ST1       ` Print A,. &H41 is ASCII code of character A.
```

ASC(String variable or Constant)

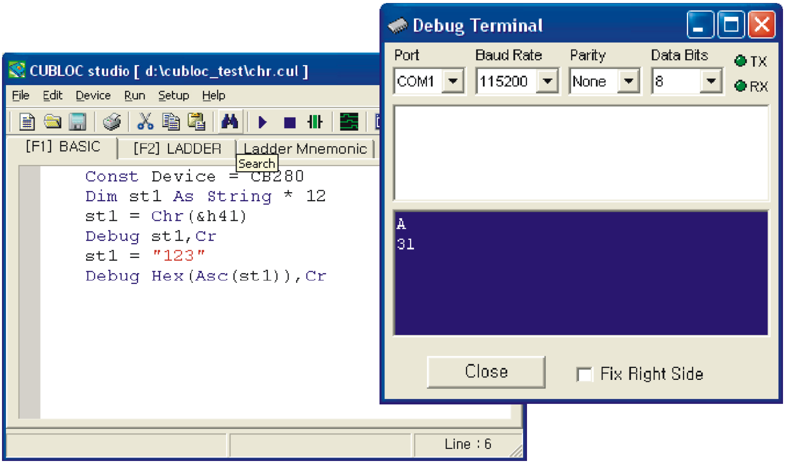
Return the converted ASCII code of the first character of the String.

```
DIM ST1 AS STRING * 12
DIM I AS INTEGER
ST1 = "123"
I = ASC(ST1)    ` &H31 is stored in variable I. ASCII code of 1
                ` is &H31 or 0x31.
```

Caution 1

A variable must be used when using string functions.

```
DEBUG LEFT("INTEGER",4) ` A string by itself cannot be used.
ST1 = "INTEGER"
DEBUG LEFT(ST1,4)     ` A string must be stored as a variable first.
```



Chapter 6 CUBLOC BASIC Statements & Library

Adin( )

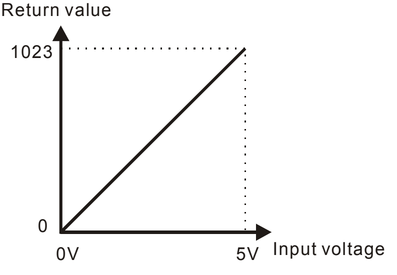
Variable = ADIN (Channel)

Variable : Variable to store results (No String or Single)
Channel : AD Channel Number (not I/O Pin Number)

CUBLOC has 10bit ADCs and 16bit PWMs. The user can use ADC to convert analog to digital signals or use PWM to convert digital to analog signal.

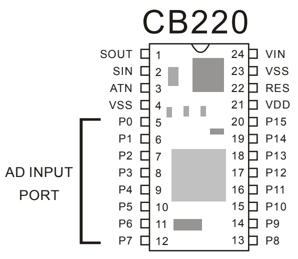
ADIN command reads the analog signal value and store the result in a variable. Depending on the model, the number of AD ports may vary. For the CB280, there are 8 AD ports (P24 to P31). The AD port **must be set to input** before use.

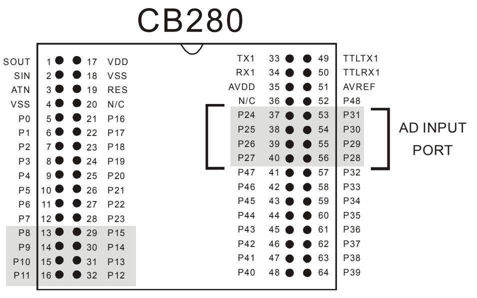
When voltage between 0 and AVREF in inputted, that voltage is converted to a value from 0 to 1023. AVREF can accept voltage between 2 to 5 V. Generally, 5V is used. If the user inputs 3V to AVREF, voltage between 0 and 3V is converted to a value between 0 and 1023.
(*Note: CB220 AVREF is fixed to 5V)




```
Dim A As Integer
Input 24            ` Set port to input.
A=Adin(0)           ` Do a A/D conversion on channel 0 and
                    ` store result in A
```

The following is AD input ports shown for CB220 and CB280.





Please refer to the table below for AD channels.

	CB220	CB280	CB290	CT17X0	CB405
A/D channel 0	I/O 0	I/O 24	I/O 8	I/O 0	I/O 16
A/D channel 1	I/O 1	I/O 25	I/O 9	I/O 1	I/O 17
A/D channel 2	I/O 2	I/O 26	I/O 10	I/O 2	I/O 18
A/D channel 3	I/O 3	I/O 27	I/O 11	I/O 3	I/O 19
A/D channel 4	I/O 4	I/O 28	I/O 12	I/O 4	I/O 20
A/D channel 5	I/O 5	I/O 29	I/O 13	I/O 5	I/O 21
A/D channel 6	I/O 6	I/O 30	I/O 14	I/O 6	I/O 22
A/D channel 7	I/O 7	I/O 31	I/O 15	I/O 7	I/O 23
A/D channel 8					I/O 32
A/D channel 9					I/O 33
A/D channel 10					I/O 34
A/D channel 11					I/O 35
A/D channel 12					I/O 36
A/D channel 13					I/O 37
A/D channel 14					I/O 38
A/D channel 15					I/O 39

ADIN command only converts once upon execution. In comparison TADIN returns the average of 10 conversions, there by giving the user more precise results. If you need more precision, we recommend the use of TADIN instead of ADIN.

Alias

ALIAS Registername = AliasName

Registername : Register name such as P0, M0, T0 (Do not use D area)

AliasName : An Alias for the Register chosen (up to 32 character)

Aliases may be made up for Registers like P0, M0, C0. With Aliases, the user will be able to write more clear and easy-to-read code.

```
Alias M0 = Rstate
Alias M0 = Kstate
Alias P0 = StartSw
```

Bcd2bin

Variable = BCD2BIN(bcdvalue)

Variable : Variable to store results (Returns LONG)

bcdvalue : BCD value to convert to binary

This command does the exact opposite of BIN2BCD command.

```
Dim A As Integer
A=Bcd2bin(&h1234)
Debug Dec A        ` Print 1234
```

Bclr

BCLR   channel, buffertype

channel : RS232 Channel (0 to 3)

buffertype : 0=Receive, 1=Send, 2=Both

Clear the specified RS232 Channel’s buffer.   Buffer type can be chosen.

```
Bclr 1,0    ‘ Clear RS232 Channel 1’s rx buffer
Bclr 1,1    ‘ Clear RS232 Channel 1’s tx buffer
Bclr 1,2    ‘ Clear RS232 Channel 1’s rx & tx buffers
```

Beep

BEEP Port, Length

Port : Port number (0 to 255)

Length : Pulse output period (1 to 65535)

The BEEP command is used to create a beep sound. Piezo or a speaker can be connected to the Port. A short beep will be outputted. This is useful for creating Key touch sound effects or alarm sounds. When this command is used, the specified Port is automatically set to output.

```
BEEP 2, 100  'Output BEEP on P2 for a period of 100
```

Bfree( )

Variable = BFREE(channel, buffertype)

Variable : Variable to store results (No String or Single)
channel : RS232 Channel number (0 to 3)
buffertype: 0=Receive Buffer, 1=Send Buffer

This function will return the number of free bytes that either receive buffer or send buffer has currently. For sending data, this command can be used to avoid overflowing the buffer.

```
DIM A AS BYTE
OPENCOM 1,19200,0, 100, 50
IF BFREE(1,1)>10 THEN
     PUT "TECHNOLOGY"
END IF
```

If buffer size is set to 50, up to 49 free bytes can be returned. The function will return 1 less than the set buffer size when buffer is empty.

Bin2bcd

Variable = BIN2BCD(binvalue)

Variable : Variable to store results (Returns Long)

binvalue : Binary value to be converted

This command BIN2BCD converts binary value to BCD code. BCD code is a way of expressing binary values as decimals.

For example. 3451 in binary is as shown below:

3 4 5 1

0000	1101	0111	1011
0	D	7	B

The below is 3451 converted to BCD code. As you can see, each 4 bits represent one of the digits.

3 4 5 1

0011	0100	0101	0001
3	4	5	1

This command is useful when the user needs to convert a variable to be representable in a device such as the 7 segment display.

```
i = 123456
j = bin2bcd(i)
Debug Hex j  ' Print 123456
```

Blen( )

Variable = BLEN(channel, buffertype)

Variable : Variable to store results (No String or Single)
channel : RS232 Channel number (0 to 3)
buffertype: 0=Receive Buffer, 1=Send Buffer

This function Blen() returns current number of bytes of data in the specified RS232 Channel's buffer. If the buffer is empty, 0 will be returned. When receiving data, this function can be used to check how much data has been received before using GET or GETSTR to read the data received.

If the receive buffer is full, it will not be able to receive any more data. To avoid these situations, receive interrupts should be used or plenty of receive buffer size should be used.

```
Dim A As Byte
Opencom 1,19200,0,100,50
On Recv1 DATARECV_RTN       ' When data is received through
                            ' RS232, jump to DATARECV_RTN
Do
Loop                        ' infinite loop

DATARECV_RTN:
     If Blen(1,0) > 0 Then        ' If there is at least 1 byte...
           A = Get(1)             ' Read 1 Byte
     End If
Return                            ' End Interrupt routine
```

Bytein( )

Variable = BYTEIN(PortBlock)

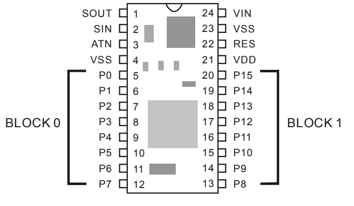
Variable : Variable to store results (No String or Single)

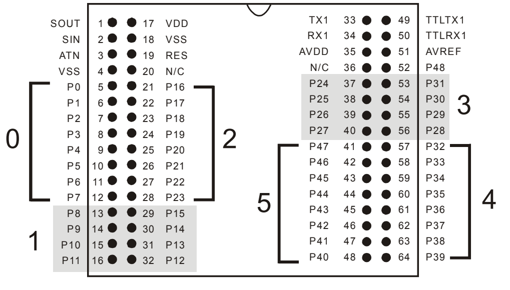
PortBlock : I/O Port Block Number (0 to 15)

Read the current status of the I/O Port Block. 8 I/O ports are collectively called as a Port Block. Port 0 to 7 is Block 0 and Port 8 to 15 is Block 1. Depending on the model of CUBLOC, the Port Block number can vary. When using this command, all I/O Ports within the Port Block are set to input and the received input value is stored in a variable..

```
DIM A AS BYTE
A = BYTEIN(0)          'Read from Port Block 0 and store in variable A.
```

The following is how Port Blocks are set according to the CUBLOC model.





Byteout

BYTEOUT   PortBlock, value

PortBlock : I/O Port Block Number. (0 to 15)
value : Value to be outputted between 0 and 255.

Output the value to a Port Block. 8 I/O Ports are collectively called as a Port Block.
Port 0 to 7 is Block 0 and Port 8 to 15 is Block 1. Depending on the model of CUBLOC, the Port Block number can vary. When using this command, all I/O Ports within the Port Block are set to output and the value is outputted.

```
Byteout 1,255      ' Output 255 to Port Block 1.
                   ' Ports 8 through 15 are set to HIGH.
```

* I/O Port 1 only supports input. Therefore, BYTEOUT 0 will not set Port 1 to Output.

CheckBf( )

Variable = CheckBf(channel)

Variable : Variable to store results (No String or Single)

channel : RS232 Channel (0 to 3)

Without affecting the RS232 receive buffer, the command CheckBf() can be used to check the current data in the receive buffer. Although it will read what is in the buffer, it will not erase the data after reading unlike the GET command. Only 1 byte can be read at a time.

```
A = Checkbf(1)            'Check current data in the receive buffer
```

Compare

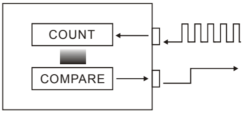
COMPARE channel, target#, port, targetstate

Channel : High Counter channel

Target# : Target # of Pulses (CH0: 0 to 65535, CH1: 0 to 255)

Port : Output Port (DO NOT USE Input-only Ports)

Targetstate : Target Output Port State



When high counter value reaches a set target point, the processor will set an I/O Port to Low or High.

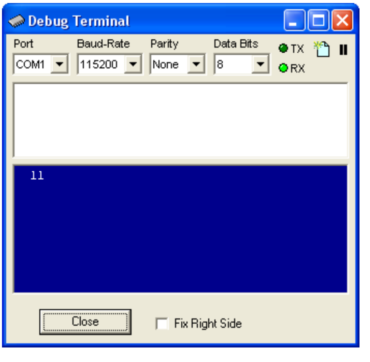
If Targetstate is set to 1 and when the Target number of pulses have been received, the Port will output logic HIGH. Likewise, if the Targetstate is set to 0 and when the Target number of pulses have been received, the Port will output logic LOW.

Channel	Compare Range
HCOUNT Channel 0	0 to 255
HCOUNT Channel 1	0 to 65535

The high counter itself supports upto 32-bits, but the COMPARE command is limited since this command was designed to not affect the overall multi-tasking of the CUBLOC main processor.

*Note: For channel 0, please use the Set Count0 On command before using the Compare command.

```
Dim i As Integer
Set Count0 On
Compare 0,10,61,1
Do
        i = Count(0)
        Debug Goxy,0,0,dec4 i,Cr
        Delay 100
Loop
```



The above uses High Counter Channel 0 with target # of 10. When the Counter 0 value becomes 11, Port 61 will ouput logic HIGH.

This command is supported for CUBLOC STUDIO 2.0.X and above.

Count( )

Variable = COUNT(channel)

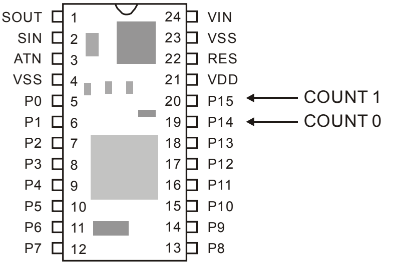
Variable : Variable to store results. (No String or Single)

Channel : Counter Channel number (0 to 1)

Return the counted value from the specified Count Channel. Please set the Counter Input Ports to input before use of this command.
Up to 32bits can be counted. (Byte, Integer, Long) Maximum frequency is 500kHz.

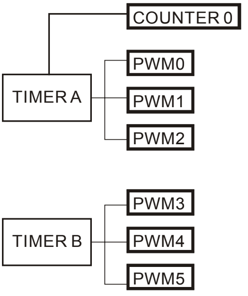
CUBLOC's counter is hardware driven, meaning it runs independently from the main program. It is able to count in real-time. No matter how busy the CUBLOC processor gets, counter will count reliably.

CUBLOC has 2 Counter inputs. Counter Channel 0 uses same resources as PWM0, 1, 2 and cannot be used together. But you are free to use Counter Channel 1 as freely as you'd like. To use Counter Channel 0, SET COUNT0 command must be used beforehand. Channel 1 requires no additional settings.




```
Dim R As Integer
Input 15           ' Set port 15 as input. (Counter Channel 1)
R = Count(1)       ' Read current Counter value.

Set Count0 On      ' Activate Counter Channel 0
                   ' (PWM0,1,2 becomes deactivated.)
Input 14           ' Set port 14 as input (Counter Channel 0)
R = Count(0)       ' Read current Counter value.
```

Since counter 0 uses the same resources as Pwm as shown below, please be careful. Not to use PWM at the same time.




```
`
`     Measure frequency from pulse output PWM 0 channel
`
Const Device = CB280
Dim A as Integer
Input 15
Low 5
Freqout 0,2000
Low 0
On Timer(100) Gosub GetFreq
Do
Loop

GetFreq:
A = Count(1)
Debug goxy,10,2
Debug dec5 A
Countreset 1
Reverse 0
Return
```

Countreset

COUNTRESET channel

Channel : Counter Channel (0 to 1)

Reset the specified Counter Channel to 0.

```
Countreset 0       'Clear Channel 0
Countreset 1       'Clear channel 1
```

Dcd

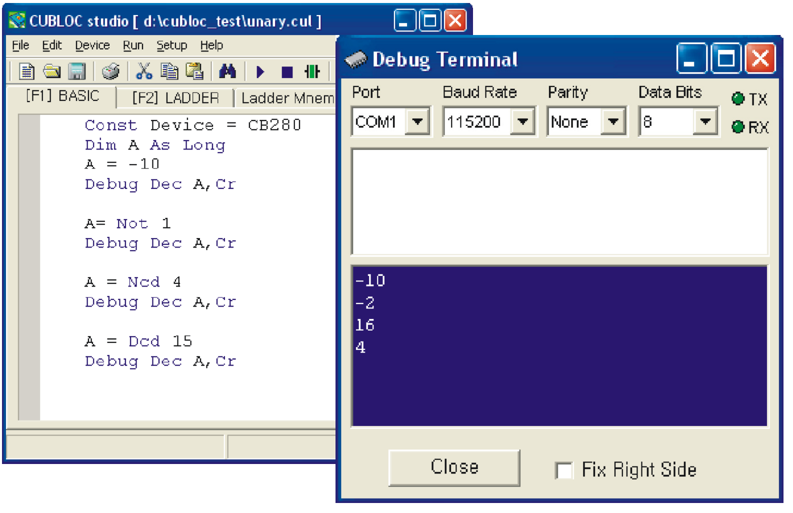
Variable = DCD source

Variable : Variable to store results. (No String or Single)

Source : source value

This command DCD is opposite of NCD command.
It will return the bit position(starting at LSB bit 0) of the highest bit that is a 1.

```
I = DCD 15 ` Result is 3 since 15 = 0b00001111
```



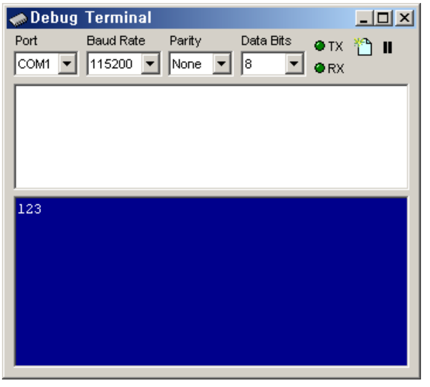
Debug

DEBUG data

data : data to send to PC

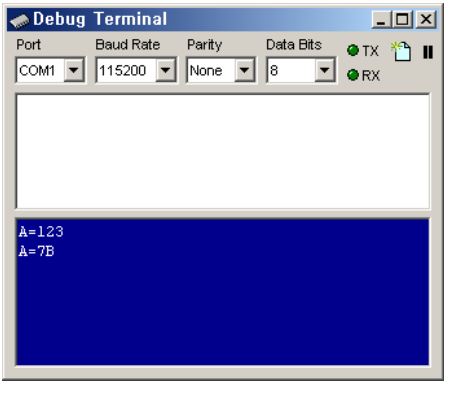
CUBLOC supports DEBUG command by allowing the user to insert DEBUG commands as he wishes during the execution of a program.
The results of DEBUG commands inserted in the source code is displayed on the DEBUG Terminal.

```
DIM A AS INTEGER
A = 123
DEBUG  DEC  A
```



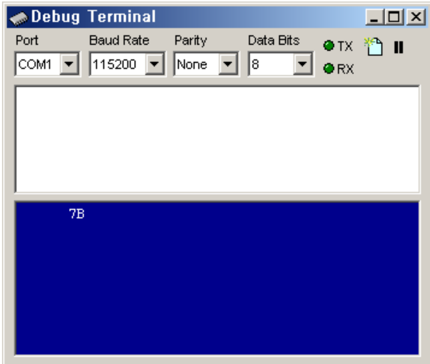
Use DEC or HEX to display numbers. Without DEC or HEX, the numbers will be printed as ASCII codes. Please use DEC or HEX for variables to see the actual values.
If you insert question mark (?) before DEC or HEX, the variable's name will be printed together.

```
DEBUG  DEC?  A,CR
DEBUG  HEX?  A,CR
```



You can also use numbers to limit the number of decimal places to print.

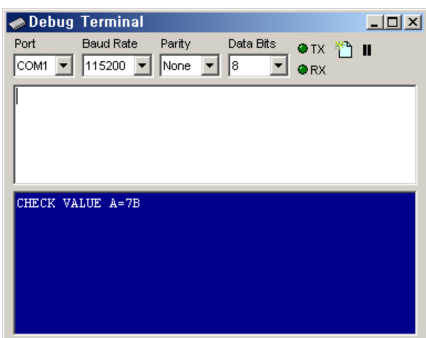
```
DEBUG HEX8 A
```



1 through 8 can be used with HEX. HEX8 will print as 8 digit hexadecimal number. 1 through 10 can be used with DEC.

You are free to mix strings, numbers, and etc…

```
DEBUG "CHECK VALUE " HEX? A, CR
```



DEBUG command is useful for printing out strings and numbers in a user friendly format. During execution of CUBLOC BASIC program, when DEBUG command is encountered, the resulting values are displayed on the DEBUG Terminal.

If you insert a DEBUG command to a certain part of the program and the DEBUG Terminal displays the values during execution, it proves that the program has executed to that point. By using these DEBUG commands, you will be able to find bugs in your program and monitor variables change in real-time.

If you enter character in the white part of the Debug Terminal, it will be sent to the DOWNLOAD port of CUBLOC. We have added this feature for future/advanced development.

Warning

DEBUG command may not be used while monitoring in Ladder Logic. Likewise, Ladder Logic monitoring can not be used while debugging using DEBUG commands.

The following is a chart of commands that can be used with the DEBUG command. You can control the DEBUG screen just like a real LCD.

Command	Code	Explanation	Example Usage
CLR	0	Clear Debug screen	Debug CLR
HOME	1	Move cursor to the upper left corner of the Debug screen	Debug HOME
GOXY	2	Move cursor to X, Y	Debug GOXY, 4, 3
CSLE	3	Move cursor one to the left.	
CSRI	4	Move cursor one to the right	
CSUP	5	Move cursor one up	
CSDN	6	Move cursor one down	
BELL	7	Make beeping sound	
BKSP	8	BACK SPACE	
LF	10	LINE FEED	Debug “ABC”,LF
CLRRI	11	Erase all characters on the right of cursor to the end of line.	
CLRDN	12	Erase all characters on the bottom of cursor	
CR	13, 10	Carriage Return (go to next line)	Debug, “ABC”,CR

You must use above commands in line with the DEBUG command.

```
Debug Goxy,5,5,Dec I
Debug Clr,”TEST PROGRAM”
```

Decr

DECR variable

Variable : Variable for decrementing. (No String or Single)

Decrement the variable by 1. (similar to “A - -“ in C language)

```
Decr A      ' Decrement A by 1.
```

Delay

DELAY time

Time : interval variable or constant (up to Long type)

Delay for the specified time in milliseconds. Delay should be only used for slight delays in getting something to work. We recommend not using it for time measurements and time-specific applications.

```
Delay 10            ` Delay about 10 ms.
Delay 200           ` Delay about 200 ms.
```

Delay is pre-made system's sub program.

```
sub delay(dl as long)
  dl1 var long
  dl2 var integer
  for dl1=0 to dl
  for dl2=0 to 1
      nop
      nop
      nop
  next
  next
end sub
```

Do...Loop

DO...LOOP will loop the commands within itself unless DO WHILE or DO UNTIL is used to set a condition in which DO…LOOP can be terminated. EXIT DO command can also be used within the DO...LOOP to exit from the loop.

```
Do
      Commands
Loop
```

```
Dim K As Integer
Do
      K=Adin(0)              'Read AD input from channel 0
      Debug Dec K,Cr
      Delay 1000
Loop
```

In the above example, the program will loop infinitely within DO and LOOP. EXIT DO or GOTO command must be used to get out of the infinite loop.

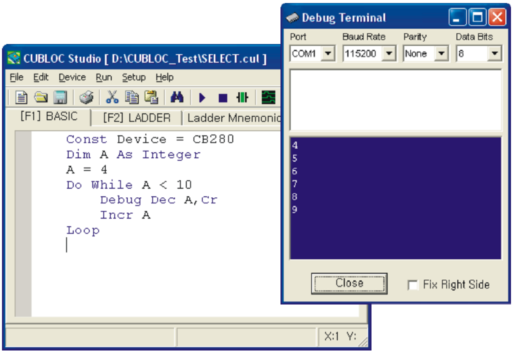
```
Do While [Condition]
      Commands
      [Exit Do]
Loop

Do
      Commands
      [Exit Do]
Loop While [Condition]
```

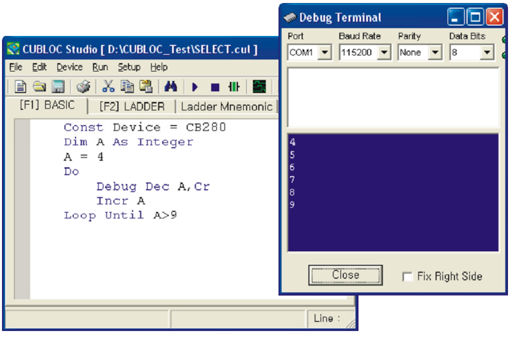
DO..WHILE will infinitely loop until condition in WHILE is met.

```
Do Until [Condition]
      Commands
      [Exit Do]
Loop

Do
      Commands
      [Exit Do]
Loop Until [Condition]
```

DO..UNTIL will infinitely loop until condition in UNTIL is met.

DEMO PROGRAM





Dtzero

DTZERO variable

Variable : Variable for decrement. (No String or Single)

Decrement the variable by 1. When variable reaches 0, the variable is no longer decremented.

```
DTZERO A    ` Decrement A by 1.
```

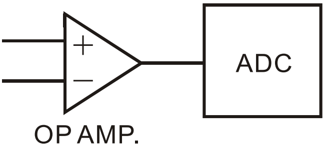
EAdin( )

Variable = EADIN (mux)

Variable : Variable to store results (No String or Single)

mux : AD input Port Combination MUX (0 to 21)

This command is used for a more precise AD conversion. CUBLOC has an internal OPAMP. When using ADIN command, the OPAMP is not used. By using this command EAdin, the user can utilize the OPAMP for more precise results.



Please set the MUX value accordingly by following the chart below:

MUX	OPAMP +	OPAMP -	Multiplier	Resolution
0	ADC0	ADC0	10	8 Bits
1	ADC1	ADC0	10	8 Bits
2	ADC0	ADC0	200	7 Bits
3	ADC1	ADC0	200	7 Bits
4	ADC2	ADC2	10	8 Bits
5	ADC3	ADC2	10	8 Bits
6	ADC2	ADC2	200	7 Bits
7	ADC3	ADC2	200	7 Bits
8	ADC0	ADC1	1	8 Bits
9	ADC1	ADC1	1	8 Bits
10	ADC2	ADC1	1	8 Bits
11	ADC3	ADC1	1	8 Bits
12	ADC4	ADC1	1	8 Bits
13	ADC5	ADC1	1	8 Bits
14	ADC6	ADC1	1	8 Bits
15	ADC7	ADC1	1	8 Bits
16	ADC0	ADC2	1	8 Bits
17	ADC1	ADC2	1	8 Bits
18	ADC2	ADC2	1	8 Bits
19	ADC3	ADC2	1	8 Bits
20	ADC4	ADC2	1	8 Bits
21	ADC5	ADC2	1	8 Bits

The EADIN port must be set to input beforehand. By using the OPAMP, more precise results or a noise-filtering effect can be obtained.

```
Dim J As Long
Input 24    'Set the port to input (Use port 24,25 for CB280)
Input 25
Do
     j = Eadin(8)  ' AD Conversion from AD0 and Ad1, use OPAMP, 1
     Locate 0,0
     Print hex5 J,cr       ' Print results to LCD
     Delay2 500            ' Little Delay
Loop
End

Sub Delay2(DL As Integer)
     Dim I As Integer
     For I = 0 To DL
     Next
End Sub
```

The EADIN command does not support full 10-bit resolution that the regular EADIN supports. When using 1X and 10X multipliers, 8-bit resolution is used. When using 8X and 200X multipliers, 7-bit resolution is used.

WARNING: The OPAMP has characteristics that it will read between 0.5V and 4.5V. With the CB405, EADIN command can only be used with Channel 0 through 7.

Please refer to the following table for AD Channel and its corresponding Port Number according to your CUBLOC module or CUTOUCH:

Channel	CB220	CB280	CB290	CT17X0	CB405
ADC0	I/O 0	I/O 24	I/O 8	I/O 0	I/O 16
ADC1	I/O 1	I/O 25	I/O 9	I/O 1	I/O 17
ADC2	I/O 2	I/O 26	I/O 10	I/O 2	I/O 18
ADC3	I/O 3	I/O 27	I/O 11	I/O 3	I/O 19
ADC4	I/O 4	I/O 28	I/O 12	I/O 4	I/O 20
ADC5	I/O 5	I/O 29	I/O 13	I/O 5	I/O 21
ADC6	I/O 6	I/O 30	I/O 14	I/O 6	I/O 22
ADC7	I/O 7	I/O 31	I/O 15	I/O 7	I/O 23

Eeread( )

Variable = EEREAD (Address, ByteLength)

Variable : Variable to store result (No String or Single)

Address : 0 to 4095

ByteLength : Number of Bytes to read (1 to 4)

Read data from the specified address in EEPROM.

```
DIM A AS INTEGER
DIM B AS INTEGER
A = 100
EEWRITE 0,A,2        ' Store A in Address 0.
B = EEREAD(0,2)      ' Read from Address 0 and store in B.
```

Eewrite

EEWRITE Address, Data, ByteLength

Address : 0 to 4095
Data : Data to write to EEPROM (up to Long type values)
ByteLength : Number of Bytes to write (1 to 4)

Store data in the specified Address in EEPROM.

```
Dim A As Integer
Dim B As Integer
A = 100
Eewrite 0,A,2      ' Store A in Address 0.
B = Eeread(0,2)    ' Read from Address 0 and store in B.
```

When writing to the EEPROM, it takes about 3 to 5 milliseconds.
When reading from the EEPROM, it takes less than 0 milliseconds.
There is a physical limit of around 100,000 writes to the EEPROM.

If you are using EEPROM for data acquisition or data that requires a lot of writes, we rather recommend use of the data memory with backup battery included modules such as the CB290.

The following is a table showing comparisons betweens SRAM and EEPROM.

Type	Battery Backup SRAM	EEPROM
Life of Data	3 Months to 1 Year (Depending on Battery Capacity)	40 Years
Maximum Writes	Infinite	About 100,000
Writing Time	0 ms	3 to 5 ms
General use	Backup Necessary Equipment in the case of power outage. Example) Production Line Counter	Small amount of data to record. Long data life requirement. Example) Product Serial Number

Ekeypad

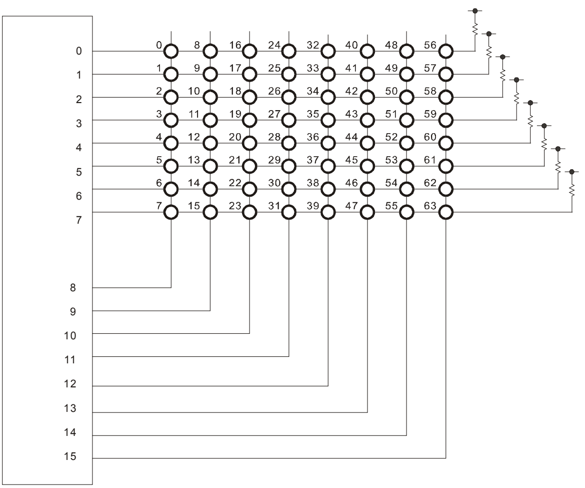
Variable = EKEYPAD(portblockIn, portblockOut)

Variable : Variable to store results (Returns Byte)
PortblockIn : Port Block to receive input (0 to 15)
PortblockOut : Port Block to output (0 to 15)

This command EKEYPAD extends KEYPAD to read up to 64 key inputs. Two Port Blocks can be used to read up to 64 key inputs. Input Port Block and output Port Block must be selected separately.

For ports not used within the input Port Block, a resistor must be connected to 5V. This Port may not be used for other purpose when using this command.

For ports not used within the output Port Block, they can be left in OPEN state. This Port also may not be used for other purposes. The following is an example of using Port Block 0 as input and Port Block 1 as output.



If no keys are pressed, 255 will be returned. Otherwise, the pressed key's scan code will be returned.

For...Next

FOR…NEXT will loop the commands within itself for a set amount of times.

```
For Variable = Starting Value To Ending Value [Incremental Step]
       Commands
       [Exit For]
Next
```

In the below example, Incremental Step is not set. FOR…NEXT loop will increment 1 every loop as default.

```
Dim K As Long
For K=0 To 10
       Debug Dp(K),CR
Next

For K=10 To 0 Step -1      ' Negative Step, step from 10 to 0.
       Debug Dp(K),CR
Next
```

EXIT FOR command can be used within the FOR…NEXT loop to exit any desired moment.

```
For K=0 To 10
       Debug Dp(K),CR
       If K=8 Then Exit For ' If K equals 8 exit the FOR…NEXT loop.
Next
```

When choosing a variable to use for FOR…NEXT loop, please make sure the chosen variable is able to cover desired range. Byte variables can cover from 0 to 255. For larger values, a variable with larger range must be chosen.

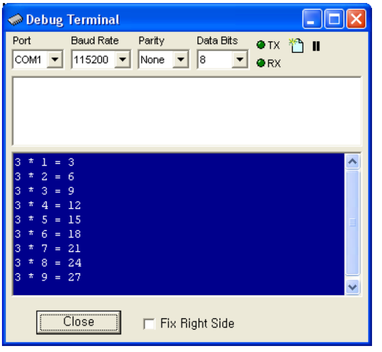
```
Dim K As Byte
For K=0 To 255
       Debug Dp(K),CR
Next
```

When using negative STEP, please choose LONG as it can handle negative numbers.

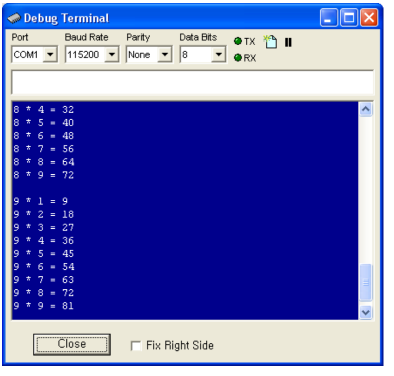
```
Dim LK As Long
For LK=255 To 0 Step -1     'This will reach -1 as last step
       Debug Dp(LK),CR
Next
```

DEMO PROGRAM

```
Const Device = CB280
Dim A As Integer
For A=1 To 9
        Debug "3 * "
        Debug Dec A
        Debug " = "
        Debug Dec 3*A,Cr
Next
```




```
Const Device = CB280
Dim A As Integer, B As Integer
For A=2 To 9
        For B=1 To 9
          Debug Dec A," * "
          Debug Dec B
          Debug " = "
          Debug Dec A*B,Cr
        Next
        Debug Cr
Next
```



Freepin

FREEPIN   I/O

I/O : I/O PORT Number

Free I/O Port set to LADDER using Usepin back to BASIC
(Use with CUBLOC STUDIO V2.0.X and above)

Freqout

FREQOUT   Channel, FreqValue

Channel : PWM Channel (0 to 15)

FreqValue : Frequency value between 1 and 65535

Output desired frequency to the desired PWM channel. Please make sure to specify the PWM channel, not I/O port number. For CB220 and CB280, ports 5,6, and 7 are PWM Channel 0,1, and 2, respectively.

The following is a basic chart showing the different FreqValues and corresponding frequencies. 1 is for the highest possible frequency and 65535 is for the lowest possible frequency. 0 does not produce any output.

FreqValue	Frequency
1	1152 KHz
2	768 kHz
3	576 KHz
4	460.8KHz
5	384 KHz
10	209.3 KHz
20	109.7 KHz
30	74.4 KHz
100	22.83 KHz

FreqValue	Frequency
200	11.52 KHz
1000	2.3 KHz
2000	1.15 KHz
3000	768 Hz
4000	576 Hz
10000	230 Hz
20000	115.2 Hz
30000	76.8 Hz
65535	35.16 Hz

You can also calculate the FreqValue to use by using the following formula:

FreqValue = 2304000 / Desired Frequency

Before using this command, please set the specified PWM Port to output mode. To stop PWM, you can use the command PWMOFF.
The following is an example:

```
Const Device = cb280
Dim i As Integer
Low 5              ` Set Port 5 to low and output.
i = 1
Freqout 0,10       ` Produce a 209.3Khz wave
Do                 ` Infinite loop
Loop
```

Since Freqout uses the same resources as PWM, there are a couple of restrictions you must be aware of. PWM Channel 0,1, and 2 use the same timer. If PWM Channel 0 is used for Freqout command, channel 0,1, and 2 all cannot be used for PWM command.

Likewise, PWM Channel 3, 4, and 5 act the same. If you use Freqout on PWM Channel 3, PWM Channels 3, 4, and 5 cannot be used for PWM command.

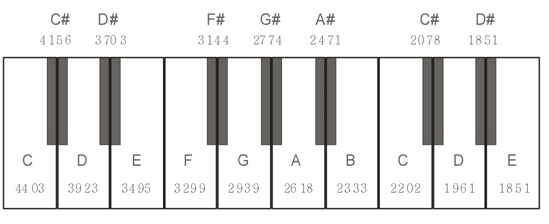
You can product different frequencies on PWM Channel 0 and 3.

To sum up, the user may produce two different frequencies at one time and when using the Freqout command, the PWM command cannot be used.

The following is a chart that shows corresponding FreqValue to the music notes.

Note	Octave 2	Octave 3	Octave 4	Octave 5
A	20945	10473	5236	2618
Bb	19770	9885	4942	2471
B	18660	9330	4665	2333
C	17613	8806	4403	2202
Db	16624	8312	4156	2078
D	15691	7846	3923	1961
Eb	14811	7405	3703	1851
E	13979	6990	3495	1747
F	13195	6597	3299	1649
Gb	12454	6227	3114	1557
G	11755	5878	2939	1469
Ab	11095	5548	2774	1387

```
Freqout 0,5236          ' Note A in Octave 4(440Hz)
Freqout 0,1469          ' Note G in Octave 5
```



Get( )

Variable = GET(channel, length)

Variable : Variable to store results (Cannot use String, Single)
channel : RS232 Channel (0 to 3)
length : Length of data to receive (1 to 4)

Read data from RS232 port. This command Get() actually reads from the receive buffer. If there is no data in the receive buffer, it will quit without waiting for data.
The command BLEN() can be used to check if there is any data in the receive buffer before reading trying to read data.
The length of data to be read must be between 1 and 4. For receiving a Byte type data, it would be one. For receiving a Long type data, it would be 4. For larger data, please use GETSTR().

TIPS

Use SYS(1) after GET() or GETSTR() to verify how much data was actually read. If 5 bytes were received and only 4 bytes got verified, 1 byte was lost.

```
Const Device = cb280
Dim A as Byte
Opencom 1,115200,3,50,10
On Recv1 Gosub GOTDATA
Do
      Do while In(0) = 0
      Loop                 ‘ Wait until press button (Connect P0)
      Put 1,asc(“H”),1
      Put 1,asc(“E”),1
      Put 1,asc(“L”),1
      Put 1,asc(“L”),1
      Put 1,asc(“O”),1
      Put 1,13,1           ‘ HELLO + Chr (13) + Chr (10)
      Put 1,10,1
      Do while In(0) = 1
      Loop
Loop

GOTDATA:
      A=Get(1,1)
      Debug A
      Return
```

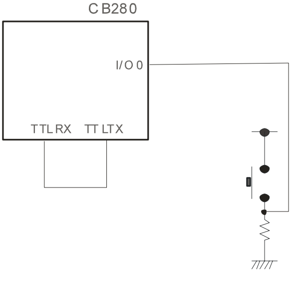
Geta

GETA channel, ArrayName, bytelength

channel : RS232 Channel (0 to 3)
ArrayName : Array to store Received data (Byte type only)
Bytelength : Number of Bytes to store (1 to 65535)

The command Geta can be used to store received RS232 data into a Byte array. Data will be stored starting from the first element of the array. Again, please check the receive buffer with BLEN() before reading to avoid reading garbage data.

```
Const Device = cb280
Dim A(10) As Byte
Opencom 1,115200,3,50,10
Set Until 1,8
On Recv1 Gosub GOTDATA
Do
     Do While In(0) = 0
     Loop                  ' Wait until press button (Connect P0)
     Putstr 1,"CUBLOC",Cr
     Do While In(0) = 1
     Loop
Loop

GOTDATA:
     Geta 1,A,8
     Debug A(0),A(1),A(2),A(3),A(4),A(5),A(6),A(7)
     Return
```



Geta2

GETA channel, ArrayName, bytelength, stopchar

channel : RS232 Channel (0 to 3)
ArrayName : Array to store Received data (Byte type only)
Bytelength : Number of Bytes to store (1 to 65535)
Stopchar : Stop character ascii code

Same as GETA command except it will stop reading data at the StopChar even if there are data left to read set by the Length. If StopChar is not found, then it will operate just like a GETA command.
(StopChar is stored into the String Variable)
You can use SYS(1) command to read # of bytes read afterwards.

```
Dim A(10) As Byte
Opencom 1,19200,0,50,10
Geta2 1,A,20,10 ‘ Read until Stop Character ascii code 10 is found
                ‘ or 20 bytes have been read
```

Use with CUBLOC STUDIO 2.0.X and above.

Getcrc

GETCRC   Variable, ArrayName, Bytelength

variable : String Variable to store results (Integer type)
ArrayName : Array with data(Must be a Byte array)
Bytelength : # of bytes to calculate CRC

This function is for calculating CRC when using MODBUS RTU Master Mode. GETCRC will return a 16-bit integer CRC value of the set Array.   You can set the number of bytes to use for CRC calculation from the Array starting at 0.

```
Const Device = CB280
 Opencom 1,115200,3,80,20
 Set Modbus 1,9
 Dim A(20) As Byte
 Dim B As Integer
 Ramclear
 Usepin 0,Out
 Usepin 9,Out

 Set Ladder On

 A(0) = 9
 A(1) = 2
 A(2) = 3
 A(3) = 0
 A(4) = 10
 A(5) = 23

 Getcrc B,A,6        'Name of Array.
 Debug Hex B,Cr
```

* Please use byte arrays when using this function.

Getstr( )

Variable = GETSTR(channel, length)

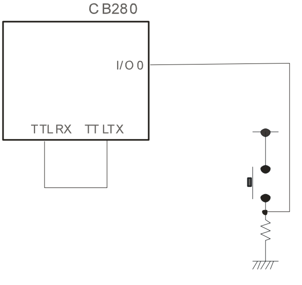
Variable : String Variable to store results

channel : RS232 Channel

length : Length of data to receive

Same as Get() except the variable to store results can only be String and length of data is not limited.

```
Const Device = cb280
Dim A As String * 10
Opencom 1,115200,3,50,10
Set Until 1,8
On Recv1 Gosub GOTDATA
Do
      Do While In(0) = 0
      Loop                    ' Wait until press button (Connect P0)
      Putstr 1,"CUBLOC",Cr
      Do While In(0) = 1
      Loop
Loop

GOTDATA:
      A=Getstr(1,8)
      Debug A
      Return
```



Getstr2( )

Variable = GETSTR(channel, length, stopchar)

Variable : String Variable to store results
channel : RS232 Channel
length : Length of data to receive
StopChrar : Stop character ascii code

Same as GETSTR command except it will stop reading data at the StopChar even if there are data left to read set by the Length. If StopChar is not found, then it will operate just like a GETSTR command.
(Use with CUBLOC STUDIO 2.0.X and above.)

Gosub..Return

GOSUB command can call a sub-routine. RETURN command must be used at the end of the sub-routine.

```
      GOSUB ADD_VALUE

ADD_VALUE:
      A=A+1
      RETURN
```

Goto

GOTO command will instruct the current Program to jump to specified label. This is part of every BASIC language but we do not recommend the use of GOTO as it can interfere with structural programming.

```
      If I = 2 Then
             Goto LAB1
      End If
LAB1:
      I = 3
```

About Label...

A Label can be set with character ':' to set a point for GOTO or GOSUB to jump to.

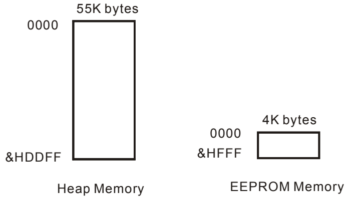
```
ADD_VALUE:
LINKPOINT:
```

A label cannot use reserved constants, numbers, or included a blank space. Below are some **not-to-do** examples:

```
Ladder:        'Reserved constant
123:           'Number.
Aboot 10:      'Blank space.
```

HEAP Memory Access

The HEAP memory access is a special feature only available on the CB405 module. The new CUBLOC CB405 has a HEAP memory. The user may use this memory from address 0 through 56831 in byte units or 0 through &HDDFF in hex. There's about 55KB of memory. You can store large data for graphics, temperature tables, etc…etc… With a backup battery, the HEAP memory can be used similar to an EEPROM memory.



There are 5 types of HEAP memory access functions.

Function	Syntax	Feature
HEAPCLEAR	Heapclear	Erase the entire Heap memory.
HREAD	Variable = HREAD(Address, Length)	Read the designated number of bytes set by Length from the Heap memory address and store into a variable.
HWRITE	HWRITE Address, Variable, Length	Store the designated number of bytes set by Length to the Heap memory Address.
HEAPW	HEAPW Address, Variable	Store one byte to the Heap memory Address.
HEAP	Variable = HEAP(Address)	Read one byte from the Heap memory Address and store into a variable.

Hread( )

Variable = HREAD (Address, ByteLength)

Variable : Variable to store results
Address : HEAP memory address
ByteLength : # of bytes to read, constant or variable (1to4)

Read data from the HEAP memory address. You can read up to a maximum of 4 bytes at a time.

Hwrite

HWRITE Address, Data, ByteLength

Address : HEAP memory address
Data : Constant or Variable with data (whole numbers only)
ByteLength : # of bytes to write

Write data in HEAP memory address.

```
DIM A AS INTEGER
DIM B AS INTEGER
A = 100
HWRITE 0,A,2      ' Write integer A to address 0.
B = HREAD(0,2)          ' Read from address 0 and store in B.
```

NOTE

EEREAD and EEWRITE have same syntax as HREAD and HWRITE.

Function	Memory Type	Feature
EEWRITE, EEREAD	EEPROM	Retains data during power-cycles without a battery. EEWRITE command takes about 5mS. 4KB of available memory
HREAD, HWRITE	SRAM	Retains data during power-cycles with a backup battery. Without a backup battery, data is lost. HWRITE command takes about 20 micro-seconds to execute. Faster speed in comparison with EEWRITE. 55KB of available memory

Heapclear

HEAPCLEAR

Clear all 55KB of HEAP memory to 0.

Heap( )

Variable = HEAP (Address)

Variable : Variable to store results

Address : HEAP memory address

Heap() function returns 1 byte of data from the HEAP memory address.

Heapw

HEAPW Address, Data

Address : HEAP memory address

Data : Constant or Variable with data (Byte only)

Write 1 byte of data to Heap memory address.

HEAP Memory Address

The HEAP memory is divided into byte unit addresses. When a LONG variable is stored, 4 bytes is stored, and 4 memory addresses are used.

```
HWRITE 0, &H1234ABCD, 4
```

0	CD
1	AB
2	34
3	12

As you can see in the above table, when a LONG variable is stored in HEAP memory address 0, four memory addresses are taken.

```
HWRITE 0, &HABCD, 2
HWRITE 1, &H6532, 2
```

The above example will overwrite HEAP memory address 1. Please be careful to not overwrite your data.

DEMO PROGRAM

```
Const Device = CB405
Dim A As Byte
Dim I As Long,J As Long

I = &HABCD1234
Heapclear
Hwrite 0,I,4
Do
Heapw 56830,100
Heapw 56831,123

Debug Dec Heap(56830),Cr
Debug Dec Heap(56831),Cr
J = Hread(0,4)
Debug Hex J,Cr
Delay 100
Loop
```

High

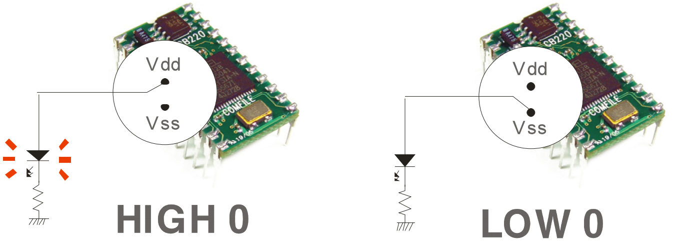
HIGH Port

Port : I/O Port number

Set the Port to HIGH state. This command sets the Port to output state and outputs HIGH or 5V.

```
OUTPUT 8      'Set Port 8 to output state.
HIGH 8        'Set Port 8 to HIGH (5V).
```

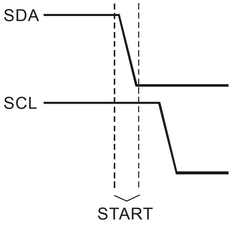
When a port is set to High, the port is internally connected to VDD, whereas if it's set to Low, the port is internally connected to VSS.



I2Cstart

I2CSTART

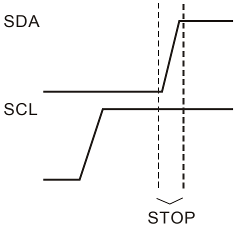
Set I2C SDA and SCL to Start mode.   After this command, SDA and SCL go LOW.



I2Cstop

I2CSTOP

Set I2C SDA and SCL to Stop mode.   After this command, SDA and SCL go HIGH.



I2Cread( )

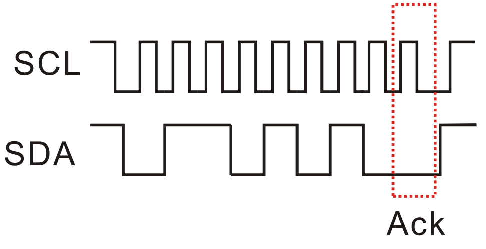
Variable = I2CREAD(dummy)

Variable : Variable to store results. (No String or Single)

dummy : dummy value. (Normally 0)

Read a byte from the I2C Ports set by SET I2C command. Use any value for dummy value.

```
A = I2CREAD(0)
```



This command will send back acknowledge ACK signal back to the slave I2C device. After reading a byte, a SCL pulse will be send while SDA is kept LOW. This will send back an acknowledge signal to your I2C slave device.

I2Creadna( )

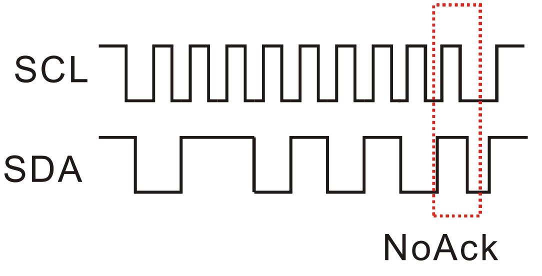
Variable = I2CREADNA(dummy)

Variable : Variable to store results. (No String or Single)

dummy : dummy value. (Normally 0)

Same function as I2CREAD command without acknowledgement.

```
A = I2CREADNA(0)
```



I2Cwrite( )

Variable = I2CWRITE data

Variable : Acknowledge
(0=Acknowledged, 1=No Acknowledgement)
data : data to send (Byte value : 0 to 255)

Send one byte of data through I2C. This command creates Acknowledge pulse and returns 0 if there is acknowledgement and 1 if there isn't. If there is no acknowledgement, it could mean two things. Either I2C lines are not connected properly or power is not supplied correctly. In case this happens, please setup an error processing function such as below:

```
IF I2CWRITE(DATA)=1 THEN GOTO ERR_PROC
```

When you don't need to check for acknowledgement you can just use any variable to receive the acknowledgement as shown below:

```
A = I2CWRITE(DATA)
```

One byte of data transfer takes approximately 60 micro-seconds.
Please refer to Chapter 8 "About I2C…" for detailed I2C communications description.

If..Then..Elseif...Endif

You can use If...Then...Elseif...Else...EndIf conditional statements to set conditions for your program.

```
If  Condition1 Then [Expression1]
      [Expression2]
[Elseif Condition2 Then
      [Expression3]]
[Else
      [Expression4]]
[End If]
```

Usage 1

```
If  A<10  Then  B=1
```

Usage 2

```
If  A<10  Then  B=1  Else  C=1
```

Usage 3

```
If  A<10  Then       '* When using more than 1 line of if,
  B=1                '* do not put any Expressions after "Then".
End If
```

Usage 4

```
If  A<10  Then
  B=1
Else
  C=1
End If
```

Usage 5

```
If  A<10  Then
  B=1
Elseif A<20 Then
  C=1
End If
```

Usage 6

```
If  A<10  Then
    B=1
  Elseif A<20 Then
    C=1
  Elseif A<40 Then
    C=2
  Else
    D=1
End If
```

In( )

Variable = IN(Port)

Variable : The variable to store result (No String or Single)

Port : I/O Port number (0 to 255)

Read the current state of the specified Port. This function reads the state of the I/O Port and stores it in the Variable. When you execute this command, CUBLOC will automatically set the Port to input and read the status. You do not need to use Input command to set the Port beforehand when using this command.

```
DIM A AS BYTE
A = IN(8)    ' Read the current state of Port 8
             ' and store in variable A(0 or 1)
```

TIPS

All CUBLOC I/O ports support both input/output. You have many options in setting the Port status to input or output. By default, all I/O Ports are set to HIGH-Z at power ON.

When Port is set to output, it will either output HIGH or LOW signal. HIGH is 5V and LOW is 0V or GND (ground).

Incr

INCR variable

Variable : Variable for increment. (No String or Single)

Increment the variable by 1.

```
INCR A              'Increment A by 1.
```

Input

INPUT   Port

Port : I/O Port number (0 to 255)

Set the specified Port to High-Z (High Impedance) input state.
All I/O Ports of CUBLOC module are set to HIGH-Z input as default at power ON.
High Impedance means that the value of resistor is so high that it's neither HIGH nor LOW.

```
INPUT 8              'Set Port 8 to HIGH-Z input state.
```

Keyin

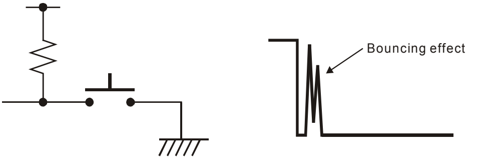
Variable = KEYIN(Port, debouncingtime)

Variable : Variable to store results (No String or Single)
Port : Input Port (0 to 255)
deboucingtime : Debouncing Time (1 to 65535)

This command KEYIN removes bouncing effect before reading the input. You can use KEYIN only when inputting LOW ACTIVE as shown below. For inputting HIGH ACTIVE, please use KEYINH. When there's input, Keyin will return 0 and 1 when there isn't.

If you use 10 for deboucing time, CUBLOC will check input for bouncing for 10 ms. Bouncing usually lasts around 10ms, so our recommendation is 10ms for most applications

```
A = KEYIN(1,10) 'Read from port after removing bouncing effect.
```



Keyinh

Variable = KEYINH(Port, debouncingtime)

Variable : Variable to store results (No String or Single)
Port : Input Port (0 to 255)
deboucingtime : Debouncing Time (0 to 65535)

KEYINH is for HIGH ACTIVE inputs. For LOW ACTIVE inputs, KEYIN command must be used.
When there's input, Keyinh will return 1 and 0 when there isn't.

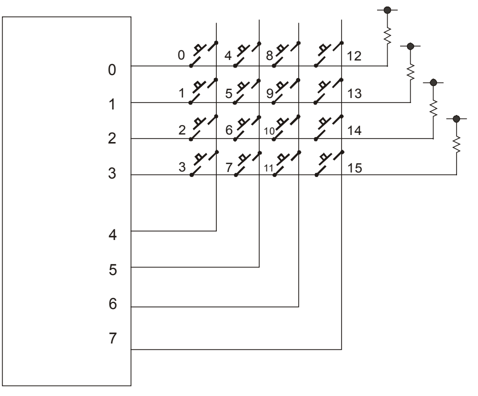
```
A = KEYINH(1,100) 'Read from port 1 after removing bouncing effect.
```

Keypad

Variable = KEYPAD(PortBlock)

Variable : Variable to store results (Returns Byte, No String or Single)
PortBlock : Port Block (0 to 15)

Use this command Keypad to read input from keypad. A Port Block can be used to read a 4 by 4 keypad input. Keypad input can be connected to the lower 4 bits of the Port Block and keypad output can be connected to higher 4 bits of the Port Block.
Please refer to the below diagram.




```
A = KEYPAD(0) ' Read the status of keypad connected to Port Block 0
```

If no keys are pressed, 255 will be returned. Otherwise, the pressed key's scan code will be returned.

Ladderscan

LADDERSCAN

This command LadderScan will force 1 scan of LADDER. When put inside an infinite loop like DO…Loop, it can enhance the speed of Ladder program more than 10 ms per scan time.
If using this command as shown below, you will not be able to use BASIC at the same time.

```
Const Device = CB280        'Device Declaration
Usepin 0,In,START           'Port Declaration
Usepin 1,In,RESETKEY
Usepin 2,In,BKEY
Usepin 3,Out,MOTOR
Alias M0=RELAYSTATE         'Aliases
Alias M1=MAINSTATE
Do
     LadderScan
Loop
```

Low

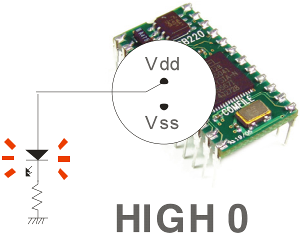
LOW   Port

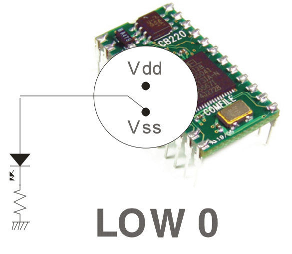
Port : I/O Port number (0 to 255)

Set the Port to LOW state. This command sets the Port to output state and outputs LOW or 0V (GND).

```
OUTPUT 8     'Set Port 8 to output state.
LOW 8        'Set Port 8 to LOW (0V).
```

When a port is set to High, the port is internally connected to VDD, whereas if it's set to Low, the port is internally connected to VSS.





Memadr( )

Variable = MEMADR (TargetVariable)

Variable : Variable to store results (No String or Single)

TargetVariable : Variable to find physical memory address

Like C language, you can use pointers in BASIC. By using pointers, you will be able to find the physical memory address of RAM and use it to store or read data.

```
Dim A as Single
Dim Adr as Integer
Adr = Memadr(A) 'Return the physical address of A.
```

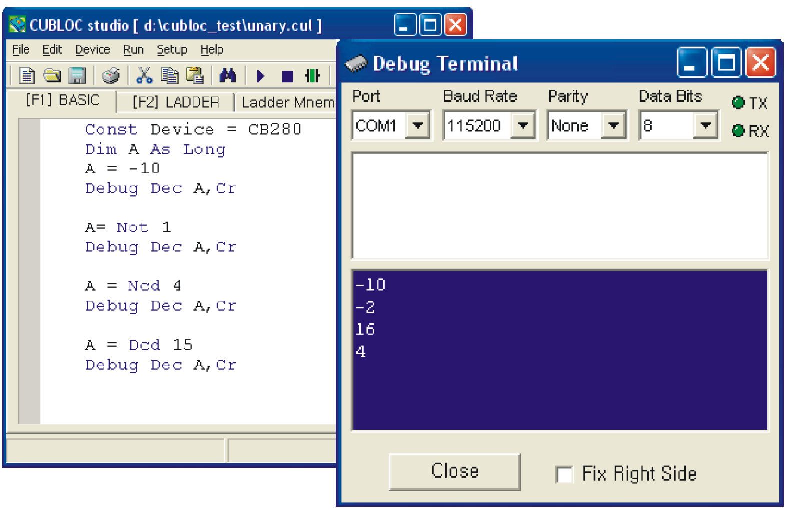
Ncd

Variable = NCD source

Variable : Variable to store results. (No String or Single)
Source : source value (0 to 31)

The command NCD can use used to set desired bit of 0x00000000 to 1 and return a 32 bit value.

```
I = NCD 0 'Result is 00000001  = 1
I = NCD 1 'Result is 00000010  = 2
I = NCD 2 'Result is 00000100  = 4
I = NCD 3 'Result is 00001000  = 8
I = NCD 4 'Result is 00010000  = 16
I = NCD 5 'Result is 00100000  = 32
I = NCD 6 'Result is 01000000  = 64
I = NCD 7 'Result is 10000000  = 128
```



Nop

Nop

This command does a no operation command. It simply takes up one command cycle time.

```
Low 8
Nop
High 8      'Output very short pulse to port 8. (About 50 micro Sec)
Nop
Low 8
```

On Int

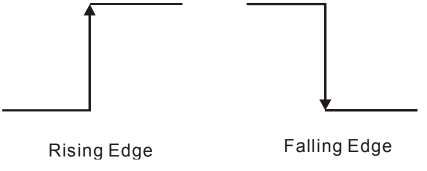
ON INTx GOSUB label

x : 0 to 3, External Interrupt Channel

This command On Int must be called before accepting external interrupt inputs. CUBLOC has 4 external interrupt Ports. The interrupt Ports can be set to sense input on the Rising-edge, Falling Edge, and Both.

SET ONINTx command must be used with this command in order for the interrupt to work.

*CB220 has no external interrupt inputs.




```
Dim A As Integer
On INT0 Gosub GETINT0
Set INT0 0          'Falling Edge Input
Do
Loop

GETINT0:
A=A+1               'Record number of interrupts
Return
```

On Ladderint Gosub

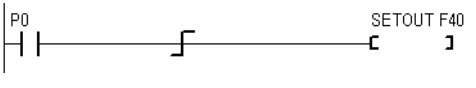
ON LADDERINT GOSUB label

If Register F40 turns on in LADDER, and ON LADDERINT GOSUB command is used, then the processor will jump to the routine specified by On Ladderint command.
This can be used when LADDER part of the program needs to jump to BASIC code.

Please use the SETOUT and DIFU command to write 1 to the Register F40. When BASIC interrupt routine is finished, Register F40 can be cleared by writing a zero to it.

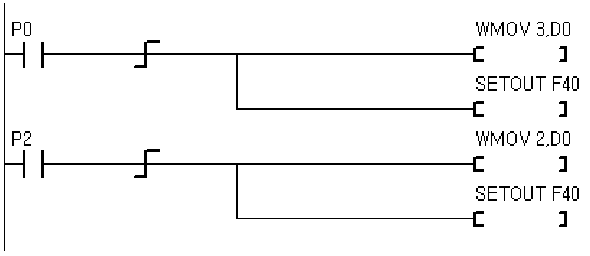
During the interrupt routine execution, writing a 1 to Register F40 will not allow another interrupt. If Register F40 is cleared from BASIC, it signs the end of the interrupt routine and is ready to receive another interrupt.

```
        Usepin 0,In
        Set Ladder On
        Set Display 0,0,16,77,50
        On Ladderint Gosub msg1_rtn
        Dim i As Integer
        Low 1

        Do
                i=i+1
                Byteout 1,i
                Delay 200
        Loop
msg1_rtn:
        Locate 0,0
        Print "ON Ladderint",Dec i
        Reverse 1
        Return
```



When P0 turns ON, it will turn on F40 and when Register F40 turns ON, msg1_rtn interrupt routine in BASIC will be executed. In the interrupt routine, a string is printed to the LCD.

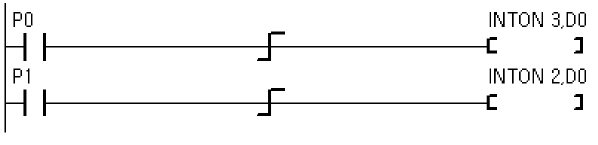
Although there is only one Register F40 to create an interrupt in BASIC from LADDER, we can use data Register D to process many different types of interrupts.



When P0 turns ON, D0 gets 3 and interrupt routine is executed. If P2 turns ON, D0 gets 2 and interrupt routine is executed. In the interrupt routine, the user can then process the type of interrupt based on the value stored in D0.

```
msg1_rtn:
        If _D(0)=3 Then
                Locate 0,0
                Print "ON Ladderint",Dec i
        End If
        If _D(0)=2 Then
                Locate 0,0
                Print "TEST PROGRAM",Dec i
        End If
        Return
```

For short version of above LADDER commands, the user can use INTON command, which accomplishes both WMOV and SETOUT in one command. The following is the equivalent shortened version of the above ladder:



On Pad Gosub

ON PAD GOSUB label

You can set the packet size using SET PAD command. The ON PAD interrupt will jump to the label when the buffer amount is equal to the set packet size. Please make sure to use RETURN command after the label.

```
      Const Device = Ct1720
      Dim TX1 As Integer, TY1 As Integer
      Contrast 450
      Set Pad 0,4,5
      On Pad Gosub GETTOUCH
      Do
      Loop

GETTOUCH:
      TX1 = Getpad(2)
      TY1 = Getpad(2)
      Circlefill TX1,TY1,10
      Pulsout 18,300
      Return
```

On RecvX

ON RECV0 GOSUB label
ON RECV1 GOSUB label
ON RECV2 GOSUB label
ON RECV3 GOSUB label

When data is received on RS232 Channel X (0 to 3), this command ON RECVX will automatically let the program jump to the specified label. The processor will automatically check for receiving data and cause interrupts when this command is used.

```
Dim A(5) As Byte
Opencom 1,19200,0, 100, 50
On Recv1 DATARECV_RTN       ' Jump to DATARECV_RTN when RS232
Do                         ' Channel 1 receives any data
Loop ' Infinite Loop

DATARECV_RTN:
     If Blen(1,0) > 4 Then
           A(0) = Get(1,1)      ' Read 1 Byte.
           A(1) = Get(1,1)      ' Read 1 Byte.
           A(2) = Get(1,1)      ' Read 1 Byte.
           A(3) = Get(1,1)      ' Read 1 Byte.
           A(4) = Get(1,1)      ' Read 1 Byte.
     End If
Return                     ' End of interrupt routine
```

IMPORTANT

When RECVX interrupt routine is being executed, another RECVX interrupt routine will not be allowed to be executed. After it finishes current interrupt routine execution, the processor will come right back to another ON RECVX interrupt routine when there's still data being received. (data in receive buffer)

On Timer()

ON TIMER(interval) GOSUB label

Interval : Interrupt Interval 1=10ms, 2=20ms……65535=655350ms
1 to 65535 can be used

On Timer() can be used to execute a interrupt routine at every specified interval. Set the desired interval in milliseconds and a label to jump to when interrupt occurs.

```
On TIMER(100) Gosub TIMERTN
Dim I As Integer

I = 0

Do
Loop

TIMERTN:
Incr I              ' I is incremented 1 every second.
Return
```

IMPORTANT

Please pay caution when creating the interrupt routine. It must be less than the interval itself. If interval is set at 10ms, the interrupt routine, from the label to its return, must be within 10 ms (About 360 instructions/lines). Otherwise, collisions can occur within the program.

Opencom

OPENCOM channel, baudrate, protocol, recvsize, sendsize

channel : RS232 Channel (0 to 3)
Baudrate : Baudrate (Do not use variable)
protocol : Protocol (Do not use variable)
recvsize : Receive Buffer Size (Max. 1024, Do not use variable)
sendsize : Send Buffer Size (Max. 1024, Do not use variable)

To use RS232 communication, this command Opencom must be declared beforehand.

CUBLOC has 2 or 4 channels for RS232C communication. Channel 0 is used for Monitor/Download but the user can use it for RS232 communication, if she/he wishes to forego monitoring. Download will still work fine regardless.

The following are allowed baudrate settings for CUBLOC RS232:

2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 76800, 115200, 230400

For the protocol parameter, please refer to the table below:

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
			Parity		Stop Bit	Bit	# of Bits
			0	0 = NONE	0=1 Stop Bit	0	0 = 5 bit
			0	1 = Reserve*	1=2 Stop Bits	0	1 = 6 bit
			1	0 = Even		1	0 = 7 bit
			1	1 = Odd		1	1 = 8 bit

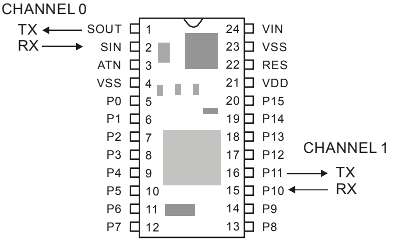
The below table shows typical settings based on the previous table:

Bits	Parity	Stop Bit	Value to Use
8	NONE	1	3
8	EVEN	1	19 (Hex = 13)
8	ODD	1	27 (Hex = 1B)
7	NONE	1	2
7	EVEN	1	18 (Hex = 12)
7	ODD	1	26 (Hex = 1A)

```
OPENCOM 1, 19200, 3, 30, 20 'Set to 8-N-1
```

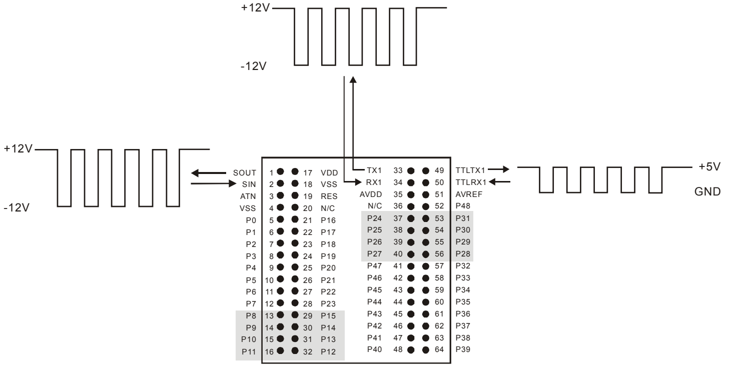
The user can set the send and receive buffer size. The send and receiver buffers take up space in the data memory. Although you can set each buffer up to 1024 bytes, it will take up that much of the data memory. The number of variables you use may decrease. We recommend receive buffer size from 30 to 100 and send buffer size from 30 to 50.

For CB220 module, port 1 and 2 can be used for Channel 0.
Port 10 and 11 can be used for RS232C Channel 1.



For the CB280 module, there are dedicated RS232 ports. For Channel 1, there are 2 types of outputs, +/- 12V and TTL (+5/0V).

Please make sure to use only one of them at one time.



*Use Set RS232 command to re-set your baudrate and parameter during execution of your program.

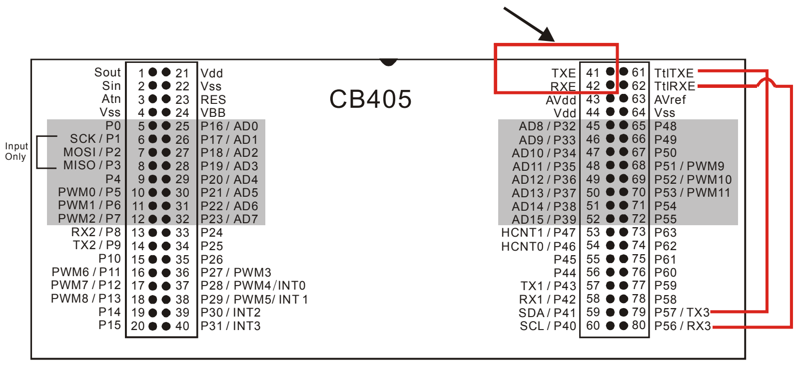
CB405 RS232 HOWTO

The following is a table of 5V TTL signal pins of the CB405

Channel	I/O Port	5V TTL
1	P42	RX
	P43	TX
2	P8	RX
	P9	TX
3	P56	RX
	P57	TX

The CB405 has a internal MAX232 that can be used to connect any of the 5V TTL signals to +/- 12V level signals. The following is an example of connecting the Channel 3:

Now you can simply connect +/- 12V RS232 signal to TXE and RXE.



Out

OUT   Port, Value

Port : I/O Port number (0 to 255)

Value : Value to be outputted to the I/O Port (1 or 0)

Output 1 or 0 to the specified Port. When you execute this command, CUBLOC will automatically set the Port to output and output the Value set. You do not need to use the Output command to set the Port beforehand when using this command.

```
OUT 8,1             'Output HIGH signal on Port 8.
                    '(This is same as using command High 8)

OUT 8,0             'Output LOW signal on Port 8.
                    '(This is same as using Low 8)
```

Output

OUTPUT Port

Port : I/O Port number (0 to 255)

Set the Port to output state. All I/O Ports of CUBLOC module are set to HIGH-Z input as default at power ON.

```
OUTPUT 8    'Set Port 8 to output state.
```

You can also use HIGH, LOW command to set to output state. When using Output command, HIGH or LOW state is not clearly defined. We recommend the use of HIGH or LOW command to set to output mode.

```
LOW 8       'Set Port 8 to output mode and output LOW signal.
```

Outstat( )

Variable = OUTSTAT(Port)

Variable : Variable to store results. (No String or Single)
Port : I/O Port Number (0 to 255)

Read the current outputted value for the specified Port. This command is different from IN() command in that it reads the status of output, not input.

```
DIM A AS BYTE
A = OUTSTAT(0) 'Read from Port 0 and store the current status in A.
```

Pause

PAUSE value

Exact same function as DELAY

Peek( )

Variable = PEEK (Address, Length)

Variable : Variable to Store Result. (No String or Single)
Address : RAM Address.
length : Length of Bytes to read (1 to 4)

Read specified length of data from RAM Address.

Poke

POKE Address, Value, Length

Address : RAM Address
Value : Variable to store results (up to Long type value)
length : length of bytes to read (1 to 4)

Write specified length of data to the RAM Address.

```
Const Device = CB280
Dim F1 As Single, F2 As Single
F1 = 3.14
Eewrite 10,Peek(Memadr(F1),4),4
Poke Memadr(F2),Eeread(10,4),4

Debug Float F2,CR
```

Pulsout

PULSOUT Port, Period

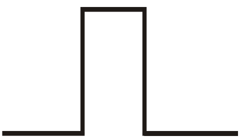
Port : Output Port (0 to 255)

Period : Pulse Period (1 to 65535)

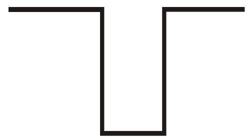
This is a SUB library that outputs a pulse. To create a High pulse, the output Port must be set to LOW beforehand. To create a Low pulse, the output Port must be set to HIGH before hand.

If you set the Pulse Period to 10, you will create a pulse of about 2.6mS. Likewise, a Pulse Period of 100 will give you about 23mS pulse.

```
LOW 2
PULSOUT 2, 100 '23mS HIGH Pulse
```



```
HIGH 2
PULSOUT 2, 100 '23mS LOW Pulse
```



Pulsout is pre-made system's sub program.

```
sub pulsout(pt as byte, ln as word)
      dim dl1 as integer
      reverse pt
      for dl1=0 to ln
      next
      reverse pt
end sub
```

Put

PUT channel, data, bytelength

channel : RS232 Channel (0 to 3)
Data : Data to send (up to Long type value)
Bytelength : Length of Data (1 to 4)

This command sends data through the specified RS232 port. For Data, variables and constants can be used. To send String, please use Putstr command instead.

IMPORTANT
The command OPENCOM must be used beforehand

```
OPENCOM 1,19200,0,50,10
DIM A AS BYTE
A = &HA0
PUT 1,A,1      ` Send &HA0 (0xA0)
               `  to RS232 Channel 1.
```

Within CUBLOC, the data is first stored in the send buffer. CUBLOC BASIC Interpreter will automatically keep sending the data in send buffer until it's empty.

If the send buffer is full when PUT command is executed, the PUT command will not wait for the buffer to flush. In other words, the data to send will be thrown away. The command BFREE can be used to check the send buffer beforehand for such cases.

```
IF BFREE(1,1) > 2 THEN  ` If send buffer has at least 2 bytes free
      PUT 1,A,2
END IF
```

BFREE() checks for how much space the buffer currently has.

TIPS

After using PUT or PUTSTR, the function SYS(0) can be used to verify that the data has been stored in the send buffer.

```
OPENCOM 1,19200,0,50,10
PUTSTR 1,"COMFILE"
DEBUG DEC SYS(0)   ` If output is 7, all data has been stored
                   ` in the send buffer
```

*Please refer to On Recv interrupt routine for receiving data using the hardware serial buffer.

Puta

PUTA channel, ArrayName, bytelength

channel : RS232 Channel. (0 to 3)
ArrayName : Array Name
Bytelength : Bytes to Send (1 to 65535)

The command Puta can be used to send a Byte Array.
Simply put name of the array and number of bytes to send.
The array data will be sent starting from the first element of the array.

```
Dim A(10) As Byte
Opencom 1,19200,0,50,10
Puta 1,A,10              ` Send 10 Bytes of Array A
```

IMPORTANT

If you try to send more bytes than the array has, CUBLOC will send garbage values.

*Please refer to On Recv interrupt routine for receiving data using the hardware serial buffer.

Puta2

PUTA channel, ArrayName, bytelength, stopchar

channel : RS232 Channel. (0 to 3)
ArrayName : Array Name
Bytelength : Bytes to Send (1 to 65535)
Stopchar : Stop character ascii code

Same as PUTA command except it will stop transmission upto a set character in the array. (StopChar will be the last character to be send)

Use with CUBLOC STUDIO 2.0.X and above.

Putstr

PUTSTR channel, data…

channel : RS232 Channel. (0 to 3)

Data : String Data (String variable or String constant or Constant)

Send String data to RS232 Channel.

```
OPENCOM 1,19200,0,50,10
PUTSTR 1,"COMFILE TECHNOLOGY", DEC I, CR
```

Similar to Put command, Putstr stores data to be sent in the send buffer. Afterwards, the CUBLOC BASIC Interpreter takes care of the actual sending. Please also be careful to not overload the send buffer when it's full, so you do not lose any data that needs be sent.

Pwm

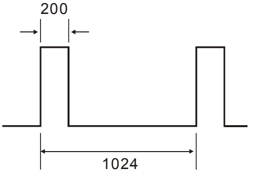
PWM Channel, Duty, Period

Channel : PWM Channel Number (0 to 15)
Duty : Duty Value, must be less than the Period.
Period : Maximum of 65535

Use PWM to Output desired PWM frequency. When using this command, please be aware that PWM Channel Number is different from I/O port number. For CB280, Ports 5, 6, and 7 are used for PWM 0, 1, and 2, respectively. Before using PWM, please make sure to set the Ports used to OUTPUT mode.

According to the set value of Period, a maximum of 16-bit precision PWM signal is created.
When Period is set to 1024, it will be a 10 bit PWM.
When Period is set to 65535, it will be a 16 bit PWM. Please set the Duty to be less than the Period. Duty can be 50% of Period to create a square wave.

PWM is independently hardware driven within CUBLOC. Once the PWM command is executed, it will keep running until PWMOFF command is called.




```
LOW 5              ` Set port 5 output and output LOW signal.
PWM 0,200,1024     ` Output 10-bit PWM with duty of 200 and
                   ` Width of 1024
```

IMPORTANT

PWM 0, 1, and 2 must used the same value of Period since they share the same resources. Their duty values can be different.

PWM Channel 3, 4, and 5 also must use the same value of Width since they share the same resources. Their duty values can be different.

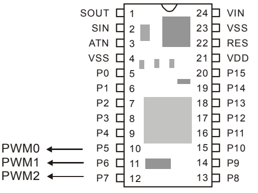
Pwmoff

PWMOFF Channel

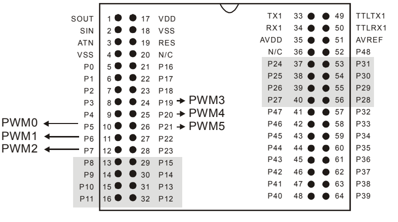
Channel : PWM Channel. (0 to 15)

Stop the PWM output.

Following is available PWM channels according to the models:



For CB220, 3 PWM channels are provided on the Ports P5, P6, and P7.



Please refer to the table below for PWM Channels and corresponding I/O ports..

	CB220	CB280	CB290	CT17X0	CB405
PWM0	I/O 5	I/O 5	I/O 5	I/O 8	I/O 5
PWM1	I/O 6	I/O 6	I/O 6	I/O 9	I/O 6
PWM2	I/O 7	I/O 7	I/O 7	I/O 10	I/O 7
PWM3		I/O 19	I/O 89	I/O 11	I/O 27
PWM4		I/O 20	I/O 90	I/O 12	I/O 28
PWM5		I/O 21	I/O 91	I/O 13	I/O 29
PWM6					I/O 11
PWM7					I/O 12
PWM8					I/O 13
PWM9					I/O 51
PWM10					I/O 52
PWM11					I/O 53

Ramclear

RAMCLEAR

Clear CUBLOC BASIC's RAM. BASIC's data memory can hold garbage values at power on. Ramclear can be used as a type of garbage collector to clear the ram.

*There are CUBLOC modules that support battery backup of the RAM. If you don't use Ramclear command in these modules, CUBLOC will remember previous values of RAM before powering off.

Reverse

REVERSE   Port

Port : I/O Port Number. (0 to 255)

Reverse the specified Port output.   High to Low or Low to High.

```
OUTPUT 8    'Set Port 8 to output.
LOW 8       'Set output to LOW.
REVERSE 8   'Reverse LOW to HIGH.
```

Rnd( )

Variable = RND(0)

The command Rnd() creates random numbers. A random number between 0 and 65535 is created and stored in the specified variable. The number inside Rnd() has no meaning.

```
DIM A AS INTEGER
A = RND(0)
```

Internally within CUBLOC, this function is Pseudo Random, it creates a random number based on the previous values. When powered off and turned back on again, the same pattern of random values are generated. Thus, this function is not a true random number generator.

Select...Case

Select..Case

If the condition Value of Case is met, the Statement under the case is executed.

```
Select Case Variable
       [Case Value [,Value],…
              [Statement 1]]
       [Case Value [,Value],…
              [Statement 2]]
       [Case Else
              [Statement 3]]
End Select
```

```
Select Case A
       Case 1
              B = 0
       Case 2
              B = 2
       Case 3,4,5,6          ` Use Comma(,) for more than 1 value.
              B = 3
       Case Is < 1           ` Use < for logical operations.
              B = 3
       Case Else             ` Use ELSE for all other cases.
              B = 4
End Select

Select Case K
       Case  Is < 10         ` If less than 10
              R = 0
       Case Is < 40          ` If less than 40
              R = 1
       Case Is < 80
              R = 2
       Case Is < 100
              R = 3
       Case Else
              R = 4
End select
```

Set Debug

SET DEBUG On[/Off]

Set Debug is set to On by default.

You can use this command to turn OFF and turn ON the DEBUG window in BASIC.
When you don't need DEBUG feature, you can use this command to turn off DEBUG feature instead of erasing all the code with Debug code. When this command is used, all DEBUG commands are not compiled, in effect, they are simply discarded from the program.

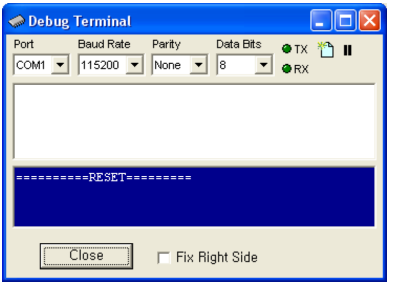
Debug Command How-to

When used correctly, the Debug command can help the user identify and fix bugs in the program. The user can check the value of variables during execution of a program, simulate an LCD, and also do other tasks to help save development time.

1. How to Check if program is being reset

Sometimes you will want to check if your program is being reset. This is usually due to faulty programming.
Simply put a Debug statement at the beginning of your program, such as 'Debug "=========Reset=========" ' as shown below:

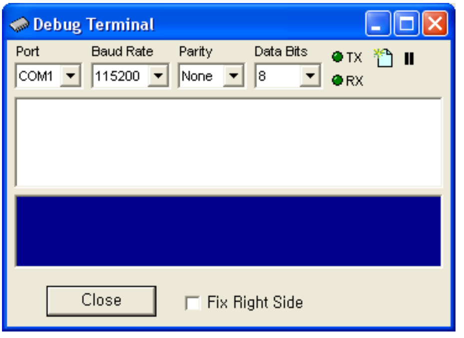
```
Const Device = CB280
Debug
"==========Reset========="
Do
        High 0
        Delay 200
        Low 0
        Delay 200
Loop
```



2. How to check if a particular point of the program is being executed

Simply insert a Debug command where you would like to tell if that part of the program is being executed, like shown here:

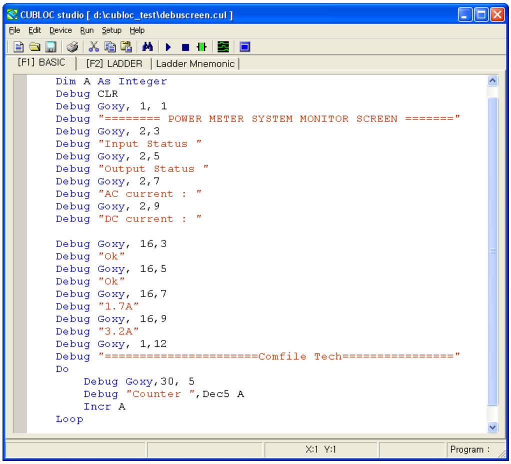
```
Const Device = CB280
Do
        High 0
        Delay 200
        Low 0
        Delay 200
Loop
Debug "This Part!"
```

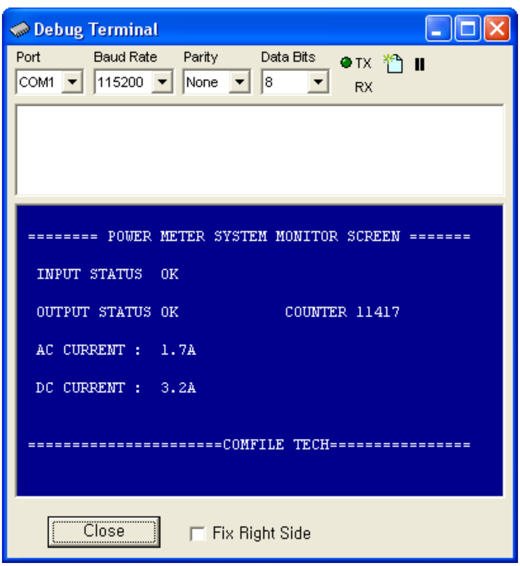


(The debug statement above will never execute as the program stays in the Do…Loop and will never get out of it)

3. How to simulate an LCD

You can simulate an LCD using the Debug terminal. Simply use the Goxy,XX,YY to locate a particular location on the LCD like shown here:





Use the command **Debug CLR** to clear the Debug window. At any time during development, you can disable and also not include Debug statement during Compiling by using the command, "**Set Debug Off**".

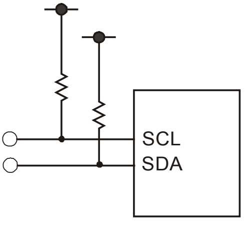
Set I2c

SET I2C DataPort, ClockPort

DataPort : SDA, Data Send/Receive Port. (0 to 255)

ClockPort : SCL, Clock Send/Receive Port. (0 to 255)

This command sets the I2C DataPort and ClockPort, SDA and SCL for I2C communication. Once this command is executed, both Ports become to OUTPUT, HIGH state. Please use Input/Output Port for I2C and use two 4.7K resistors as shown below.



Some of the I/O ports only support Input or Output. Please check the Ports in the data sheet for the model you are using.

Set Int

SET INTx mode

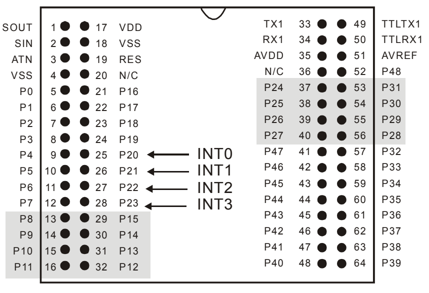
x : 0 to 3, External Interrupt Channel

mode : 0=Falling Edge, 1=Rising Edge, 2=Changing Edge

This command must be used with On Int command in order to receive external interrupt inputs.

The mode of interrupt input can be set here to either falling edge, rising edge, or changing edge.

```
SET INT0 0   ' Set external interrupt to be on the Falling Edge.
```



Set Ladder on/off

SET LADDER On[/Off]

Ladder is set to Off by default.
Use this command to turn On Ladder Logic.

The following is an example of such minimal BASIC code for Ladder logic.

```
Const Device = CB280          'Device Declaration

Usepin 0,In,START             'Port Declaration
Usepin 1,In,RESETKEY
Usepin 2,In,BKEY
Usepin 3,Out,MOTOR

Alias M0=RELAYSTATE 'Aliases
Alias M1=MAINSTATE

Set Ladder On                 'Start Ladder

Do
Loop                          'BASIC program will run in infinite loop/
```

Set Modbus

Set Modbus   mode, slaveaddress, returninterval
mode : 0=ASCII, 1=RTU
slaveaddress : Slave Address (1 to 254)
returninterval : return interval (1 to 255)

CUBLOC supports MODBUS protocol. MODBUS can connect to RS232 Channel 1.

To enable MODBUS slave mode, please use the Set modbus command. This command set modbus is to enable the MODBUS slave. It must come after OPENCOM command and only runs on RS232 Channel 1. Baudrate, bit, and parity can be set with OPENCOM.

```
Opencom 1,115200,3,80,80    ` Please set receive buffer
                            ` of at least 50.
Set Modbus 0,1,100          ' ASCII Mode, Slave Address=1
```

After this command, CUBLOC responds automatically. CUBLOC supports MODBUS commands 1,2,3,4,5,6,15, and 16.

Command	Command Name
01, 02	Bit Read
03, 04	Word Write
05	1 Bit Write
06	1 Word Write
15	Multiple Bit Write
16	Multiple Word Write

Please refer to Chapter 9 for detailed MODBUS description and MOBUS ASCII and RTU examples.

The term returninterval is the delay time for CUBLOC or CUTOUCH to respond to the Master MODBUS device. If the returninterval is set too fast, the Master device might not be able to receive all data. The default setting is 1, which is about 200 micro-seconds. The user may also set this value to 100, which is about 4.5ms or to 255, which is about 11ms.

Set Onglobal

SET ONGLOBAL On[/Off]

At power On, Set Onglobal is ON by default.

This command turns on or off the ability to receive ALL interrupts.
When Onglobal is turned Off and turned On, all interrupt settings set before turning Off will be in effect.

```
SET ONGLOBAL OFF ` Turn ALL interrupts OFF.
```

If you don’t use any interrupts, you can turn off all interrupts to increase the execution speed of CUBLOC.

Set Onint

SET ONINTx   On[/Off]

At power On, Set Onint is ON by default.

This command turns On or Off the ability to receive individual external interrupts using global flags. The names of these flags correspond to the interrupt number supported by the device. For example ONINT1 is used for Interrupt 1.

When the ONINTx global is set to ON for a specific interrupt, then an interrupt can be received using the ON INTx command. If the global is set to OFF, then the code for ON INTx will not be executed if the corresponding external interrupt occurs. See also the SET INTx command which controls external interrupts to fire.

```
Set ONINT0 On
Set ONINT1 On
Set ONINT1 Off
Set ONINT2 Off
Set ONINT3 On
```

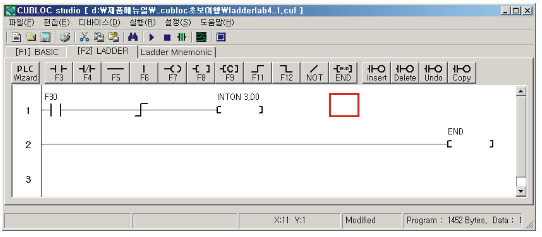
Set OnLadderint

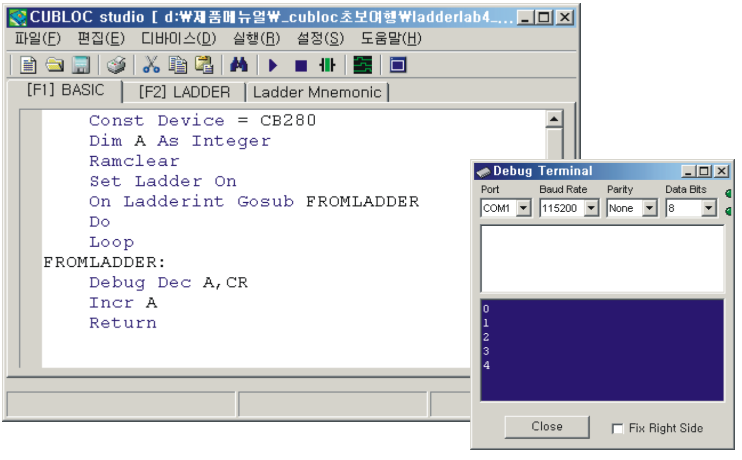
SET ONLADDERINT On[/Off]

At power On, Set OnLadderint is ON by default.

This command turns On or Off the ability to receive Ladder interrupts using global flags.

When the OnLadderint is set to On, then an interrupt can be received using the On Ladderint command. If the global is set to OFF, then the code for On Ladderint will not be executed if the Ladder interrupt occurs. See also the On Ladderint command.





Set Onpad

SET ONPAD On[/Off]

At power On, Set Onpad is On by default.

This command turns On or Off the ability to receive Onpad interrupts using global flags.

When the Onpad is set to on, then an interrupt can be received using the On Pad command. If the Onpad is set to OFF, then the code for On Pad will not be executed if the interrupt occurs. See also the Set Pad and On Pad commands.

Set Onrecv

SET ONRECV0   On[/Off]
SET ONRECV1   On[/Off]
SET ONRECV2   On[/Off]
SET ONRECV2   On[/Off]

At power On, Set Onrecv is On by default.

This command turns On or Off the ability to receive On RecvX interrupts using global flags. A On RecvX interrupt occurs after data is received on the serial port AND stored into the receive buffer.

When the Onrecv is set to On, then an interrupt can be received using the On RecvX command. If the Onrecv is set to OFF, then the code for On RecvX will not be executed if the interrupt occurs. See also the On Recv command.

```
Set ONRECV1 On
Set ONRECV1 Off
```

Set Ontimer

SET ONTIMER   On[/Off]

At power On, Set Onrecv is On by default.

This command turns On or Off the ability to receive On Timer interrupts using global flags. An interrupt occurs at every time interval set by the On Timer() command.

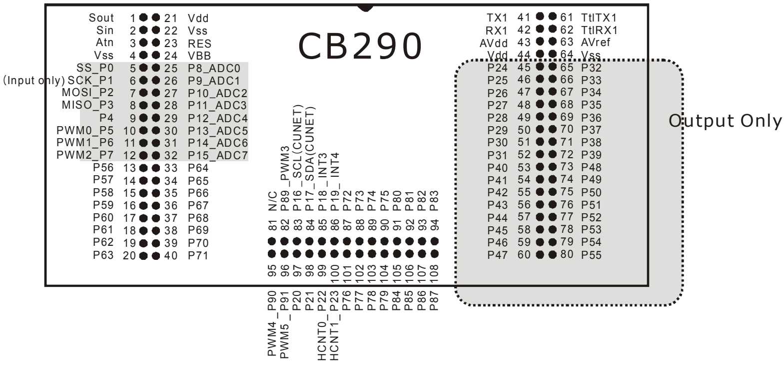
When the Ontimer is set to on, then an interrupt can be received using the On Timer() command. If the Ontimer is set to OFF, then the code for On Timer() will not be executed if the interrupt occurs. See also the On Timer() command.

Set Outonly

SET OUTONLY On[/Off]

The CB290/CT1720 (Rev B) output ports are in high impendence (High-Z) state in order to prevent garbage values outputting at power ON.
You must use "Set OUTONLY ON" command to set the CB290 / CT1720 output ports to output status.

```
Const device = cb290
Set outonly on
Low 24
```



Model	Output only port
CB290	P24 to P55
CT1720 / CT1721	P24 to P55

Set Pad

SET PAD mode, packet, buffersize

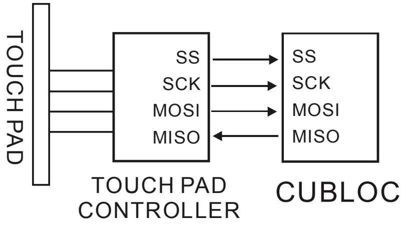
mode : Bit Mode (0 to 255)

packet : Packet Size (1 to 255)

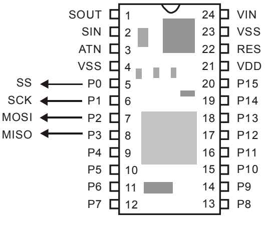
buffersize : Receive Buffer Size (1 to 255)

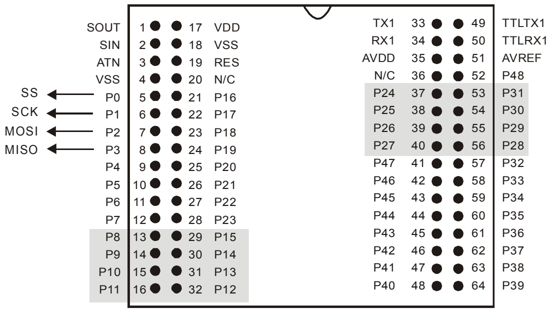
The CUBLOC has a dedicated port for Keypad / Touchpad inputs similar to a PC's Keyboard and Mouse ports. This port can be used with the Set Pad command to create interrupts when input is received on the Keypad, Touchpad, etc… This port is basically a Slave mode SPI communication.

To use the PAD communications, you must use Set Pad command at the beginning of your program. The PAD communication uses 4 wires. SCK is used as clock signal, SS as Slave Select, MOSI as Master Out Slave In, and MISO as Master In Slave Out signals.



I/O ports P0 through P3 can be used for PAD communications.

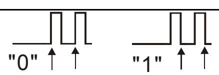




Packet is for size of packet that will cause an interrupt.
For example, the touchpad require 4 bytes to be received before an interrupt is called. Here, the size of the packet is 4.

Buffersize is the total size of the receive buffer. The buffer size must be at least 1 greater than packet size. (buffersize = packet+1) A larger buffer will essentially give you more time to process the interrupt routine. The buffer size is usually set to 5 or 10 times the packet size.

Mode will set the receiving mode of the received data. Please refer to the below table:

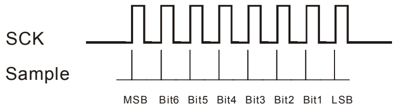
Mode	Value	Bit Pattern	Diagram
LSB First	&H20	0010 xxxx	
MSB First	&H00	0000 xxxx	
SCK Low-Edge Triggered	&H08	xxxx 1xxx	
SCK High-Edge Triggered	&H00	xxxx 0xxx	
Sampling after SCK	&H04	xxxx x1xx	
Sampling before SCK	&H00	xxxx x0xx	

You can add the values of the receiving modes. For example, for MSB first, High-Edge Triggered SCK and sampling after SCK:

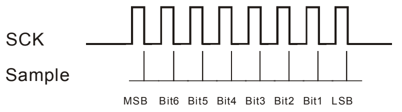
0x00 + 0x00 + 0x04 = 0x04

Here are some of the common examples:

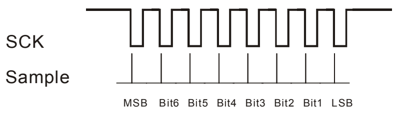
&H00



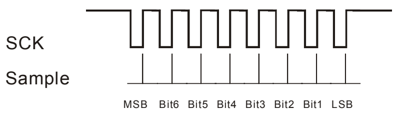
&H04



&H08



&H0C



For PAD communications, you can use Comfile's Keypads or Touch screens.

The Set Pad command will automatically set the ports P0 through P3, the user doesn't have to set them.

Set Rs232

Set Rs232 channel, baudrate, protocol

channel : RS232 Channel (0 to 3)
Baudrate : Baudrate (Do not use variable)
protocol : Protocol (Do not use variable)

You can only use Opencom command once to open a serial port. In order to change the baudrate and protocol, the Set Rs232 command can be used.

For the protocol parameter, please refer to the table below:

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
			Parity		Stop Bit	Bit	# of Bits
			0	0 = NONE	0=	0	0 = 5 bit
					1 Stop Bit		
			0	1 = Reserve*	1=	0	1 = 6 bit
					2 Stop Bits		
			1	0 = Even		1	0 = 7 bit
			1	1 = Odd		1	1 = 8 bit

The below table shows typical settings based on the previous table:

Bits	Parity	Stop Bit	Value to Use
8	NONE	1	3
8	EVEN	1	19 (Hex = 13)
8	ODD	1	27 (Hex = 1B)
7	NONE	1	2
7	EVEN	1	18 (Hex = 12)
7	ODD	1	26 (Hex = 1A)

```
Opencom 1, 19200, 3, 30, 20       `Open Rs232 channel 1
Set Rs232 1, 115200, 19           `Change Baudrate & Parity
```

Set Rs485

Set Rs485 Channel, PortNumber

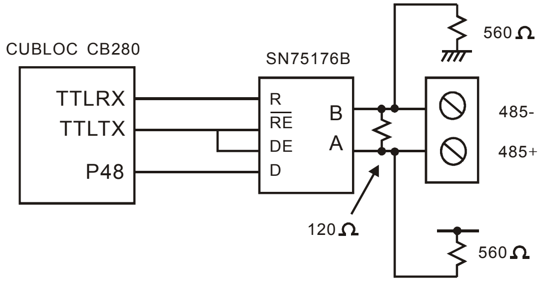
Channel : RS232 Channel (0 to 3)

PortNumber : Transmit Enable Port Number

RS485 allows you to daisy link multiple CUBLOCs up to a distance of 1.2km. With RS485, there must be 1 master and the rest must be slave devices. You can either use a chip such as the SN75176B or use a RS232 to RS485 converters.

With RS485, transmitting and receiving data must occur one at a time. The RS485 is known for being stable under noisy conditions.

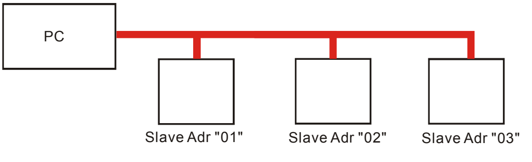
You can refer to the following circuit schematic for connecting TTL signals from CB280 to RS485 chip, SN75176B:



The RS485 communication needs a “Transmit Enable” signal to signal when the device is sending and receiving. There can only be one device transmitting while all the other devices are in receiving mode.

Example:

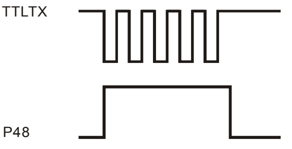
When the PC is transmitting, all the slave devices can only receive data.



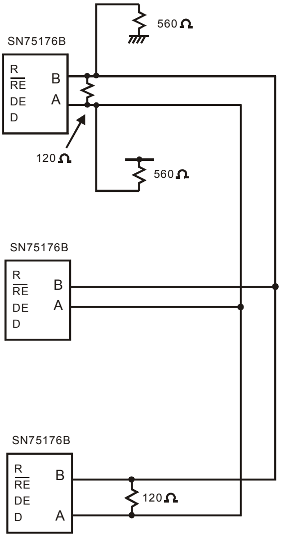
The SET RS485 command allows CUBLOC or CUTOUCH to control the data line whenever it want to send or receive. While the data is being sent, the Transmit Enable pin will output Active High. This will automatically be done by the CUBLOC RTOS.

*NOTE: If you are using a RS232-to-RS485 converter and it supports automatic mode, then you don't need to use this command.

```
SET RS485 1,48 ` Set P48 as Trasmit Enable pin
```



When using the SET RS485 command, the Port being used may not be used



1: Please refer to the diagram on the left when connecting multiple CUBLOCs or CUTOUCH using RS485.

Please use a 120 Ohm terminating resistor for the device at the end.

The two 560 Ohm Pull-Up and Pull-Down resistors are required for proper communication.

Set Until

SET UNTIL channel, packetlength, stopchar

channel : RS232 Channel. (0 to 3)
packetlength : Length of packet (0 to 255)
stopchar : Character to catch

This is a conditional statement you can put right after the ON RECV command. Since the ON RECV command will cause an interrupt even when there 1 byte of data received, this command Set Until can be used to set when the interrupt will be called.

When the specified character is received or length of bytes received has exceed the set packetlength value, then ON RECV will jump to the specified interrupt routine. This way, you can control when you want to process received data.

The packet length is set in case the specified character never arrives.

You MUST use this command with ON RECV command.
The following is an example:

```
Dim A(5) As Byte
Opencom 1,19200,0, 100, 50
On Recv1 DATARECV_RTN
Set Until 1,99,"S"
```

As you can see above, the packet size is 99 bytes. In other words, if character “S” is not received within 99 bytes, interrupt will occur.

```
SET UNTIL 1,5
```

The user may also just set the packet size and not set the character as shown above.

The character may also be written in decimal as shown below:

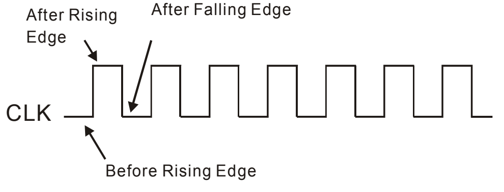
```
SET UNTIL 1,100,4
```

Shiftin( )

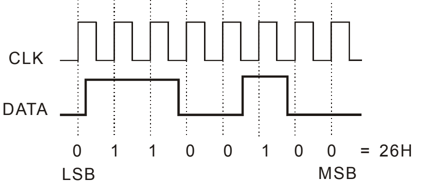
Variable = SHIFTIN(clock, data, mode, bitlength)

Variable : Variable to store results. (No String or Single)
Clock : Clock Port. (0 to 255)
Data : Data Port. (0 to 255)
Mode : 0 = LSB First (Least Significant Bit First), After Rising Edge
1 = MSB First (Most Significant Bit First), After Rising Edge
2 = LSB First (Least Significant Bit First), After Falling Edge
3 = MSB First (Most Significant Bit First), After Falling Edge
4 = LSB First (Least Significant Bit First), Before Rising Edge
5 = MSB First (Most Significant Bit First), Before Rising Edge
bitlength : Length of bits (1 to 16)

This command Shiftin() receives shift input. It uses 2 Ports, CLOCK and DATA to communicate.
SHIFTIN and SHIFTOUT command can be used to communicate with SPI, MIcrowire, and similar communication protocols. When using EEPROM, ADC, or DAC that requires SPI communication, this command can be used.




```
DIM A AS Byte
A = SHIFTIN(3,4,0,8)       ` Port 3 is Clock, Port 4 is Data,
                           ` Mode 0, 8 bit received.
```



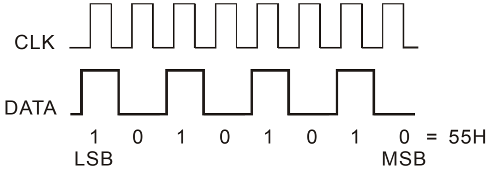
Shiftout

SHIFTOUT clock, data, mode, variable, bitlength

Clock : Clock Port. (0 to 255)
Data : Data Port. (0 to 255)
Mode : 0 = LSB First (Least Significant Bit First)
1 = MSB First (Most Significant Bit First)
2 = MSB First(Most Significant Bit First) , Create ACK (For I2C)
variable : Variable to store data (up to 65535)
bitlength : Bit Length (1 to 16)

This command Shiftout sends shift output. There are 3 modes. Mode 2 is for I2C protocol. In I2C communication, there requires an acknowledgement (ACK) signal for every 8 bits.

```
SHIFTOUT 3,4,0,&H55,8 ` Port 3 = Clock,
                      ` Port 4 = Data, Mode = 0, send 0x55
                      ` bitlength 8 bit,
```



Steppulse

STEPPULSE Channel, Port, Freq, Qty

Channel : StepPulse Channel(0 or 1)
Port : Output Port
Freq : Output Frequency (Up to 15kHz)
Qty : # of pulses to output (up to 2147483647)

Output a set of number of pulses at a set frequency (up to 15kHz). FREQOUT and PWM can also output pulses but user cannot control the number of pulses and must use the PWM ports. With STEPPULSE, the user can use any of the output ports and control the number of pulses at a desired frequency.

Depending on the core module used, the number of available channels may change. Please refer to the following table for detailed info:

Module	Channels	Channel	PWM Channels that cannot be used during use of the command
CB220, 280, 290, CT17XX	1	0	Channel 0: PWM 3, 4, 5
CB405	2	0 or 1	Channel 0: PWM 3, 4, 5 Channel 1: 6, 7, 8

STEPPULSE uses the CUBLOC processor’s PWM counters meaning when using this command, PWM3, PWM4, and PWM5 cannot be used.

For CB405, when using Channel 1, PWM6, PWM7, and PWM8 cannot be used. With CB2XX series, only Channel 0 may be used. With CB405, 2 Channels may be used simultaneously.

You can use any of the available output I/O ports on the CUBLOC. When the STEPPULSE command is executed, that Port is automatically set to ouput state. Even after the output of pulses have finished, the Port remains in output state.

Output Frequency can be set from 1hz to 15000Hz or 15kHz.

Number of pulses can be set from 1 to 2147483647.
This command will run in the background independently, so the user may use system resources for other tasks.

Stepstop

STEPSTOP Channel

Channel : StepPulse Channel (0 or 1)

STEPSTOP command will stop Pulse Output Channel immediately.

Stepstat( )

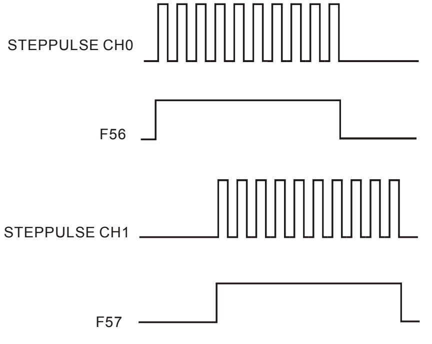
Variable = STEPSTAT (Channel)

Variable : Variable to store results

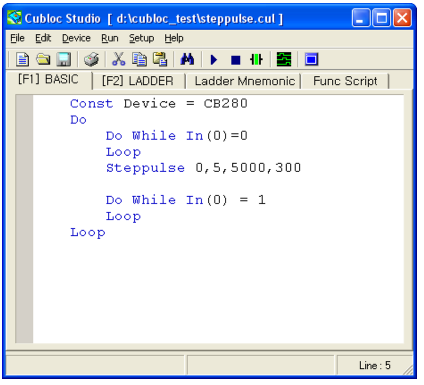
Channel : StepPulse Channel(0 or 1)

STEPSTAT allows you to monitor how many pulses have been outputted since the last STEPPULSE command.
STEPSTAT will return double the number of pulses remaining to be outputted. If there are 500 pulses left to output, STEPSTAT will return 1000.

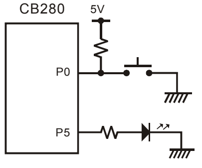
You can also check the output status of pulses using _F(56) or F56 in Ladder Logic. When Channel 0 is outputting pulses, _F(56) will be logic HIGH, 1. When Channel 1 is outputting pulses, _F(57) will be set to logic HIGH, 1. If no pulses are outputting at the moment, the F registers will be set to logic LOW, 0.

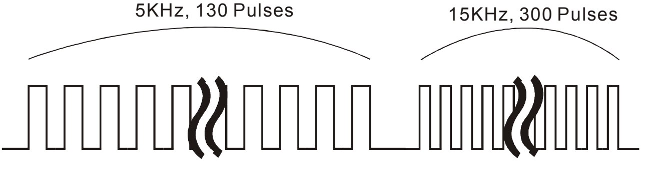


DEMO PROGRAM

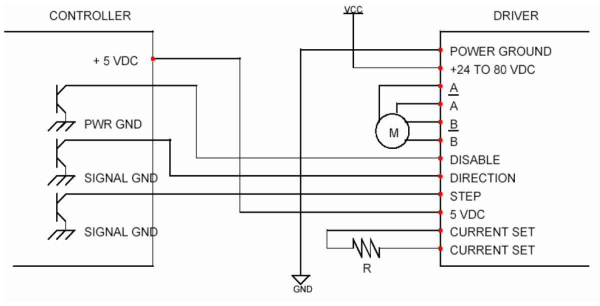


When Port 0 switch is pressed, Port 5 or P5, will output 300 pulses at the speed of 5kHz. The following is a circuit diagram for the above code:





You can connect a stepper motor and stepper motor driver such as below to control a stepper motor.



Connect 3 I/Os of CUBLOC to the stepper motor driver. The DISABLE and DIRECTION pins are only to enable and set the direction of the stepper motor.

Please refer to your stepper motor specifications on how many pulses are required to move the stepper motor one step.

Sys( )

Variable = SYS(address)

Variable : Variable to store results. (No String or Single)
address : Address. (0 to 255)

Use command Sys() to read the status of RS232 buffers for both Channel 0 and 1.

- Address 0 : Actual bytes of sent data in send buffer after executing commands PUT or PUTSTR.
- Address 1 : Actual bytes of sent data in receive buffer after executing commands GET or GETSTR
- Address 5 : Timer value that increments every 10ms
- Address 6 : Data Memory (RAM) Address

SYS(5) will return the value of the system timer which increments every 10ms.
You may only read the value, not change it. The Timer will increment up to 65535 and then reset to 0. You can use this system timer for applications requiring extra timer.

SYS(6) will return the current Data Memory Address. At power ON, the Data Memory Address is reset to 0. After calling Sub routines or Functions, the Data Memory Address will increment.

If will also increment when Sub routines or Functions are called within a Sub routine or a function. Interrupts will also increment the Data Memory Address. When the Data Memory Address exceeds the total Data Memory available, it will cause Overflow. By using this function, you can avoid Overflow. CB280 has maximum of 1948 bytes of Data Memory. Please make sure to have at least 100 bytes of free Data Memory for safety.

```
A = Sys(6)   'Store the current Data Memory Address in A
```

Tadin()

Variable = TADIN(Channel)

Variable : Variable to store results. (No String or Single)
Channel : AD Channel Number (Not Port number, 0 to 15)

This command Tadin() is similar to Adin(). It returns the average of 10 ADIN converted value. When working under noisy environments, using Tadin() could help in obtaining more precise results.

Tadin( ) is pre-made system's functions program

```
function tadin(num as byte) as integer
      dim ii as integer, ta as long
      ta = 0
      For ii = 0 To 9
             ta = ta + Adin(num)
      Next
      TADIN = TA / 10
End Function
```

Time( )

Variable = TIME (address)

Variable : Variable to store results. (No String or Single)

address : Address of time value (0 to 6)

CUBLOC module CB290 has an RTC chip internally. You can use Time() and Timeset commands to set and return time values to and from the RTC. Time information such as current time, day of the week and year can be set to the RTC and read from it in real-time.
Time is kept alive even when module powers off through use of its backup battery.

The following is a chart showing the addresses of the RTC and its corresponding values.
* You cannot use these commands for CB220 and CB280 since they do not have an RTC.

<table>
<tr><td>Address</td><td>Value</td><td>Range</td><td colspan="6">Bit Structure</td></tr>
<tr><td>0</td><td>Second</td><td>0 to 59</td><td></td><td colspan="3">2^{nd} digit place</td><td colspan="2">1^{st} digit place</td></tr>
<tr><td>1</td><td>Minute</td><td>0 to 59</td><td></td><td colspan="3">2^{nd} digit place</td><td colspan="2">1^{st} digit place</td></tr>
<tr><td>2</td><td>Hour</td><td>0 to 23</td><td></td><td></td><td colspan="2">2^{nd} digit place</td><td colspan="2">1^{st} digit place</td></tr>
<tr><td>3</td><td>Date</td><td>01 to 31</td><td></td><td></td><td colspan="2">2^{nd} digit place</td><td colspan="2">1^{st} digit place</td></tr>
<tr><td>4</td><td>Day</td><td>0 to 6</td><td></td><td></td><td></td><td></td><td></td><td>1^{st} digit place</td></tr>
<tr><td>5</td><td>Month</td><td>1 to 12</td><td></td><td></td><td></td><td>2^{nd} digit</td><td colspan="2">1^{st} digit place</td></tr>
<tr><td>6</td><td>Year</td><td>00 to 99</td><td colspan="4">2^{nd} digit place</td><td colspan="2">1^{st} digit place</td></tr>
</table>

Please refer to the chart below for day of the week and its corresponding numerical value:

Sunday	0
Monday	1
Tuesday	2
Wednesday	3
Thursday	4
Friday	5
Saturday	6

System clock RTC

This command will allow you to use the system timer of CUBLOC as an RTC. You can use TIME() and TIMESET functions to access the following addresses:

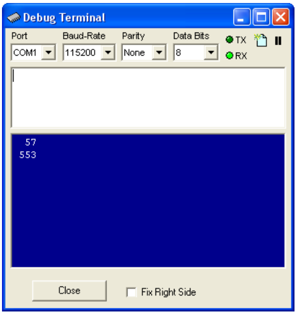
Address	Returning Value	Range
10	Seconds	0 to 59
11	Minutes	0 to 59
12	Hours	0 to 65535
13	Continuous Seconds	0 to 65535

The Address 10 will increment its value by 1 every one second. When its value becomes 60, Address 11 will increment its value by 1. When Address 11's value becomes 60, Address 12 will increment its value by 1. When Address 12's value becomes 65535, it will reset back to 0. At power ON, all Addresses are set to 0. TIMESET command can be used to set the time at beginning of user's program.

The system clock RTC (Address 10 to 13) values are stored as raw binary values, unlike the on-chip RTC on CB290 and CB405. There is no need for the user to convert the values using BCD2BIN and BIN2BCD.

System Clock RTC uses the processor's system clock and there can be slight time difference (< 1%) during a 24 hour period.

```
Const Device = CB405
Dim i As Integer
Cls
Timeset 10,58
Timeset 13,254
Do
  i = Time(10)
  Debug Goxy,0,0,dec4 i,Cr
  Debug Goxy,0,1,dec4 Time(13)
  Delay 100
Loop
```



Address 13 will increment its value by 1 every one second similar to Address 10 except it will increment until 65535 before resetting to 0.
Address 10 through 13 must be used with CUBLOC STUDIO 2.0.X and above versions.

Timeset

TIMESET address, value

address : Address of time value (0 to 6)

value : time value. (0 to 255)

Use TIMESET command to store new time values.

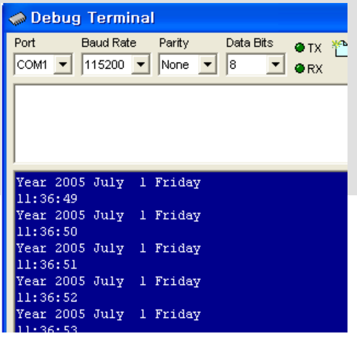
Address	Value	Range	Bit Structure				
0	Second	0 to 59		2nd digit place			1st digit place
1	Minute	0 to 59		2nd digit place			1st digit place
2	Hour	0 to 23			2nd digit place		1st digit place
3	Date	01 to 31			2nd digit place		1st digit place
4	Day	0 to 6					1st digit place
5	Month	1 to 12				10	1st digit place
6	Year	00 to 99	2nd digit place				1st digit place

The following is an example code showing how to set new time, and outputting current time to the debug window:

```
Const Device =CB290
       Dim I As Byte
       Timeset 0,0          'Sec
       Timeset 1,&H32       'Min
       Timeset 2,&H11       'Hour
       Timeset 3,&H1        'Date
       Timeset 4,&H5        'Day of the week
       Timeset 5,&H6        'Month
       Timeset 6,&H5        'Year

       Do
              I = Time(6)
              Debug "Year ","200",Hex I, " "
              I = Time(5)
              Select Case I
              Case 0
                     Debug "January"
              Case 1
                     Debug "February"
              Case 2
                     Debug "March"
              Case 3
                     Debug "April"
              Case 4
                     Debug "May"
              Case 5
                     Debug "June"
```

```
            Case 6
                  Debug "July"
            Case 7
                  Debug "August"
            Case 8
                  Debug "September"
            Case 9
                  Debug "November"
            Case 10
                  Debug "December"
            End Select
            I = Time(3)                'Print date
            Debug " ", Hex2 I
            Debug " "

            I = Time(4)
            Select Case I
            Case 0
                  Debug "Sunday "
            Case 1
                  Debug "Monday "
            Case 2
                  Debug "Tuesday "
            Case 3
                  Debug "Wednesday "
            Case 4
                  Debug "Thursday "
            Case 5
                  Debug "Friday "
            Case 6
                  Debug "Saturday "
            End Select
            Debug cr

            I = Time(2)
            Debug Hex2 I,":"
            I = Time(1)
            Debug Hex2 I,":"
            I = Time(0)
            Debug Hex I,cr
            Delay 1000
Loop
```

Debug Terminal Screenshot:



Udelay

UDELAY   time

time : interval (1 to 65535)

A more specific delay function. Delay will start out at about 70 micro-seconds. Every unit added will add 14 to 18 micro-seconds.

For example. Udelay 0 would be about 70 micro-seconds. Udelay 1 would be about 82 to 84 micro-seconds. When Interrupt or LADDER code is being executed at the same time, this delay function might be affected. During this delay, BASIC interrupts are enabled and could cause further delay when using this command.

To not get affected by LADDER or BASIC, we recommend stopping LADDER and all interrupts before using this command.

```
Udelay 100  ` Delay about 1630 micro-seconds.
```

Usepin

Usepin I/O, In/Out, AliasName

I/O : I/O Port Number. (0 to 255)

In/Out : “In” or “Out”

AliasName : Alias for the port (Optional)

This command Usepin is used to set the I/O Port status and alias name for LADDER program.

Please use this command to set the I/O Ports before using them in LADDER.

```
Usepin 0,IN,START
Usepin 1,OUT,RELAY
Usepin 2,IN,BKEY
Usepin 3,OUT,MOTOR
```

Utmax

UTMAX variable

Variable : Variable for decrement. (No String or Single)

Increment the variable by 1. When maximum is reached, the variable is no longer incremented. The Maximum here refers to the variable's maximum value. In the case with Byte, the maximum would be 255 and in the case with Integer, the maximum would be 65535.

```
Utmax A      ‘ Increment A by 1
```

Wait

Wait   time

Time : interval variable or constant (mS unit) 10 to 2147483640

Wait for the specified time in milliseconds.

This command will delay using the system clock. This delay function is accurate to 10ms units.

```
Wait 10              ` Delay 10 ms.
Wait 15              ` Delay 10 ms.
Wait 110             ` Delay 110 ms.
Wait 115             ` Delay 110 ms.
```

Use with CUBLOC STUDIO 2.0.H and above.

WaitTx

WAITTX channel

channel : RS232Channel. (0 to 3)

This command WaitTx will wait until the send buffer is flushed.
This one command accomplishes same functions as shown below:

```
OPENCOM 1,19200,0, 100, 50
PUTSTR 1,"ILOVEYOU",CR

DO WHILE BFREE(1,1)<49 ' Wait until all data have been sent
LOOP
```

By using WaitTx, the process of sending data becomes simpler as shown below:

```
OPENCOM 1,19200,0, 100, 50
PUTSTR 1,"ILOVEYOU",CR

WAITTX 1                  ' Wait until all data have been sent
```

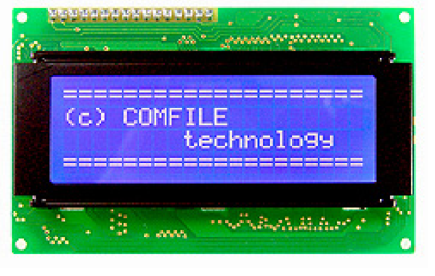
When this command is waiting, other interrupts may be called. In other words, this command will not affect other parts of the CUBLOC system.

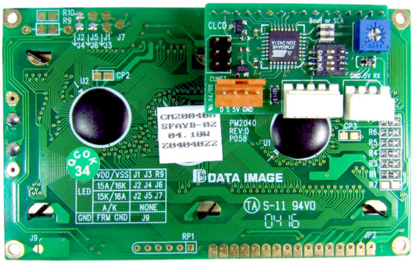
Chapter 7 CUBLOC Display Library

With CUBLOC, you can easily control LCD through Comfile LCD products such as the GHLCD or CLCD. Drawing lines, circles, boxes and printing strings can be done with single line of code. Below are some of our LCD specifications that will aid the user in understanding the basics.

Character LCD : CLCD

CLCD is a blue-screen LCD that can print characters and numbers. A control board that receives serial data and outputs to the LCD is attached to the back of the CLCD.





CLCD receives data through the I2C communication protocol.

.

Set Display

SET DISPLAY type, method, baud, buffersize

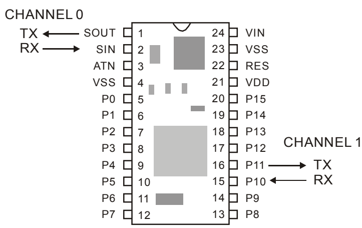
type	*: 0=RS232LCD, 1= GHB3224, 2=CLCD*
Method	*: Communication Method 0=CuNET, 1=RS232 CH1*
baud	*: Slave Address when Method = 0* *Baudrate when Method = 1*
Buffersize	*: Send Buffer Size (up to 128)*

This command SET DISPLAY can be used to set the settings for display. It can only be used once. All displays will communicate using method set here.

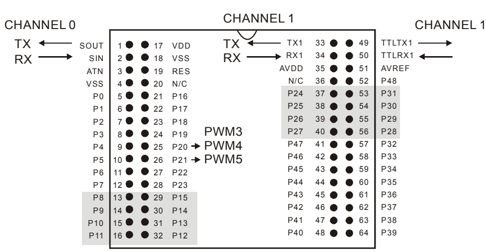
Please choose the type of LCD, the method, baud rate, and buffer size.
CLCD will use Method 0.

Method = 1 (RS232 Channel 1)

Use RS232 Channel 1 for display. For the CB220, port 11(TX) is used.



For the CB280, pin 33 or pin 49 can be used. Pin 49 outputs 12V level signal and 33 outputs 5V level signal.



The possible Baud Rate settings are as follows:

2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 76800, 115200, 230400.

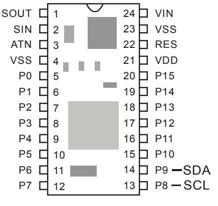
The recommended buffer size is around 50 to 128. If the send buffer size too small, data will not be displayed correctly. If the send buffer size is too big, it will take up that much data memory space.

```
SET DISPLAY 0,1,19200,50 ` Set Baud rate to 19200 and
                          ` send buffer to 50..
```

SET DISPLAY command can only be used once at the beginning of the program.

Method = 0 (Use CuNET)

CuNET is a type of I2C protocol that is part of CUBLOC.
For CB220 , use I/O Port 8 (Clock) and Port 9 (Data).



CuNET can be used with displays that support it. CuNET does not used Baud Rate Settings, it uses slave address settings instead.

SET DISPLAY 2,0,1,50 'CLCD, Slave address of 1, Send buffer of 50

Although multiple devices can be connected to the I2c, for displays, **only ONE device may be attached.**

Cls

Initialize the LCD and clear all layers.
(Set a little bit of delay for the LCD to initialize.)

```
CLS
DELAY 200
```

Csron

Turn Cursor ON. (Default if OFF).

Csroff

Turn Cursor OFF.

Locate

LOCATE x,y

X : X-axis position of LCD
Y : Y-axis position of LCD

Set the position of the text layer. After the CLS command, the LCD defaults to position 0,0.

```
LOCATE 1,1    ` Move cursor to 1,1
PRINT "COMFILE"
```

Print

PRINT String/Variable

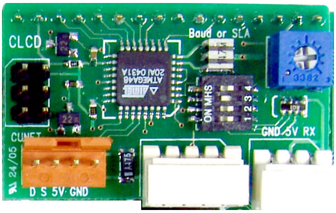
String : String
Variable : When using variables/constants,

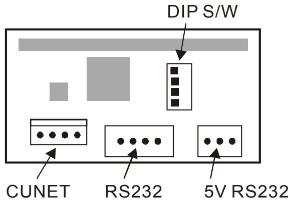
String representation of the variable/constant will be printed.
Print characters on the text layer. To print characters to the graphic layer, GPRINT command can be used.

```
LOCATE 1,1    ` Move to position 1,1
PRINT "COMFILE",DEC I
```

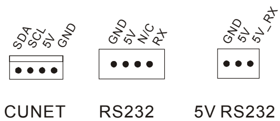
CLCD Module

On the back of the CLCD, a control board is attached. This control board receives CuNET signal and prints on the CLCD.

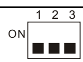
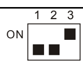
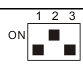
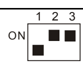
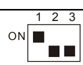
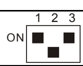
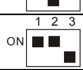
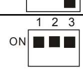




CLCD can also communicate using RS232. There are two RS232 connector, one for 3-pin 5V level signals and the other for 4-pin +/- 12V level signals.



Use the CLCD DIP switch to set the I2C slave address. The 4th DIP switch is not used.

DIP Switch	RS232 Baud rate	I2C Slave Address
	2400	0
	4800	1
	9600	2
	19200	3
	28800	4
	38400	5
	57600	6
	115200	7

One of CUNET or RS232 communication can be used. If both are connected, please make sure when one of them is working, other is not.

The following is CLCD command table:

Command	Example (hex)	Bytes	Execution Time	Explanation
ESC ' C'	1B 43	2	15mS	Clear screen. A 15ms delay must be given after this command.
ESC 'S'	1B 53	2		Cursor ON (Default)
ESC 's'	1B 73	2		Cursor OFF
ESC 'B'	1B 42	2		Backlight ON (Default)
ESC 'b'	1B 62	2		Backlight OFF
ESC 'H'	1B 48	2		LOCATE 0,0
ESC 'L' X Y	1B 4C xx yy	4	100 uS	Change the position of the cursor.
ESC 'D' 8byte	1B 44 Code 8bytes	11		Character code 8 through 15 is 8 custom characters that the user is free to create and use. This command will store the bitmap in this custom character memory area. Code : 8-15 Character code
1	01	1		Move to beginning of row 1
2	02	1		Move to beginning of row 2
3	03	1		Move to beginning of row 3
4	04	1		Move to beginning of row 4

If received data is not a command, the CLCD will display it on the screen.

When connecting RS232, maximum baud rate settings for 12V(4-pin) level is 38400bps. For TTL 5V level (3-pin), up to 115200bps can be used.

The following is an example code when using the CB280 to connect to the CLCD module through CUNET protocol. When you execute this program, CLCD will display increment of numbers.

```
Const Device = Cb280
Set Display 2,0,1,50  ` Set the SLAVE ADDRESS to 1 by
                      ` manipulating the DIP switch.
Dim i As Integer
Delay 100            ' Delay for start up of CLCD
Cls
Delay 200            ' Delay for initializing and clearing CLCD
```

```
Csroff
Locate 5,2
Print "Start!!!"
Delay 500
Cls
Delay 100
Do
      Incr i
      Locate 0,0
      Print "COMFILE"
      Locate 1,3
      Print "CUBLOC ",Dec i
      delay 100
Loop
```

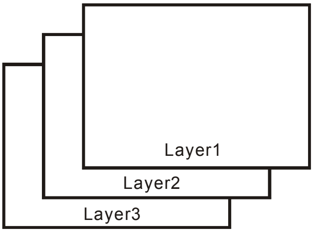
* The slave address of CLCD and SET DISPLAY command should match.

GHLCD Graphic LCD : GHB3224 Series

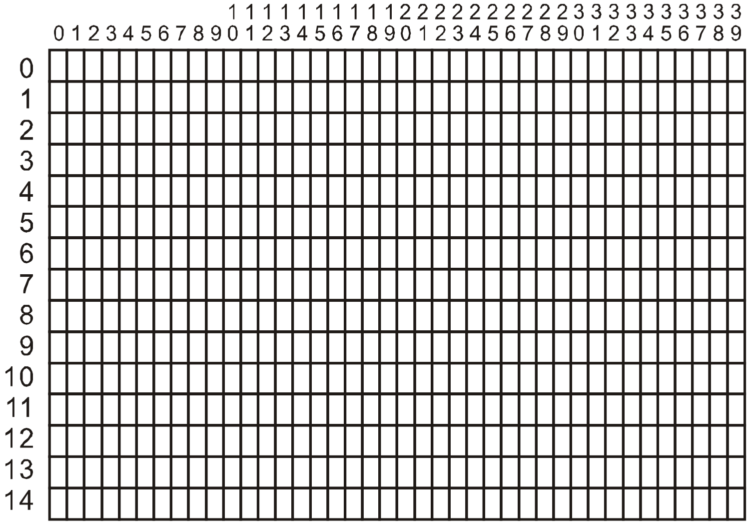
GHLCD is able to display characters and graphic on 3 different layers. Unlike our CLCD, the GHLCD supports many different commands for easy drawing of lines, circles, and boxes. There are also commands such as copy, cut, paste, and a graphic software CuCanvas for downloading BMP images to the GHLCD.

The GHB3224 model is a black and white STN type LCD with display area of 320 by 240 pixels. There are 3 layers. The first layer is for text and the other 2 layers can be used for graphics.

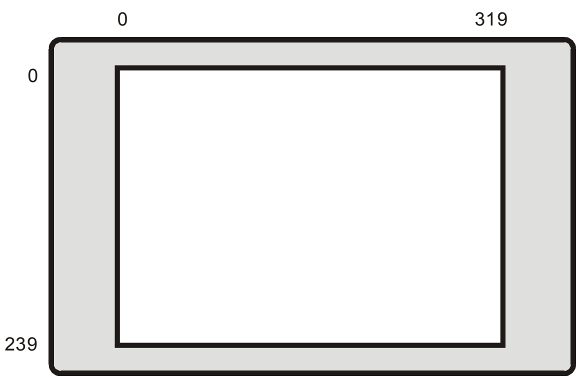
* GHLCD Library is 99% compatible with CUTOUCH modules.



The text layer size is 40x15 as you can see in the below grid. Each character size is 8 by 16.



For graphics, 320 by 240 pixels are provided for the GHLCD series.



Please note that graphics or characters will be printed in random places when trying to print outside the specified range of pixels shown here.
With the graphic layer, you have a complete control over where to display graphics over the 320 x 240 pixels.

With the text layer, you can display text over the specified text pixels of 40 by 15.

We recommend to draw the background in the graphic layer and to print characters in the text layer.

GHB3224C supports CuNET.

GHB3224C model support CuNET. When using CUBLOC, please use the GHB3224C model as you have one more RS232 port free to use for something else.

GHB3224C CuNET setup settings:

```
Set Display 1,0,1,50 'GHLCD, CUNET, Set Address to 1,
                     'Send buffer to 50..
```

*Warning : CUNET Slave address and Display Slave address must match. Display Slave address can be set with the DIP switch.

Cls

CLS

Initialize the LCD and clear all layers.
(Set a little bit of delay for the LCD to initialize.)

```
CLS
DELAY 200
```

Clear

CLEAR layer

Erase the specified layer(s).

```
CLEAR 1 ` Erase (Text) Layer 1.
CLEAR 2 ` Erase (Graphic) Layer 2.
CLEAR 0 ` Erase all layers.  Same as CLS.
```

Csron

CSRON

Turn Cursor ON.   (Default if OFF).

Csroff

CSROFF

Turn Cursor OFF.

Locate

LOCATE x,y

X : X-axis position of LCD
Y : Y-axis position of LCD

Set the position of the text layer. After the CLS command, the LCD defaults to position 0,0.

```
LOCATE 1,1  ` Move cursor to 1,1
PRINT "COMFILE"
```

Print

PRINT String / Variable

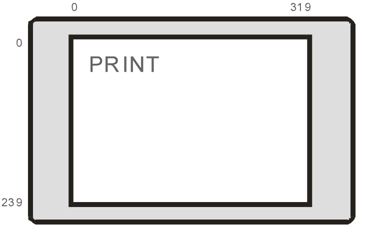
String : String

Variable : When using variables/constants,

String representation of the variable/constant will be printed.

Print characters on the text layer. To print characters to the graphic layer, GPRINT command can be used.

```
LOCATE 1,1   ` Move to position 1,1
PRINT "COMFILE",DEC I
```



Layer

LAYER layer1mode, layer2 mode, layer3 mode

Layer1mode : Set Layer 1 mode (0=off, 1=on, 2=flash)

Layer2mode : Set Layer 2 mode (0=off, 1=on, 2=flash)

Layer3mode : Set Layer 3 mode (0=off, 1=on, 2=flash)

Set the mode of the specified layer. The flash mode will flash the layer at 16Hz. Layer 1 and 2 are ON and Layer 3 if OFF when LCD is first turned ON.

Use this command to hide the process of drawing lines, circles, and etc… Set the layer OFF when drawing and set the layer ON, when you are finished drawing everything.

GLayer

GLAYER   layernumber

Layernumber : Set the graphic layer. (0,1,2)

There are 3 layers of GHLCD GHB3224 series. One of the layers may be used as graphic layer. Graphic commands such as LINE, CIRLCLE, and BOX can be used for the layer set a the graphic layer. Normally, Layer 1 is used for text while Layer 2 is used for graphics. Layers 2 and 3 have slight different characteristics. We recommend Layer 2 for graphics that require a lot of erasing.

Layer 1 can also be used as graphic layer. In this case, you can even erase text characters with graphic commands. To set Layer 3 to graphic layer, use command LAYER to turn Layer 3 ON to use Layer 3.

Overlay

OVERLAY   overmode

overmode : Logical Mode (0=or, 1=and, 2=xor)

This command Overlay determines the logic mode between Layer 1 and Layer 2.
Layer 1 is text and Layer 2 is graphics.
By using this command, the user can decided what to do when Layer 1 and Layer 2 are displaying on the same position. The default is XOR, which will invert when Layer 1 and Layer 2 print to the same positions. To no invert, you can set this to OR state.

Contrast

CONTRAST value

value : Contrast Value (1 to 1024)

Control the contrast of the LCD with CONTRAST command.

```
Contrast 450
```

Light

LIGHT value

value : Back light 0=OFF, 1=ON

Turn back light ON and OFF. Default is ON.

Font

FONT fontsize, efontwidth

fontsize : 0 to 8 Font Selection

efontwidth : 0 = fixed width, 1=variable width

GHB3224 has 4 different size and 2 different width.

Font Type	Font
0,1	10 x 16
2,3,4,5	16 x 16
6,7	24 x 24
8	48 x 48

```
Const Device = CB290
Cls
Delay 100
Font 0,0
Glocate 10,10
GPrint "FONT 0,0 :ABCDEFGHIJKLMN"
Font 2,0
Glocate 10,30
GPrint "FONT 2,0 :ABCDEFGHIJKLMN"
Font 6,0
Glocate 10,50
GPrint "FONT 6,0 :ABCDEFGHIJKLMN"
Font 8,0
Glocate 10,72
GPrint "FONT 8,0 "
Font 0,1
Glocate 10,120
GPrint "FONT 0,1 :ABCDEFGHIJKLMN"
Font 2,1
Glocate 10,140
GPrint "FONT 2,1 :ABCDEFGHIJKLMN"
Font 6,1
Glocate 10,160
GPrint "FONT 6,1 :ABCDEFGHIJ"
Font 8,1
Glocate 10,185
GPrint "FONT 8,1 "
```

Style

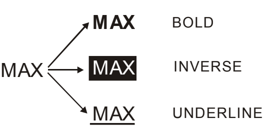
STYLE bold, inverse, underline

bold : 0=Normal, 2 or 3 =Bold

inverse : 0=Normal, 1=Inverse

underline : 0=Normal, 1=Underline

You can use STYLE command to add Bold, Inverse, or Underline to your fonts.



Cmode

CMODE value

value : 0=BOX type, 1=Underline type

Choose the type of cursor to use. Default is the Underline type.

■ 0 : BOX Type

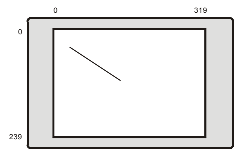
▁ 1 : Under Line Type

Line

LINE x1, y1, x2, y2

Draw a line from x1,y1 to x2,y2.

```
LINE 10,20,100,120 ` Draw line
```

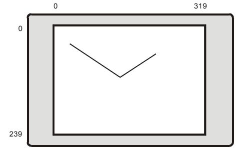


Lineto

LINETO x, y

Draw line from the last point to x,y.

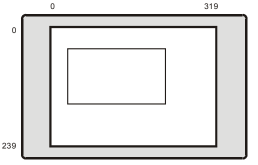
```
LINETO 200,50
` Continue drawing line from the last point
```



Box

BOX   x1, y1, x2, y2

Draw a box with diagonal positions of X1,Y1 and X2,Y2.

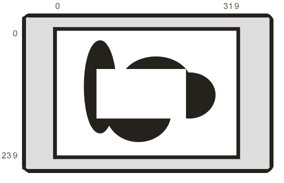



```
BOX  10,20,200,100   ` Draw box
```

Boxclear

BOXCLEAR   x1, y1, x2, y2

Clear the box with diagonal positions of X1,Y1 and X2,Y2.



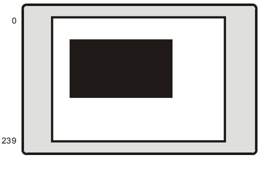

```
BOXCLEAR  10,20,200,100   ` Clear box
```

Boxfill

BOXFILL   x1, y1, x2, y2,logic

logic : 0=OR, 1=AND, 2=XOR

Draw a box with diagonal positions of X1,Y1 and X2,Y2 and fill according to specified logic.



0 OR will display all overlapped areas.
1 AND will display only the overlapped areas.
2 XOR will display the overlapped areas inversed.

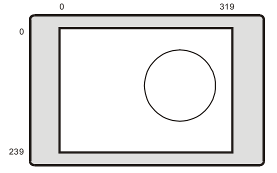
```
BOXFILL  10,20,200,100,0   ` Draw and fill box
```

Circle

CIRCLE   x, y, r

Draw a circle with center of circle at x,y, and r as radius.

```
CIRCLE  200,100,50  ` Draw circle
```

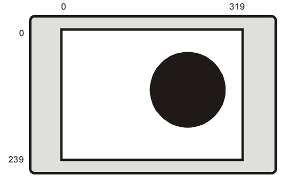


Circlefill

CIRCLEFILL   x, y, r

Draw a circle and fill with center of circle at x,y, and r as radius.

```
CIRCLEFILL  200,100,50
` Draw and fill circle
```

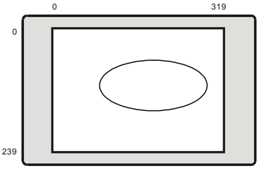


Ellipse

ELLIPSE   x, y, r1, r2

Draw an ellipse with center of circle at x,y, and r1 as horizontal radius and r2 as vertical radius.

```
ELLIPSE  200,100,100,50   ` Draw ellipse
```

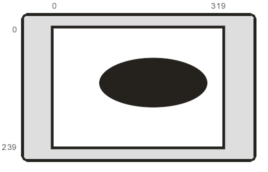


Elfill

ELFILL   x, y, r1, r2

Draw an ellipse and fill with center of circle at x,y, and r1 as horizontal radius and r2 as vertical radius.

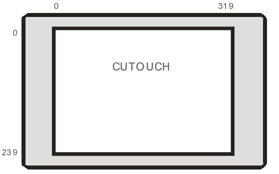
```
ELFILL  200,100,100,50
` Draw and fill ellipse
```



Glocate

GLOCATE x, y

Locate new position for the graphic layer.

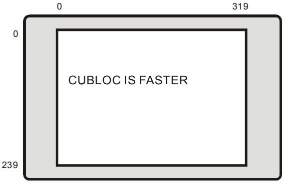



```
GLOCATE 128,32   ` locate new position
Gprint "CUTOUCH"
```

Gprint

GPRINT string

Print String on the graphic layer. You have more freedom in the graphic layer as you can use GLOCATE to specify exact position. Then you can use this command GPRINT to print a string at that location.



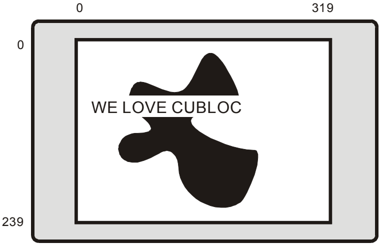

```
GPRINT "CUBLOC IS FASTER",CR
` Print String and go to next line(CR)
```

Dprint

DPRINT   string

DPRINT is similar to GPRINT except it will over-write the current graphics.

```
DPRINT "WE LOVE CUBLOC",CR ` Print String and go to next line
```



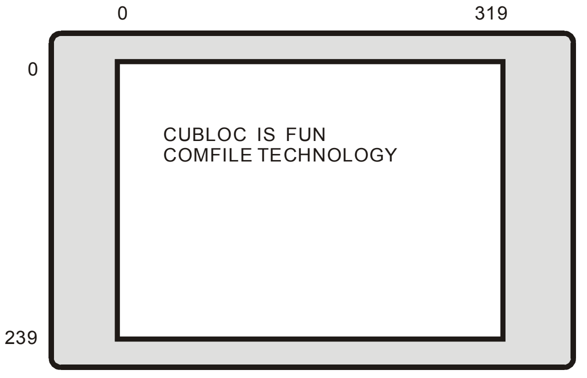
This command will allow a much faster printing speed as it will simply overwrite the background. When trying to display animations or numbers that change rapidly such as moving ball or current time, Dprint will allow smooth transitions.

Dprint can only be used with X-Axis that is multiple of 8.
For example, you can use Glocate 8,2 or Glocate 16,101.

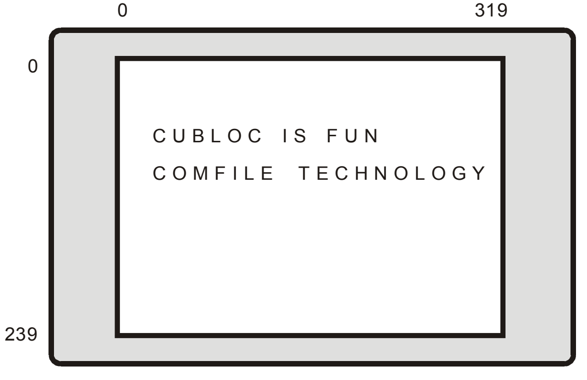
Offset

OFFSET x, y

You can set offset for the printed strings on the graphic layer. The default value is 0. You can control either the x or the y axis offsets.




```
OFFSET 3,3 ` Set x and y offset to 3.
```



After the command, the strings will automatically adjust to the new offsets.

Pset

PSET   x, y

Place a dot on x,y

```
PSET  200,100  ` Place a dot
```

Color

COLOR   value

Set the color of LCD.   1 is black and 0 is white.   Default value is 0.

```
COLOR  0  ` Set color to 0.
```

Linestyle

LINESTYLE   value

Set line style using this command.   You can make dotted lines by increasing the value.   The default value is 0, a straight line.

```
LINESTYLE 1  ` Use dotted lines
```

Dotsize

DOTSIZE   value, style

Set the dot size.   Value is the size of the dot and style can either be 0 for rectangular or 1 for circular dot.

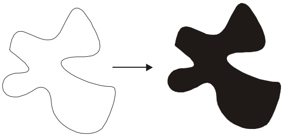
```
DOTSIZE 1,1  ` Set dot size to 1 and dot type to circle
```

Paint

PAINT   x, y

Fill the enclosed area within position x,y.

```
PAINT 100,100   ` Fill the enclosed area
within 100,100
```

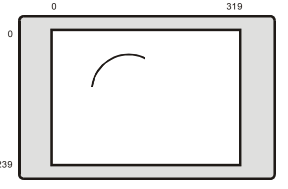


Arc

ARC   x, y, r, start, end

Draw an arc with x and y as the center. Start and end are the values between 0 and 360 degrees.

```
ARC 200,60, 100, 10, 20   ` Draw an arc
from 10 to 20 degrees.
```



Defchr

DEFCHR   code, data

Code : Custom character code (&hdb30   to   &hdbff)

Data : 32byte bitmap data

Create custom characters using this code. A character of size 16 by 16 can be created and stored in the LCD memory. Then the character can be used just like any other regular character using the command PRINT or GPRINT, DPRINT. Total of 207 custom characters can be stored in the memory.
At power off, the characters are not preserved.

```
DEFCHR &HDB30,&HAA,&HAA,&HAA,&HAA,&HAA,&HAA,&HAA,&HAA,_
      &HAA,&HAA,&HAA,&H55,&HAA,&HAA,&HAA,&HAA,_
      &HAA,&HAA,&HAA,&HAA,&HAA,&HAA,&HAA,&HAA,_
      &HAA,&HAA,&HAA,&HAA,&HAA,&HAA,&HAA,&HAA

print CHR(&HDB30)
```

Bmp

BMP   x, y, filenumber, layer

X, y : x,y position to display BMP

Filenumber : BMP File number

Layer : Layer to display BMP

GHB3224has FLASH memory to store BMP files. Use the BMP Downloader to download BMP files. Once BMP files are stored in the LCD, you can simply use this command BMP to print to the LCD.

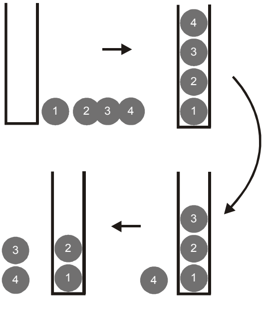
*The GHB3224 has 102,400 bytes of Flash memory space to store BMP files.
You can store about 10 of 320x240 full screen size files.

Graphic Data PUSH, POP Commands

On the GHB3224 series, there is a separate stack for storing graphic data. You can push and pop current screen or part of the current screen to this stack. By storing to the stack, you can easily implement a copy, cut, and paste feature, similar to text editors.
GPUSH and GPOP can be used for precise cutting of the current screen while HPUSH and HPOP can be used for high speed push and pop.

The stack is a LIFO (Last in First out) that will pop the last data that was pushed.

There is about 32KB of Stack memory. You can store about 3 to 4 full screens. Please refer to the picture below for how the stack works:

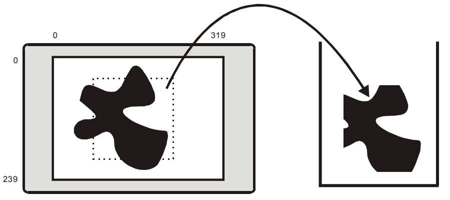


Gpush

GPUSH   x1, y1, x2, y2, layer

Push x1,y1 to x2, y2 box to the stack.

```
GPUSH 10,20,200,100,2
```



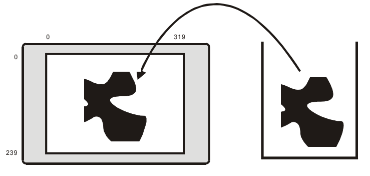
Gpop

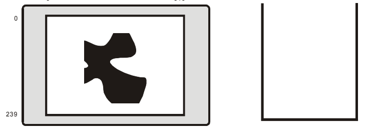
GPOP   x, y, layer, logic

logic =0 : OR
logic =1 : AND
logic =2 : XOR
logic =3 : Clear screen then pop

Pop from stack and display on the specified layer at position x,y with specified logic.

```
GPOP 120,20,2,0
```

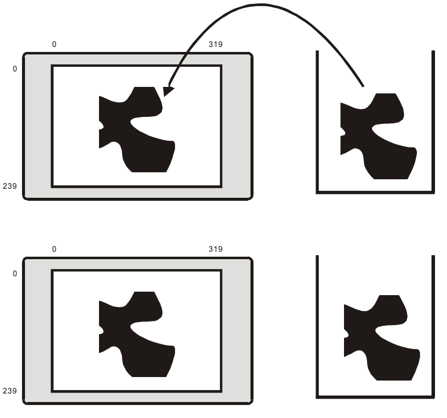




Gpaste

GPASTE   x, y, layer, logic
logic =0 : OR
logic =1 : AND
logic =2 : XOR
logic =3 : Clear screen then pop

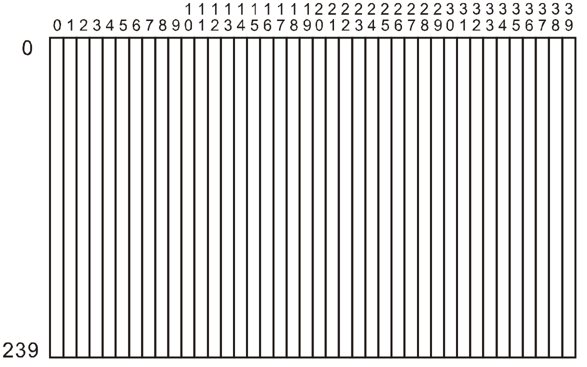
Paste from stack and display on the specified layer at position x,y with specified logic.
This is exact same command as GPOP except it will not pop from stack. Therefore, you can use this command if there is further need to use the current item in stack.



Hpush

HPUSH   x1, y1, x2, y2, layer

HPUSH, HPOP, HPASTE commands are similar to GPUSH, GPOP, and GPASTE except that the columns can only be multiple of 8 as shown below:
*The 320 pixels have been divided by 8, there are only 40 columns, each 8 pixels wide.




```
HPUSH 6,20,12,100,2
```

Hpop

HPOP   x, y, layer

Same as GPOP, except x value is 0 to 39.

```
HPOP 10,20,2,0
```

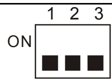
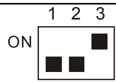
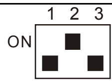
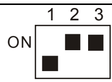
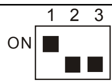
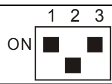
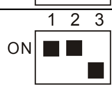
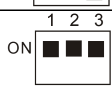
Hpaste

Hpaste   x, y, layer,

Same as GPASTE except x is between 0 and 39.

GHB3224C DIP Switch Settings

On the back of the GHB3224B, there are DIP switches to set the RS232 baud rate and I2Cslave address. GHB3224 DIP Switch number 4 is not used.

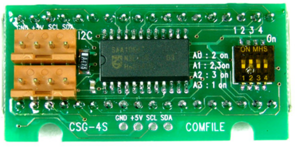
DIP Switch	RS232 Baud Rate	I2C Slave Address
	2400	0
	4800	1
	9600	2
	19200	3
	28800	4
	38400	5
	57600	6
	115200	7

Please choose one communication method to use at a single time. (Either CuNET or RS232)

Seven Segment Display : CSG Series

The seven segment display can be used to display numbers. 8 LEDs are used for most seven segment displays as shown below.

To incorporate a seven segment display into products, in the past, people had to create a dynamic display method that is very complicated for the average user. To simplify the matter, we have developed an easy to use seven segment display called the CSG module.



As you can see above, the front has 4 digit seven segment display and the back has two I2C connections. After connecting the CSG to CUBLOC, you can use the commands in the below table to easily and quickly display numbers you want.

Command	Explanation	Example Usage
CSGDEC SlaveAdr, Data	Output decimal value.	CSGDEC 0, I
CSGHEX SlaveAdr, Data	Output hex as decimal value	CSGHEX 0,I
CSGNPUT SlaveAdr, Digit, Data	Control digit places	CSGNPUT 0,0,8
CSGXPUT SlaveAdr, Digit, Data	Control digit places and output data as binary number	CSGNPUT 0,0,9

Csgdec

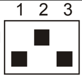
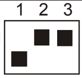
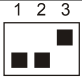
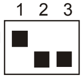
Use CSGDEC command to print decimal values to the SGN.

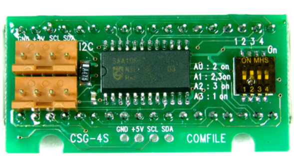
```
Const Device = cb280
Set I2c 9,8          '←-- must be used before csgdec command
b=8
Do
        Csgdec 0,b    '←-- csgdec command
        Delay 100
        b = b + 1
        If b=0 Then b=200
Loop
```

To use CSG commands,
SET I2C command must be used beforehand.

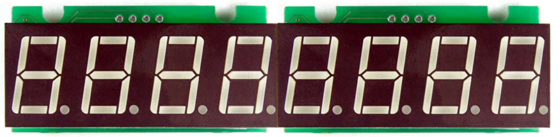
Slave Address

Set the slave address of the CSG module at the back. 0 to 3 can be set. A total of 4 addresses can be set per I2C line pair.
CSG Dip switch:

DIP Switch	Slave Address
1 2 3 ON 	0
1 2 3 ON 	1
1 2 3 ON 	2
1 2 3 ON 	3



To display more than 4 digits, use 2 CSG modules like shown below and set different slave addresses for each.



Csgnput

CSGNPUT   slaveadr, digit, data

slaveadr : CSG module Slave Address

digit : Digit position (0 to 3)

data : Data (&h30 to &h39, &h41 to &h46)

&h30 is print "0"
&h31 is print "1"
:
&h39 is print "9"
&h41 is Print "A"
&h42 is Print "b"
:
&h46 is Print "F"

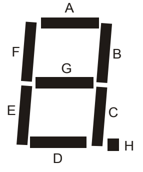
Display the desired number to the specified CSG module. DATA most upper bit is for setting the DOT of the CSG.

You can use &H30 to 39 and &H41 to &H46 only.

Csgxput

CSGXPUT slaveadr, digit, data
slaveadr : CSG module Slave Address
digit : Position (0 to 3)
data : Data

Set the LED ON at the specified position. When displaying anything other than numbers, this command can be used to control each position of the LED itself.



Bit	7	6	5	4	3	2	1	0
LED	H	G	F	E	D	C	B	A

To print character ‘L’, positions D, E, and F must be turned ON. Since the bit value would be 0011 1000, in hex that’s &H38 or 0x38.
CSGXPUT 0, 0, &H38 would be the exact command to use.

Csgdec

CSGDEC slaveadr, data
slaveadr : CSG Slave Address
data : Data

Print decimal value to the CSG.

Csghex

CSGHEX slaveadr, data
slaveadr : CSG Slave Address
data : Data

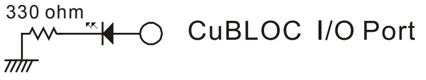
Print hexadecimal value to the CSG.

Chapter 8
Interface

Input/Output Circuits

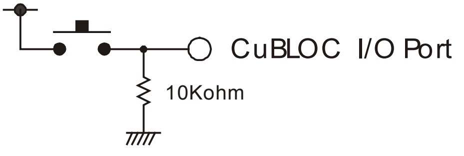
How to connect LEDs

Please connect the LED as shown below and output HIGH to the connected I/O port to turn the LED ON.



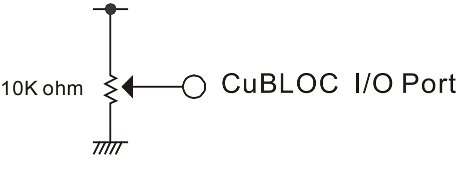
How to connect push-switches

Please connect the push-switch as shown below and set the connected I/O port to INPUT mode. When the switches in pressed, CUBLOC will read HIGH and when LOW otherwise.



How to connect Volume knob

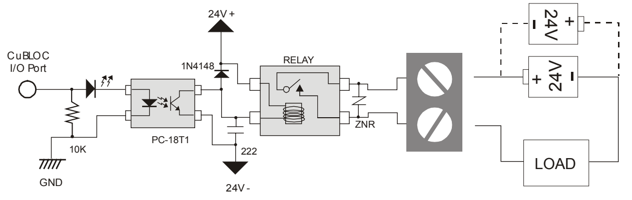
Please connect the Volume knob as shown below to a A/D I/O port and use ADIN command to read the input value of the Volume knob.



The CUBLOC core module uses 5V power. When using larger voltage, please use appropriate voltage converter or regulator.

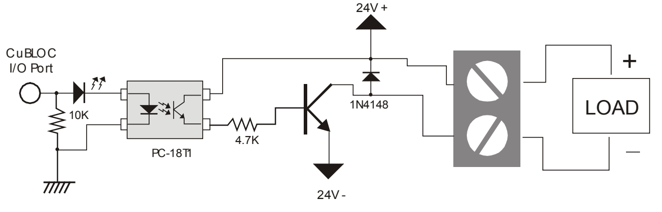
How to Connect a Output Relay.

The following diagram shows how to connect a output relay to a CUBLOC I/O port. A photocoupler can be used to separate 24V and 5V and protect against noise. Noise coming from 24V side will not affect the 5V side and vice versa.



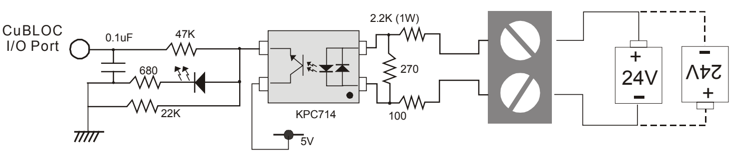
How to Connect a NPN TR Output

This circuit diagram shows a NPN TR photocoupler separating 5V from the LOAD.



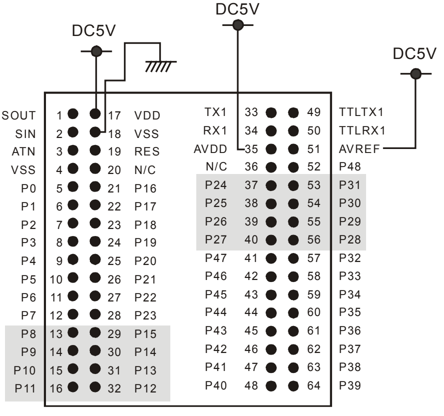
How to Connect DC24V Input

Use a double polarity photocoupler to convert 24V signals to 5V. When input is received, CUBLOC will receive a HIGH(5V) signal.



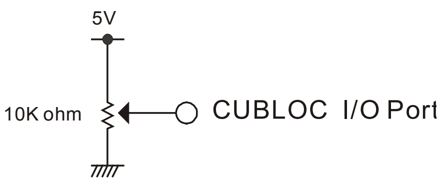
How to connect AD Input

To connect an AD input to the CB280, AVDD and AVREF pins must be connected to 5V. AVDD supplies power to the ADC of CUBLOC and AVREF is the reference voltage that the ADC uses to do conversions. If 5V is inputted to AVREF pin, 0 to 5V input voltage will be converted and if 3V is inputted to AVREF pin, 0 to 3V input voltage will be converted.

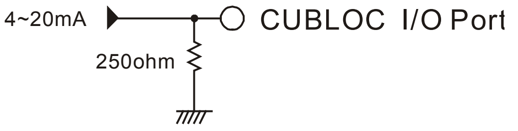


The CB220's AVDD and AVREF are internally connected to 5V.

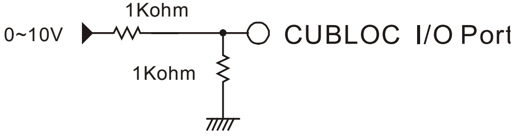
The following is the simplest type of AD input circuit using a Volume knob. When you turn the knob, the input will be converted by the CUBLOC ADC to a value from 0 to 1023



The following is AD input that receives 4 to 20mA of input. You can use a 230 Ohm and 20 Ohm resistors in serial instead of a 250 Ohm resistor.

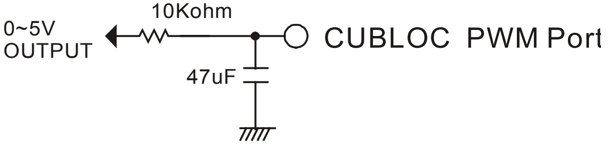


For 0 to 10V of input, use 2 resistors as shown below. This is also called a voltage divider.



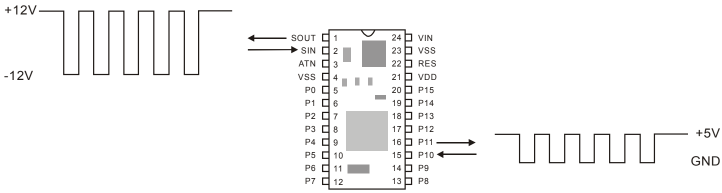
How to use PWM as Digital-to-Analog converter

CUBLOC has 6 PWM ports. If you use the simple circuit shown below, you can make a D/A converter.

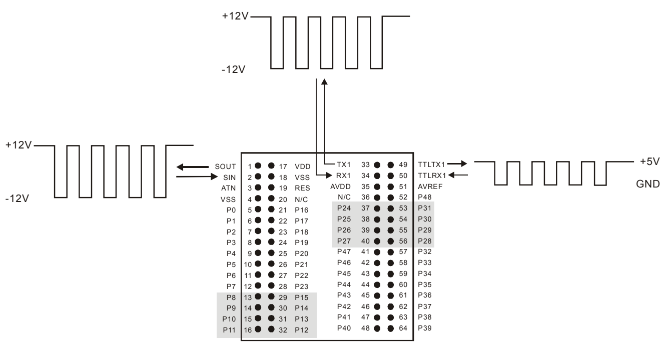


RS232 HOWTO

Pin 1 and 2 are for connecting to the +/- 12V signals of RS232 Channel 0 (Download port). The CB220 model has ports 10 and 11 for RS232 Channel 1 5V signals.



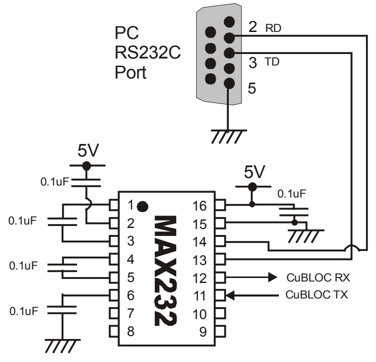
For CB280, there is are 5V and 12V signals for RS232C Channel 1.



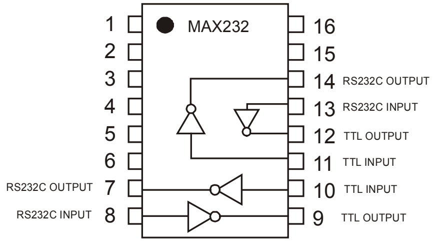
The reason for two 5V and 12V signal level exist is as follows. Since PC uses RS232 12V signals, we will need to make a separate circuit for converting to 5V signals for CUBLOC.
But since there are 12V signal outputs, the user doesn't have to worry about making a separate circuit.
For downloading to CUBLOC, it is very easy since you can connect a PC cable directly to pins 1 and 2. For RS422 and RS485 conversions, 5V signals are provided for RS232 Channel 1.

For CB280, 12V signals are provided for RS232 communication. Please be careful to use only one of the 5V or 12V connections at one time.

The following shows a simple circuit diagram of RS232 conversion from 12V to 5V signal using a MAX232 chip.



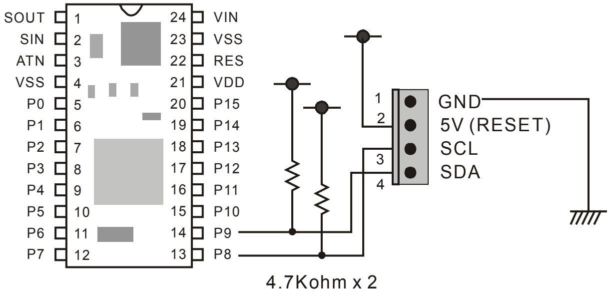
MAX232 is a very useful chip for converting between 5V and 12V of RS232 signals.



CuNET

CuNET is a communication protocol for CUBLOC peripherals such as CLCD, GHLCD, CSG modules. With just 2 pins, SCL and SDA, you can communicate with up to 127 devices simultaneously. CuNET uses CUBLOC's I2C protocol to communicate.

To use CuNET, please make sure to add pull up resistors(4.7K each) to the SCL and SDA lines. SCL and SDA pins are in a open-collector style, protecting against outside noise. It automatically removes pulses less than 50ns.

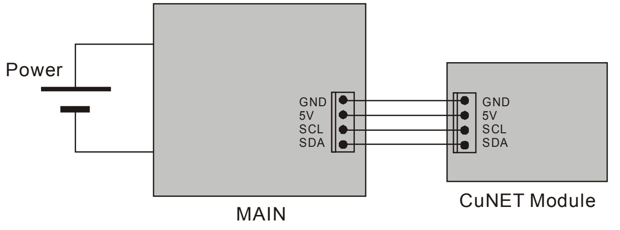


For using CuNET, the 4 pin connector's pin 1 must be connected to ground, pin 2 to 5V or RESET, pin 3 to SCL, and pin 4 to SDA. This 4 pin connector will be used as standard for CuNET communications.

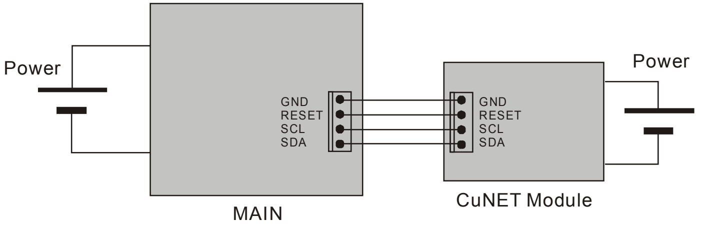
When using CuNET, the CUBLOC core module will act as the "master" and the device connected to as the "slave". All CuNET devices will respond to CUBLOC while in idle state.

CuNET operates in a Master-Slave mode. Slave cannot start communication with the master. For this type of communication, you must use PAD communication. PAD can receive inputs from other devices. Please refer to ON PAD command for detailed information.

CuNET device's connector's pin 2 connects to 5V of the main module:



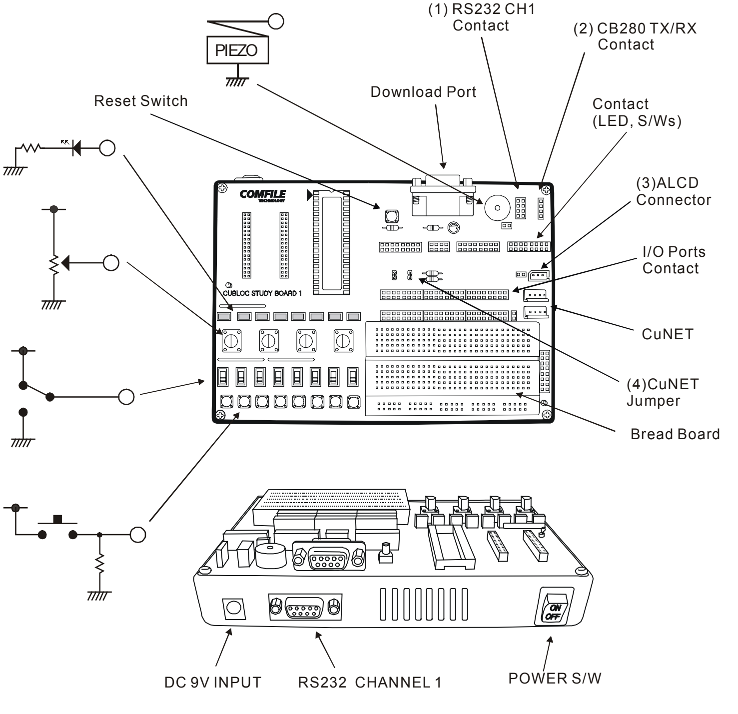
CuNET device's connector's pin 2 connects to RESET of the main module when power is supplied to the CUNET device. (Active LOW to RESET causes CUBLOC to reset)



CuNET lines can be used within 3 feet. For longer communications(up to about 1mile), you can use Phillips I2C Long distance interface chip. (P82B96 or P82B715)

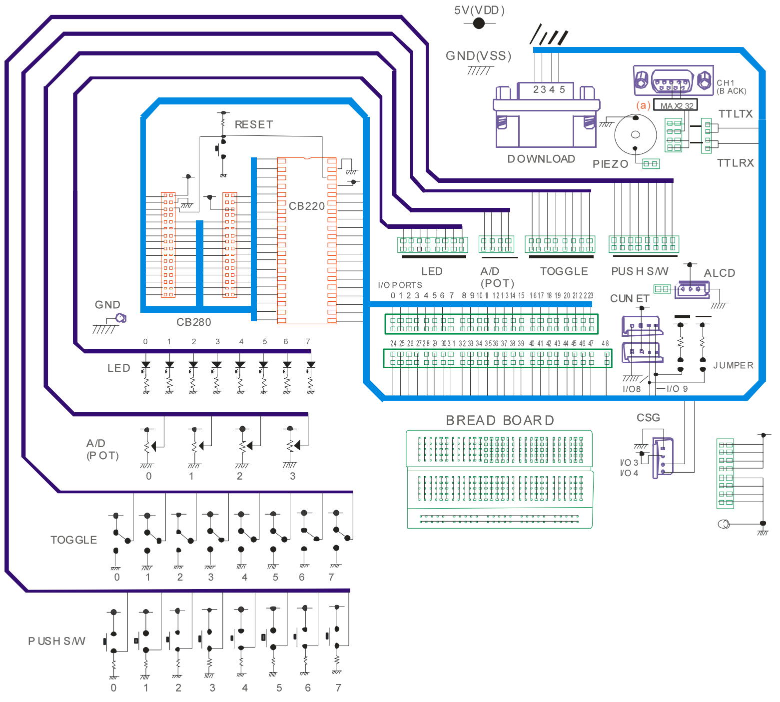
CUBLOC STUDY BOARD Circuit Diagram

Study board is especially for first timers and developers of CUBLOC. Simple experiments including switches, LED, RS232 communication, I2C, piezo, ADC, toggle switches, and LCDs are included. Communication protocol CuNET, I2C, and LCD connections are also provided.



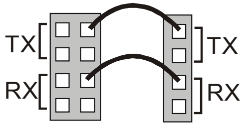
When 9V is inputted, the 5V regulator inside the Study Board will automatically provide 5V to the module and peripherals. DC Adaptor polarity can be used either way. For normal operation, please use a 9V adaptor with at least 200mA of current.

Cubloc Study board 1 Schematic



(1) RS232 Channel 1 Connection point : to use the RS232 Channel 1, please connect wires to the appropriate pin input on the upper right hand corner labeled RS232C.

(2) For CB280, connect RS232 Channel 1 as shown below:



(3) For using CuNET, all jumpers must be shorted. If using pin 8 and 9 directly, please leave all jumpers to open state.

About I2C...

CUBLOC provides easy set of commands to communicate using I2C protocol. I2C communication is a widely used protocol, mainly used for communicating with ADC, EEPROM, DAC, External I/O chips.

I2C uses two lines, SDA and SCL, and operates in either MASTER or SLAVE mode. CUBLOC can only be used as a MASTER.

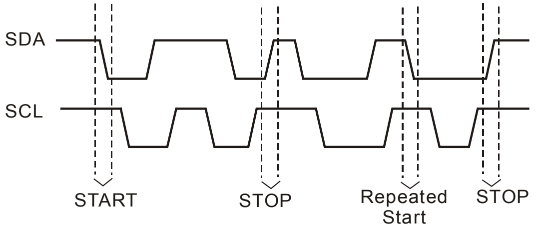
Please make sure to use command SET I2C before using I2C commands.

I2C's START, STOP

When SCL(Clock) and SDA(Data) are HIGH, I2C is in idle state. If START command is executed during idle state, I2C begins.

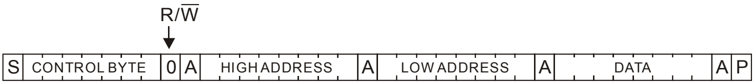
When SCL and SDA are both LOW, I2C is in busy state. If STOP command is executed during busy state, I2C stops.

There is also a Repeated Start in I2C. If START command is executed during busy state, I2C Restarts.



Using EEPROM through I2C

We will go through an example showing I2C communication between CUBLOC and EEPROM 24LC32. The following is a picture taken from the EEPROM's data sheet. It shows how to send data to the EEPROM.



S : Start
A : Acknowledge
P : Stop

The first bit is for Start command. The 4 upper bits of CONTROL BYTE must be 1010 and the 3 lower bits are for selecting the Chip's address. The user may change the EEPROM chip's address by configuring the chip.

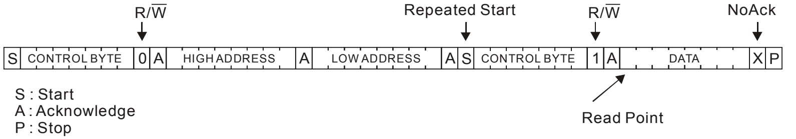
For a read, 1 can be written for R/W and for a write, 0 can be written for R/W. A is for acknowledgement of the 8 bits(1 byte) sent. Then HIGH ADDRESS, LOW ADDRESS and DATA can be sent. When all data are sent, Stop command can be sent.

It takes about 5ms of time for EEPROM write.

The following is a write EEPROM sequence in CUBLOC's BASIC code:

```
Set I2c 8,9           ' Set P8 as SDA, P9 as SCL
I2cstart
If I2cwrite(&H10100000) = 1 Then ERR_PROC       ' Chip Address = 0
If I2cwrite(ADR.BYTE1)  = 1 Then ERR_PROC       ' ADDRESS WRITE
If I2cwrite(ADR.LOWBYTE)  = 1 Then ERR_PROC
If I2cwrite(DATA)  = 0 Then ERR_PROC            '1 Byte WRITE
I2cstop
Delay 5               '  Wait until WRITE is done
```

Next, we will look at how to read 1 byte from the EEPROM. Although it might look more complex than writing 1 byte, we will soon find out that they are very similar.



Read Point is where the actual DATA will be read from the EERPOM. The front part of the command is for setting the address to read data.

```
Set I2c 8,9
I2cstart
If I2cwrite(&H10100000) = 1 Then ERR_PROC       ' Chip Address = 0
If I2cwrite(ADR.BYTE1) = 1 Then ERR_PROC        ' ADDRESS WRITE
If I2cwrite(ADR.LOWBYTE) = 1 Then ERR_PROC
I2cstart                                        ' Repeated Start
If I2cwrite(&H10100001) = 1 Then ERR_PROC       ' Read command..
DATA = I2cread(0)                        ' Result store in DATA.
I2cstop
```

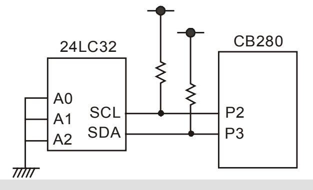
And now, we will look at how to read multiple data from the EEPROM. Without using the STOP command, we can keep reading from the EEPROM since it automatically increments its address.
In this way, we can set the address to read from only once, and then read the rest of the data much faster.

```
Set I2c 8,9
I2cstart
If I2cwrite(&H10100000) = 1 Then ERR_PROC       ' Chip Address = 0
If I2cwrite(ADR.BYTE1) = 1 Then ERR_PROC        ' ADDRESS WRITE
If I2cwrite(ADR.LOWBYTE) = 1 Then ERR_PROC
I2cstart                                 ' Repeated Start
If I2cwrite(&H10100001) = 1 Then ERR_PROC       ' Read command..
For I = 0 To 10
       ADATA(I) = I2cread(0)            ' Read 10 bytes continuously,
                                   ' ADATA is an array
Next
I2cstop
```

I2c example

The following example shows CB280 and EEPROM 24LC32 connected. A value will be written to a specified address of the EEPROM and then read back to display on the DEBUG window of CUBLOC Studio.

```
        Const Device = cb280
        Dim adr As Integer
        Dim data As Byte
        Dim a As Byte
        data = &ha1
        adr = &h3
        Set I2c 3,2
        Do
                ` Write 1 Byte
                I2cstart
                If I2cwrite(&b10100000)= 1 Then Goto err_proc
                a=I2cwrite(adr.byte1)
                a=I2cwrite(adr.lowbyte)
                a=I2cwrite(data)
                I2cstop
                Delay 1000
                ` Read 1 Byte
                I2cstart
                a=I2cwrite(&b10100000)
                a=I2cwrite(adr.byte1)
                a=I2cwrite(adr.lowbyte)
                I2cstart
                a=I2cwrite(&b10100001)
                a=I2cread(0)
                I2cstop
                ` Print Results
                Debug Hex a,cr
                Delay 500
        Loop

err_proc:
        Debug "Error !"
        Do
        Loop
```



More About I²C... (Advanced)

I²C is a common protocol used by many industrial controllers today. CUBLOC uses I²C as one of its main communication protocols.

CuNET is built on the I²C protocol. The main advantage of CuNET is that it's hardware controlled for LCD displays. (Not CSG modules or I/O ports)

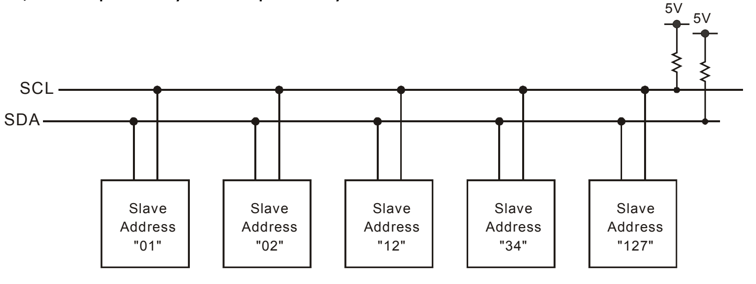
I²C commands such as I2CWRITE and I2CREAD are software commands. The advantage of I²C commands is that it does not require receive interrupts like serial communications. This allows the CUBLOC to multi-task, not letting any situations where the processor can "freeze" indefinitely.

As a result, a CUBLOC CB280 module can interface with almost 24 separate I2C buses! (That's buses, you can add multiple I²C device per I²C bus!)

The CUBLOC simulates a Master I²C device. Since it can only simulate a Master I²C device, the I²C devices connected must be Slave I²C devices.

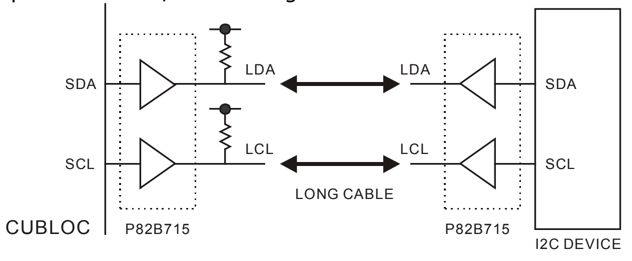
The main advantage of I²C protocol is that it does not cause any delays as CUBLOC is the Master I²C devices. CUBLOC can simply request for data when it wants to, it does not have to wait for the I²C Slave device to respond.

*Note: The I/O port used for I²C communication must be an Input/Output port, not Input Only or Output Only.

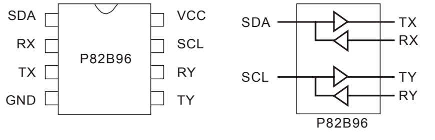


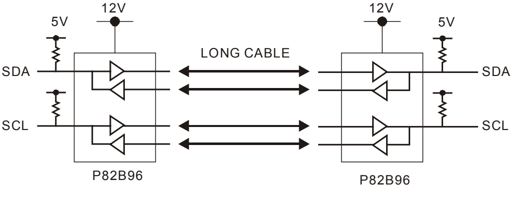
Even though maximum range for typical I²C bus is around 12 feet, a long distance extender chip such as the P82B715 can be used to extend the bus almost up to 3/4 mile. P82B96 can also be used as buffer to protect the I2C devices in case of electrical surges and interferences.

Extend up to about of 3/4 mile using the P82B715.



By using the P82B96, ground and power can be isolated on the device ends.

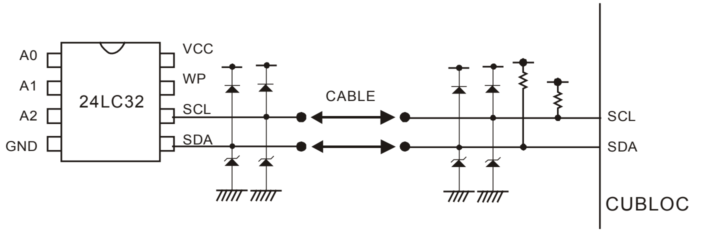




Please refer to Phillips website for more information on the specific chips discussed here: http://www.standardics.nxp.com/.

If you are using I²C interface **within 12 feet**, we recommend to use the following protection circuit:

If the I²C devices are connected with no buffers, electrical interference can cause damage to either CUBLOC or the I²C Slave device. By using diodes as shown below, you can protect against most of the electrical interference. If the devices are in a heavy, industrial environment, we recommend to use P82B96 chips as buffers.



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Chapter 9
MODBUS

About MODBUS…

MODBUS is a protocol developed by MODICON to help interface peripherals for their PLCs.

It is usually used with devices like Touch screens, HMI devices, and SCADA software. A lot of Touch screen panels, HMI and SCADA software now days support MODBUS.

In MODBUS, there is Master and Slave mode. The Master provides data while the Slave receives the data. The slave can only respond to master and cannot communicate on its own.

Each slave has a unique address called Slave Address. The Master, using those Slave Addresses, can talk to one of the slaves at a time.

For 1 to 1 connections, RS232 can be used. For 1 to N connections, RS485 can be used.
The master sends messages in units of "Frames". Each Frame contains the Slave address, command, Data, Error Checksum codes. Slave receives a Frame and analyzes it. When responding to the Master, Slave also sends in "Frames".

In other words, MODBUS send and receive can be seen as composed of Frames that are sent and received.

There are two types of MODBUS, ASCII and RTU. RTU type can be implemented by using less bytes in the communication.
ASCII use LRM for error checking and RTU uses CRC.

The next is how ASCII and RTU are used:

Field	Hex	ASCII	RTU
Header		: (colon)	None
Slave Address	0X03	0 3	0X03
Command	0X01	0 1	0X01
Start Address HI	0X00	0 0	0X00
Start Address LO	0X13	1 3	0X13
Length HI	0X00	0 0	0X00
Length LO	0X25	2 5	0X25
Error Check		LRC (2 Bytes)	CRC(2 Bytes)
Ending Code		CR LF	None
Total Bytes		17 Bytes	8 Bytes

ASCII type uses a colon (:) to start and ends with CR or LF.

START	SLAVE ADR	FUNCTION	DATA	LRC	END
: (COLON)	2 Bytes	2 Bytes	n Bytes	2 Bytes	CR,LF

RTU requires no special characters to start and finish. It uses 4 bytes of blank space to indicate start and finish.

START	SLAVE ADR	FUNCTION	DATA	CRC	END
T1-T2-T3-T4	1 Byte	1 Byte	N Bytes	2 Byte	T1-T2-T3-T4

CUBLOC supports MODBUS command & Address

CUBLOC supports MODBUS commands 1,2,3,4,5,6,15, and 16.

Command	Command Name
01, 02	Bit Read
03, 04	Word Write
05	1 Bit Write
06	1 Word Write
15	Multiple Bit Write
16	Multiple Word Write

In MODBUS, there are addresses which stand for Registers in CUBLOC. CUBLOC's Registers P, M, F, C, T, and D can be accessed using the following table:

Bit Units		Word Units	
Address	Register	Address	Register
0000H	P		
1000H	M		
2000H	Not Used		
3000H	Not Used		
4000H	F		
		5000H	T
		6000H	C
		7000H	D
		8000H	WP
		9000H	WM
		0A000H	WF

Device Address...

The above table shows MODBUS device addresses. Device Addresses are used to identify different registers on the CUBLOC or CUTOUCH. Most Host equipment including CUBLOC, CUTOUCH, PC, and HMI will use the following rules:

Device Address	Modbus Address	Explanation
1…10000	Device Address – 1	Subtract one to get Modbus Address.
40001 … 50000	Device Address – 40001	Subtract 40001 to get Modbus Address.

Device Address after 40000 are word registers, meaning you can access 16-bits at one time.

Please refer to the below Device Address when using MODBUS with CUBLOC or CUTOUCH. Device Address here is shown in decimals. Earlier Modbus Addresses were in hexadecimals.

Bit Access (Coil, Input Status)	
Function Codes : 1,2,4,15	
Device Address (Decimal)	Data
1 to 128	P Registers
385 to 512	F Registers
4097 to 8192	M Register

Word Access (Holding/Input Registers)	
Function Codes : 3,4,6,16	
Device Address (Decimal)	Data
40001 to 41000	D Registers
41001 to 42000	T Registers
42001 to 43000	C Registers
43001 to 44000	WM Registers

Floating Device Addresses...

Please use the Device Addresses within the available number of registers in the module used.

For example, the CUBLOC CB280 has data registers from D0 through D99. There can only exist Device Addresses from 40001 to 40099. The rest of 400100 through 41000, the floating device addresses, are not to be used for future firmware updates, we ADVISE NOT to use them.

Function Code 01: Read Coil Status
Function code 02 : Read Input Status

This function code can read the bit status of PLC's Register. The following is an example of reading Registers P20 through P56 from Slave Address of 3.

Query:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X01	1	0 1	2
Start Address HI	0X00	1	0 0	2
Start Address LO	0X14	1	1 4	2
Length HI	0X00	1	0 0	2
Length LO	0X25	1	2 5	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

LRC is the 2's complement of 8-bit sum of all values except Colon, CR, and LF.

For the table above, 0x03 + 0x01 + 0x13 + 0x25 = 0x3C.

To fin d the 2's complement of 0x3C, we can write it in binary first.

0011 1100

Then we can invert the bits.

1100 0011

Then add one which is:

1100 0100 = 0xC4

LRC = 0xC4

ASCII	:	0	3	0	1	0	0	1	3	0	0	2	5	C	4	CR	LF
Hex	3A	30	33	30	31	30	30	31	33	30	30	32	35	43	34	13	10

Response to the query above is ..

Response:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X01	1	0 1	2
Byte Count	0X05	1	0 5	2
Data 1	0X53	1	5 3	2
Data 2	0X6B	1	6 B	2
Data 3	0X01	1	0 1	2
Data 4	0XF4	1	F 4	2
Data 5	0X1B	1	1 B	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

If you look at the response to the query, you can see that bit 20 through 27 makes one byte.

P20 is placed as LSB of Data 1 and P27 is placed as MSB of Data 1.
Likewise we can acquire all of P20 through P56 and the left over bits can just be disregarded.

Function Code 03: Read Holding Registers
Function Code 04: Read Input Registers

This function code can read 1 Word (16 bits), usually used for Counters, Timers, and Data Registers. The following shows an example that reads Slave Address 3's D Register 0 to 2.

Query:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X03	1	0 3	2
Start Address HI	0X70	1	7 0	2
Start Address LO	0X00	1	0 0	2
Length HI	0X00	1	0 0	2
Length LO	0X03	1	0 3	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

1 Word is has 2 bytes, so we are going to get 6 bytes total as response.

Response:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X03	1	0 3	2
Byte Count	0X06	1	0 6	2
Data 1 LO	0X03	1	0 3	2
Data 1 HI	0XE8	1	E 8	2
Data 2 LO	0X01	1	0 1	2
Data 2 HI	0XF4	1	F 4	2
Data 3 LO	0X05	1	0 5	2
Data 3 HI	0X33	1	3 3	2
Length LO	0X03	1	0 3	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

Function Code 05 : Force Single Coil

PLC's can remotely control the status of its Registers in units of bits through this function code. The following is an example showing Slave Address 3's P1 Register being turned ON.
To turn ON Registers, FF 00 is sent and to turn OFF Registers, 00 00 is sent.

Query:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X05	1	0 5	2
Start Address HI	0X01	1	0 1	2
Start Address LO	0X00	1	0 0	2
Length HI	0XFF	1	F F	2
Length LO	0X00	1	0 0	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

The response shows that the data was entered correctly.
You MUST use FF 00 and 00 00 to turn ON/OFF Registers, other values will simply be ignored.

Response:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X05	1	0 5	2
Start Address HI	0X01	1	0 1	2
Start Address LO	0X00	1	0 0	2
Length HI	0XFF	1	F F	2
Length LO	0X00	1	0 0	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

Function Code 06 : Preset Single Registers

PLC's can remotely control the status of its Registers in units of Words through this function code.
The following is an example showing Slave Address 3's D1 being written.

Query:

Field	RTU	Bytes	ASCII	Bytes
Header		1	: (colon)	1
Slave Address	0X03	2	0 3	2
Function Code	0X06	2	0 6	2
Start Address HI	0X70	2	0 1	2
Start Address LO	0X01	2	7 0	2
Length HI	0X12	2	1 2	2
Length LO	0X34	2	3 4	2
Error Check	CRC	2	LRC	2
Ending Code		2	CR LF	2

Response:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X06	1	0 6	2
Start Address HI	0X70	1	0 1	2
Start Address LO	0X01	1	7 0	2
Length HI	0X12	1	1 2	2
Length LO	0X34	1	3 4	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

Function Code 15: Force Multiple Coils

PLC's can remotely control the status of its Registers in units of multiple bits through this function code. The following is an example showing Slave Address 3's P20 through P30 being turned ON/OFF.

Query:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X0F	1	0 F	2
Start Address HI	0X00	1	0 0	2
Start Address LO	0X14	1	1 4	2
Length HI	0X00	1	0 0	2
Length LO	0X0B	1	0 B	2
Byte Count	0X02	1	0 2	2
Data 1	0XD1	1	D 1	2
Data 2	0X05	1	0 5	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

Below table shows how the DATA in the above query is divided. P27 is placed in the MSB of the first Byte send and P20 is placed in the LSB of the first Byte. There will be total of 2 bytes sent in this manner. Left over bits can be set to zero.

Bit	1	1	0	1	0	0	0	1	0	0	0	0	0	1	0	1
Reg.	P27	P26	P25	P24	P23	P22	P21	P20						P30	P29	P28

Response:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X0F	1	0 F	2
Start Address HI	0X00	1	0 0	2
Start Address LO	0X14	1	1 4	2
Length HI	0X00	1	0 0	2
Length LO	0X0B	1	0 B	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

Function Code 16 : Preset Multiple Registers

PLC's can remotely control the status of its Registers in units of Multiple Words at a time through this function code. The following is an example showing Slave Address 3's D0 through D2 being written.

Query:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X10	1	1 0	2
Start Address HI	0X70	1	7 0	2
Start Address LO	0X00	1	0 0	2
Length HI	0X00	1	0 0	2
Length LO	0X03	1	0 3	2
Byte Count	0X06	1	0 6	2
Data 1 HI	0XD1	1	D 1	2
Data 1 LO	0X03	1	0 3	2
Data 2 HI	0X0A	1	0 A	2
Data 2 LO	0X12	1	1 2	2
Data 3 HI	0X04	1	0 4	2
Data 3 LO	0X05	1	0 5	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

Response:

Field	RTU	Bytes	ASCII	Bytes
Header			: (colon)	1
Slave Address	0X03	1	0 3	2
Function Code	0X10	1	1 0	2
Start Address HI	0X70	1	7 0	2
Start Address LO	0X00	1	0 0	2
Length HI	0X00	1	0 0	2
Length LO	0X03	1	0 3	2
Error Check	CRC	2	LRC	2
Ending Code			CR LF	2

Error Check

If there is error in the data from the Master, Slave will send back an error code.

Field	Hex	ASCII	Bytes
Header		: (colon)	1
Slave Address	0X03	0 3	2
Function Code	0X81	8 1	2
Error Code	0X09	0 9	2
Error Check		LRC	2
Ending Code		CR LF	2

There are the following types of error codes:

Code	Error Name	Explanation
01	ILLEGAL FUNCTION	When a non-supported function code is received.
02	ILLEGAL DATA ADDRESS	When an incorrect address is received.
03	ILLEGAL DATA VALUE	When bad data is received.
09	LRC UNMATCH	When LRC is incorrect.

The error check is only for MODBUS ASCII, there are no error check in RTU. MODBUS RTU uses CRC to check for errors in transmission.

MODBUS ASCII Master Mode

There are no special commands to set CUBLOC to Master Mode for MODBUS communication. Master Mode simply needs to be able to use RS232 data communication using commands like CUBLOC's GET and PUT.

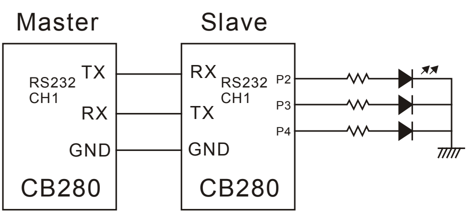
The following is an example of ASCII Master Mode implemented in CUBLOC BASIC:

```
'Master Source

Const Device = cb280
       Dim RDATA As String * 80
       Dim a As Byte, ct As Byte
       Dim b As String * 17
       Dim Port As Integer

       Opencom 1,115200,3,80,80
       On Recv1 Gosub GETMODBUS   ' Data Receive Interrupt routine
       Set Until 1,60,10          ' When Ending Code (10)
                                  ' on Channel 1 is discovered,
                                  ' create an interrupt
       Do
              For Port=2 To 4
                     BitWrite Port, 1    'Turn P0,P1,P2 ON!
                     Delay 100
              Next
              For Port=2 To 4
                     BitWrite Port, 0    'Turn P0,P1,P2 OFF!
                     Delay 100
              Next

       Loop

GETMODBUS:
       If Blen(1,0) > 0 Then      ' If buffer empty then
              A=Blen(1,0)         ' Store the buffer length in A!
              Debug "GOT RESPONSE: "
              B=Getstr(1,A)       ' Store received data in B
              Debug B
       End If
       Return

End
       Sub BitWrite(K As Integer, D As Integer)
              Dim LRC As Integer
              Putstr 1,":0305"
              Putstr 1,Hp(k,4,1)
```

```
            If D=0 Then
                  Putstr 1,"0000"
                  LRC = -(3+5+K.Byte1+K.Byte0)      'Calculate LRC
            Else
                  Putstr 1,"00FF"
                  LRC = -(3+5+K.Byte1+K.Byte0+0xFF) ' LRC
            End If
            Putstr 1,Hex2(LRC),13,10   'Send

      End Sub
```

MODBUS ASCII Slave Mode

```
` Slave Source
      Const Device = cb280
      Opencom 1,115200,3,80,80
      set modbus 0,3
      Usepin 2, Out
      Usepin 3, Out
      Usepin 4, Out
      Set Ladder On
```



When the Slave finishes processing the Data sent by the Master, the Slave will jump to the label GETMODBUS. We can use SET UNTIL command to check for ending code LF (10).

Then Getstr command is used to store all received data in RDATA.
The data in RDATA can be analyzed to verify if the communication was achieved soundly or not.

When the slave is not connected, the program will never jump to GETMODBUS.

MODBUS RTU Master Mode

The following is an example of RTU Master Mode implemented in CUBLOC BASIC to write 32-bit floating point values (2 Word Registers) to an RTU slave device 1:

```
Const Device = CB280
#include "crctable.inc"
'______________Open serial port for MODBUS________________________
'_________[Set Baudrate as 115200bps and 8-N-1 with]________________
'_________[receive buffer of 200 bytes and send buffer of 100 bytes]
Opencom 1,115200,3,200,100

'_________[Data Receive Interrupt routine]__________________________
On Recv1 Gosub GETMODBUS
'______________[Clear All Buffers]__________________________________
Bclr 1,2
'______________[User Timer for MODBUS Timeout]______________________
On timer(1) Gosub MyClock

Debug "__________[MODBUS FloatingPoint Value Write RTU Example]_____",Cr

'Test writing 32bit SINGLE to Register Address 0 of device 1
Debug "writing 3.14 and 6.99 Long value to register 0",Cr
writesingle 1,0,3.14
writesingle 1,0,6.99

'Example showing how to send multiple floating point variables
'by making a simple function as WriteMultipleSingle()
SDataArray(0)=1.11
SDataArray(1)=2.22
SDataArray(2)=3.33
Debug "Writing multiple Single values to address 0",Cr
writemultiplesingle 1,0,3
'-----------------------------------------------------------------
Do
Loop

'Modbus Receive routine
#include "ModbusRTUrecv.bas"
End

'Modbus Low-Level include file
#include "ModbusRTULib016.bas"
```

*Please check our Forum on the internet, www.cubloc.com for more Modbus ASCII and RTU examples and MODBUS BASIC include file downloads.

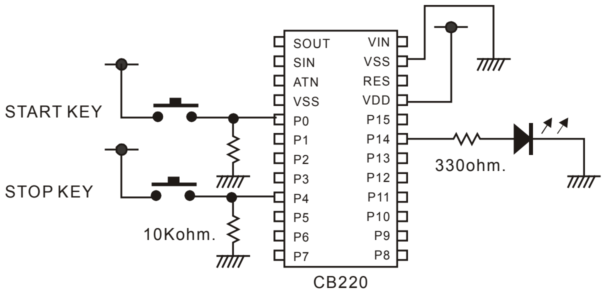
MEMO

Chapter 10 Application Notes

NOTE 1. Switch Input

Let’s say for example you are developing some kind of a machine, the first thing you need is a user interface. Our task today is to build a machine that will receive input from a switch and processes it to its assigned task..

We will make a START and STOP button that will light a lamp ON and OFF.

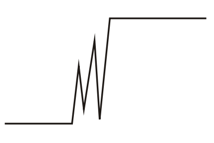


As you can see above, P0 and P4 ports will be connected to a pull-down resistor (resistor attached to ground). CB220 will read these switches as LOW or OFF when the switch is not pressed. To find out if these switches are pressed or unpressed, we can use CUBLOC BASIC command IN().

<Filename: startstopkey.cul>

```
Const Device = cb220

Dim a As Byte
Do
        If In(0) = 1 Then a = 1
        If In(4) = 1 Then a = 0
        Out 14,a
Loop
```

When the switch is pressed, a “bouncing” effect occurs from the switch’s mechanical spring.

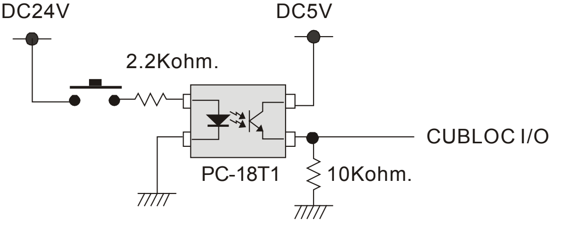


The above picture shows how bouncing can confuse CUBLOC controller by bouncing up and down. To get rid of this bouncing effect, a capacitor and resistor can be added to filter it out.
A simpler method is to use the command KEYINH() rather than IN() which will remove the bouncing effect by software.
<Filename: keyinhinput.cul>

```
Const Device = cb220

Dim a As Byte
Do
        If Keyinh(0,20) = 1 Then a = 1
        If Keyinh(4,20) = 1 Then a = 0
        Out 14,a
Loop
```

The 2nd parameter of KEYINH(0, 20) sets the time for removing the bouncing effect, also called debouncing time. In other words, the 20 means to wait 20ms before accepting input.

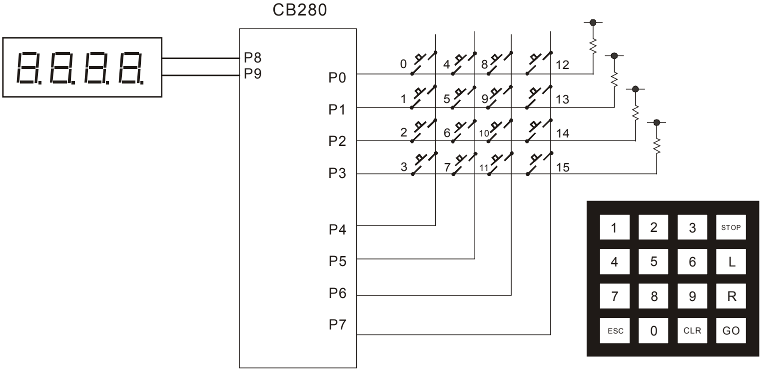
For the industrial field, there can be a lot of noisy environments where it can affect the switch signals. In order to block noise, the user can implement a circuit diagram similar to one shown below. By using a photocoupler, the user is able to raise the voltage and minimize the noise from affecting the switch.



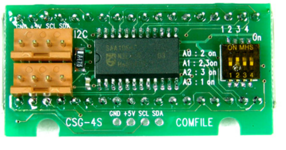
<END>

NOTE 2. Keypad Input

Application note 2 will cover a 4 by 4 Keypad by taking its input and outputting the results to a 4 digit 7 segment module (CSG module)



The CSG module is a 4 digit seven segment LED module that can be connected via CUNET or I2C protocol to display numbers and custom characters.



<Filename: csgprint.cul>

```
Const Device = CB280
Set I2c 9,8
Dim I As Byte
Do
        Csgdec 0,I
        I = I + 1
Loop
```

If you connect CUNET to CSG and execute the above program, the CSG module will show numbers that will count up.

The key matrix can be read easily through the command KEYPAD. If you look carefully at the keypad, you will see that scancode does not match the actual key pressed. In order to read the correct key, we will use a KEYTABLE before outputting the value to the CSG.

<Filename: keypadnum.cul>

```
Const Device = CB280
Set I2c 9,8
Dim I As Integer
Dim K As Integer

Const Byte KEYTABLE = (1,4,7,10,2,5,8,0,3,6,9,11,12,13,14,15)
Do
        I=Keypad(0)
        If I < 16 Then
                I = KEYTABLE(I)
                Csgdec 0,I
        End If
Loop
```

And now, we will make a simple program that receives input. When a number key input is received, it is displayed to the CSG module as a 4 digit number. The number is stored into the variable K, which is in BCD code. We then use the function BCD2BIN to convert the BCD value back into binary.

<Filename: num4in.cul>

```
Const Device = CB280
Set I2c 9,8
Dim I As Integer
Dim K As Integer
Dim M As Integer
K = 0
Const Byte KEYTABLE = (1,4,7,10,2,5,8,0,3,6,9,11,12,13,14,15)
Do
        I=Keypad(0)
        If I < 16 Then
                I = KEYTABLE(I)
                If I < 10 Then
                        K = K << 4
                        K = K + I
                        Csghex 0,K
                End If
                '
                '       WAIT UNTIL KEY DEPRESS
```

```
                    '
                    Do While Keypad(0) < 255
                    Loop
                    M = Bcd2bin(K)
                    Debug Dec M,CR
               End If
          Loop
```

When there is no input, the returned scancode is 255. By using Do While keypad(0) < 255, we will wait until a key is unpressed which will return a scancode of 255. This is to let the processor stop reading input while a key is pressed. Otherwise, the processor might receive multiple key inputs since execution time of CUBLOC is very fast.

By using _D(0) = M, you can pass the scancode value to Register D0 of Ladder Logic. If you need to use a keypad in LADDER, you can modify this code a little bit to get your results quick.

<END>

NOTE 3. Temperature Sensor

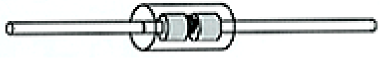
In our world today, there are countless number of devices that senses temperature. Refrigerator, heater, air conditioner, automobiles, and many other devices that uses temperature sensors. Therefore, this is one of the very basic components we must know.

What types of temperature sensors are there? There is PT100, NTC, PTC thermistor, and other chip-type sensors such as the DS1620.

Today, we will dive into the NTC thermistor and figure out how to connect and use it with CUBLOC.

The NTC thermistor can be comparable to a very sensitive resistor. Depending on the temperature, the value of resistance will change. By reading the value of this resistance, we can figure out the current temperature. Among NTC thermistors, the ceramic types can sense around -20 to 130 degrees Celcius temperature.

There is an NTC thermistor that resembles a diode. With this thermistor, we can sense between -30 and 250 degrees Celcius temperature.

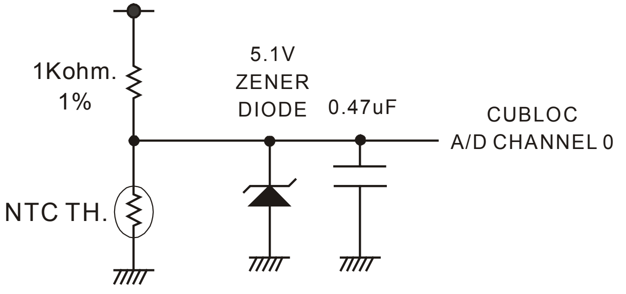


You can acquire R-T(Resistance – Temperature) conversion table from the maker of the thermistor. The following is a diode-type 10K Ohm NTC Thermistor R-T conversion chart and table.

Temperature	Minimum	Average	Maximum
0	31260.0	32610.0	33987.7
1	29725.7	30993.7	32286.7
2	28275.6	29466.8	30680.6
3	26904.5	28023.9	29163.6
4	25607.8	26660.0	27730.3
5	24381.0	25370.2	26375.7
6	23220.0	24150.1	25094.9
7	22120.9	22995.7	23883.7
8	21080.1	21903.1	22737.7
9	20094.1	20868.5	21653.3
10	19159.9	19888.7	20626.7
11	18274.4	18960.5	19654.6
12	17434.8	18080.8	18733.8
13	16638.5	17246.9	17861.4
14	15883.1	16456.1	17034.4
15	15166.2	15706.0	16250.4

16	14485.7	14994.4	15506.9
17	13839.6	14318.9	14801.5
18	13225.9	13677.7	14132.2
19	12642.8	13068.7	13496.9
20	12088.7	12490.3	12893.6
21	11561.9	11940.6	12320.7
22	11061.0	11418.2	11776.4
23	10584.6	10921.6	11259.2
24	10131.3	10449.3	10767.5
25	9700.0	10000.0	10300.0
26	9281.3	9572.5	9864.0

For connecting the sensor to the CUBLOC, please refer to the following circuit diagram. To protect against voltage surges, the Zener diode must be used.



As you can see in the circuit diagram, we will be using A/D (Analog-to-Digital) converter to read the current voltage flowing through the sensor. The A/D converter will convert the current voltage into a value between 0 and 1024.
The most important part of this application note is the following table which converts the value of voltage to A/D value between 0 and 1024. (Only some of the temperatures are shown.)

Temp	Resistance	Voltage	A/D value
-30	175996.6	4.971750865	1018
-29	165473.9	4.969965259	1018
-28	155643.6	4.968080404	1017
-27	146456.3	4.966091647	1017
-26	137866.4	4.963994167	1017
-25	129831.7	4.961782976	1016
-24	122313.4	4.959452909	1016
-23	115275.4	4.956998627	1015
-22	108684.3	4.954414614	1015
-21	102509.3	4.951695171	1014
-9	52288.3	4.90617073	1005
-8	49549.7	4.901087406	1004

-7	46970.5	4.895769279	1003
-6	44540.6	4.890207868	1002
-5	42250.5	4.884394522	1000
-4	40091.5	4.878320427	999
-3	38055.4	4.871976604	998
-2	36134.4	4.865353924	996
-1	34321.5	4.858443112	995
0	32610.0	4.851234752	994
1	30993.7	4.8437193	992
2	29466.8	4.835887094	990
3	28023.9	4.827728362	989
4	26660.0	4.819233234	987
5	25370.2	4.810391755	985
6	24150.1	4.801193902	983
7	22995.7	4.79162959	981
8	21903.1	4.781688696	979
9	20868.5	4.771361072	977
10	19888.7	4.760636561	975
11	18960.5	4.749505017	973
12	18080.8	4.737956327	970
13	17246.9	4.725980424	968
14	16456.1	4.713567319	965
15	15706.0	4.700707114	963
16	14994.4	4.68739003	960
17	14318.9	4.673606431	957
18	13677.7	4.659346849	954
19	13068.7	4.644602011	951
20	12490.3	4.629362861	948
21	11940.6	4.613620595	945
22	11418.2	4.597366683	942
23	10921.6	4.580592903	938
24	10449.3	4.563291365	935
25	10000.0	4.545454545	931
26	9572.5	4.527075313	927
27	9165.6	4.508146964	923
28	8778.3	4.488663246	919
29	8409.4	4.468618396	915
30	8058.1	4.448007162	911
31	7723.3	4.426824842	907
32	7404.3	4.405067304	902
33	7100.2	4.382731022	898
34	6810.2	4.359813102	893
35	6533.7	4.336311306	888
36	6269.8	4.312224084	883
37	6018.0	4.287550592	878
38	5777.7	4.262290722	873
39	5548.3	4.236445118	868
50	3606.1	3.914475937	802
51	3472.1	3.881948015	795
52	3343.7	3.848917708	788
53	3220.8	3.815397329	781
54	3103.1	3.781399998	774
55	2990.2	3.746939622	767

56	2882.1	3.712030877	760
57	2778.4	3.676689176	753
58	2679.0	3.640930651	746
59	2583.6	3.604772114	738
81	1220.4	2.748157207	563
82	1181.9	2.7084025	555
83	1144.8	2.668747011	547
84	1109.0	2.629210536	538
85	1074.5	2.589812422	530
86	1041.3	2.550571543	522
87	1009.2	2.511506263	514
88	978.3	2.472634416	506
89	948.5	2.433973277	498
90	919.8	2.395539544	491
91	892.0	2.357349316	483
92	865.3	2.319418079	475
93	839.4	2.281760687	467
94	814.5	2.244391354	460
95	790.4	2.207323646	452
96	767.1	2.170570465	445
97	744.7	2.134144055	437
98	723.0	2.098055989	430
99	702.0	2.062317177	422
100	681.8	2.026937858	415
101	662.2	1.99192761	408
102	643.3	1.957295352	401
103	625.0	1.92304935	394
104	607.3	1.889197225	387
105	590.2	1.855745964	380
106	573.7	1.822701928	373
107	557.7	1.790070865	367
108	542.2	1.757857926	360
109	527.2	1.726067674	353
239	33.5	0.162295782	33
240	33.0	0.159800146	33
241	32.5	0.157350769	32
242	32.0	0.154946682	32
243	31.5	0.152586936	31
244	31.0	0.150270604	31
245	30.5	0.147996779	30
246	30.0	0.145764577	30
247	29.6	0.143573131	29
248	29.1	0.141421596	29
249	28.7	0.139309144	29
250	28.2	0.137234968	28

```
'
'       NTC THERMISTOR READ TABLE
'       10K DIODE TYPE
'
Const Device = cb280
```

```
Const Integer TH_TABLE = (992,990,989,987,985,983,981,979,977,975,
                    973,970,968,965,963,960,957,954,951,948,
                    945,942,938,935,931,927,923,919,915,911,
                    907,902,898,893,888,883,878,873,868,862,
                    857,851,845,839,833,827,821,815,808,802,
                    795,788,781,774,767,760,753,746,738,731,
                    723,716,708,700,692,684,677,669,661,652,
                    644,636,628,620,612,604,596,587,579,571,
                    563,555,547,538,530,522,514,506,498,491,
                    483,475,467,460,452,445,437,430,422,415)

       Dim a As Integer,b As Integer
       Do
              b = Tadin(0)
              If b > 990 Or b < 400 Then
                     Debug "Out of Range"    'Check short or open th.
              End If
              For a=0 To 100
                     If b > TH_TABLE(a) Then Exit For
              Next
              Debug Dec a,cr
              Delay 500
       Loop
```

<Filename: ntcth.cul>

By using the TADIN command for AD conversion, CUBLOC will automatically calculate the average of 10 A/D conversion reads. By using this command, you get more precise results. The sample program shown here will be able to sense between 0 to 100 degrees. For larger range, you can simply modify the code.

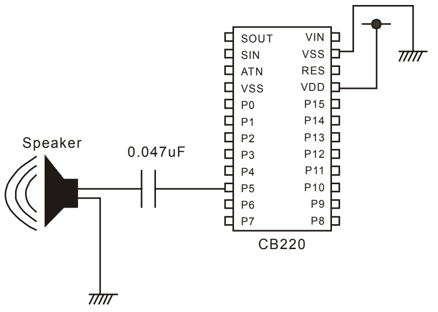
The formula for acquiring A/D conversion value from the R-T table is as follows:

$$V = \frac{5}{(1000 + THR)} \times THR$$

THR is the resistance value. 1000 is for 1K Ohm resistor and 5 is for 5 volts. The 10 bit A/D converter of CUBLOC will return a value between 0 and 1024. There for to get the A/D value, you must multiply result V by 204.8. You can easily make a chart by using an excel spreadsheet to enter these formulas. <END>

NOTE 4. Sound Bytes

In this application note, I will be showing you simple ways to create key touch sound, musical notes, and alert sound. An I/O port or a PWM Channel of CUBLOC can be used for sound. With a PWM Channel, you have the advantage of creating different tones of sounds.



The above example shows PWM Channel 0 of CB220 being used with Freqout command to produce a sound.

```
Const Device = cb280

Dim PLAYSTR As String
Low 5
Freqout 0,5236      'Create a sound with frequency of 440Hz
Delay 500           'Delay
Pwmoff 0            'Stop Sound by turning off PWM
```

With commands like Freqout and Delay, simple sounds can be created.

<Filename: playcdec.cul>

```
Const Device = CB280
Low 5
Freqout 0,4403
Delay 200
Freqout 0,3703
Delay 200
Freqout 0,3114
Delay 200
Freqout 0,2202
Delay 200
Pwmoff 0
```

By changing frequencies, we have made a simple program that can play musical notes.

Octave 4							Octave 5						
A	B	C	D	E	F	G	A	B	C	D	E	F	G
A	B	C	D	E	F	G	H	I	J	K	L	M	N

To express one note, you can use 2 characters. The first character is for the note and second character is for the length of the note.

<Filename: play.cul>

```
    Const Device = cb280

    Dim PLAYSTR As String
    Low 5
    PLAYSTR = "G5E3E3G3E3C5"
    PLAY 0,PLAYSTR

    Do
    Loop
    End

Sub PLAY(CH As Byte,NOTE As String)
    Dim PL As Byte
    Dim CHAR As Byte
    Const Integer PLAYTABLE = (5236,4665,4403,3923,3495,3299,2939,
          2618,2333,2202,1961,1747,1649,1469,0)
    For PL=1 To Len(NOTE) Step 2
          CHAR = Asc(Mid(NOTE,PL,1)) - &H41
          Freqout CH,PLAYTABLE(CHAR)
          CHAR = Asc(Mid(NOTE,PL+1,1)) - &H30
          Delay CHAR*100
    Next
    Pwmoff CH
End Sub
```

When using PWM port for other purposes, Freqout command no longer becomes available for use. In this case, we can use any regular I/O port to create sound.

We will use TOGGLE and UDELAY commands to set the I/O Port to HIGH and LOW. The following example shows how to make an alert sound with a regular I/O port, P4.

<Filename: playport.cul>

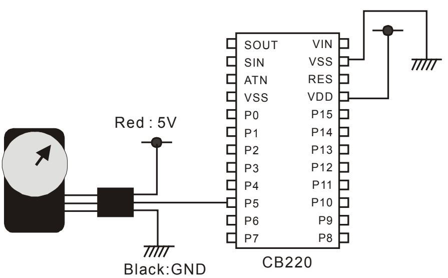
```
    Const Device = CB280
    Low 4
    Do
    SOUND 4,110,60
    SOUND 4,80,60
    SOUND 4,40,160
    Loop
    End

Sub SOUND(PN As Byte,FR As Byte,LN As Byte)
    Dim SI As Byte,SJ As Byte
    For SJ = 0 To LN
           Reverse PN
           Udelay FR
           Reverse PN
           Udelay FR
    Next
End Sub
```

<END>

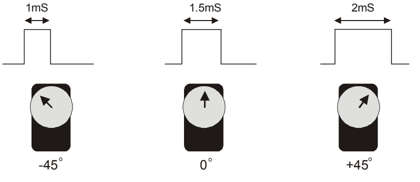
NOTE 5. RC Servo Motor

RC Servo Motors are used by many hobbyist to make remote control cars, planes, and etc… In the recent years, it has been used for robot arms, legs, and other body parts.
With CUBLOC, you can use the PWM to easily implement an RC Servo motor into your project.

There are 3 wires to the RC servo motor. The black wire is ground and red wire is for power. The other yellow wire is for inputting PWM signal. For PWM signal, you can input about 60 pulses per second to enable the RC servo.



The RC Servo motor will move to a location set by pulse and duty value and will hold its position. By being able to control the exact angles at which the RC servo stops, we can control the RC servo as freely as we want.



A pulse of 1ms will stop the RC servo at -45 Degrees.
A pulse of 1.5ms will stop the RC servo at 0 Degrees.
A pulse of 2ms will stop the RC servo at +45 Degrees.
Depending on the RC servo you use, these specification will vary.

<Filename: rcservo.cul>

```
Const Device = CB280
Low 5
Pwm 0,2500,32768
```

When the code above is executed, a 1ms pulse will be outputted from port number 5. RC servo will position itself to -45 degrees.

```
Const Device = CB280
Low 5
Pwm 0,4000,32768
```

When the code above is executed, a 1.5ms pulse will be outputted from port number 5. RC servo will position itself to +45 degrees.

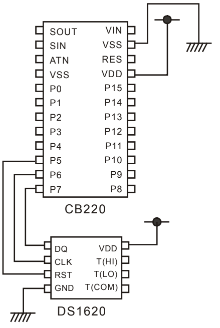
As you can see, by simply change the duty value of PWM command, RC servo can easily be controlled. For the CB220, 3 RC servos can be controlled simultaneously while the CB280 and CB290 can control 6 RC servos.

Warning: When the RC servo is in operation, it will need about 500mA of current, please make sure to use a power supply of at least 500mA.

<END>

NOTE 6.
DS1620 Digital Thermometer

The DS1620 is a digital thermometer. The chip internally has a temperature conversion table so the user does not have to make a separate conversion table. Temperature range between -55 and 125 degrees Celcius can be obtained by the DS1620 in units of 0.5 Degrees.



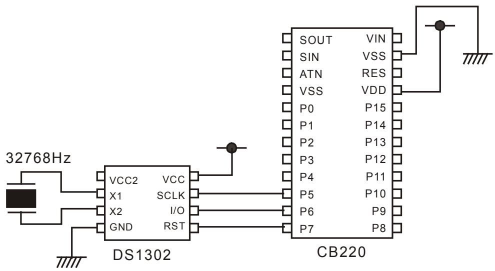
<Filename: ds1620.cul>

```
Const Device = CB280
Const iorst = 7
Const ioclk = 6
Const iodq = 5
Dim I As Integer
Delay 100
High iorst          ` init ds1620
Shiftout ioclk,iodq,0,12,8
Shiftout ioclk,iodq,0,3,8
Low iorst
Do
      High iorst
      Shiftout ioclk,iodq,0,&haa,8
      i = Shiftin(ioclk,iodq,4,9)
      i = i
      debug dec i,cr
      Low iorst
      Delay 100
Loop
```

The final value received can be divided into 2 to obtain the current temperature.<END>

NOTE 7. DS1302 RTC

DS1302 RTC (Real Time Clock) is a chip that will acts as an electronic time keeper. It has the ability to keep time and date in real-time. We will show you how to implement this clock chip into your application in this note.



Pin	Function	I/O Direction	Explanation
RST	Reset	Input	Data transfer when High
SCLK	System Clock	Input	Clock signal
I/O	Data Input/Output	Input / Output	Data input/output

<Filename: ds1302.cul>

```
Const Device = CB220
       Const iorst = 7
       Const iodio = 6
       Const ioclk = 5
       Dim I As Integer
       Dim adr As Byte
       High iorst
       Shiftout ioclk,iodio,0,&h8e,8
       Shiftout ioclk,iodio,0,0,8
       Low iorst
       Delay 1
       High iorst
       Shiftout ioclk,iodio,0,&h80,8
       Shiftout ioclk,iodio,0,&H50,8
       Low iorst

       Do
              High iorst
              adr = &h81
              Shiftout ioclk,iodio,0,adr,8
              i = Shiftin(ioclk,iodio,4,8)
```

```
                Debug Hex i,cr
                Low iorst
                Delay 1000
        Loop
```

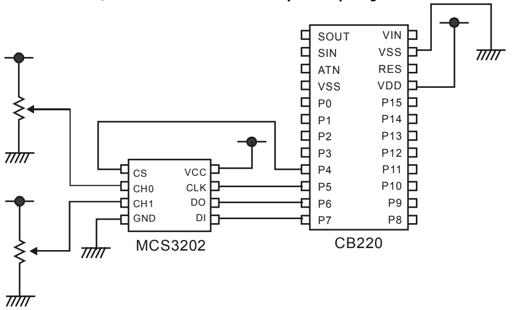
The above code will read ADDRESS 0, second’s value, and display it onto the DEBUG window.
At the beginning of the program, we will enable writes to the DS1302 chip and set the ADDRESS 0 to 50 seconds.
Within the Do Loop, we will read the data from DS1302. The DS1302 chip has 6 addresses as shown below:

ADDRESS 0 (sec)	CH	10 SEC	SEC			
ADDRESS 1 (min)	0	10 MIN	MIN			
ADDRESS 2 (hour)	12/24	0	10 A/P	HR	HR	
ADDRESS 3 (date)	0	0	10DATE	DATE		
ADDRESS 4 (month)	0	0	0	10M	MONTH	
ADDRESS 6 (day)	0	0	0	0	0	DAY
ADDRESS 6 (year)	10 YEAR	YEAR				

These addresses can be used to read and write to the DS1302.
Please note that the data is in BCD code format.
<END>

NOTE 8. MCP3202
12 Bit A/D Conversion

The CUBLOC has a 10 bit A/D converter. Without a separate chip, you can get up to 10 bits of A/D conversion. But for greater resolution, meaning greater precision, you can use a chip like the MCP3202. MCP3202 is a 12 bit A/D converter that supports SPI protocol. Here we will show you how to implement this 12 bit A/D converter into your project.



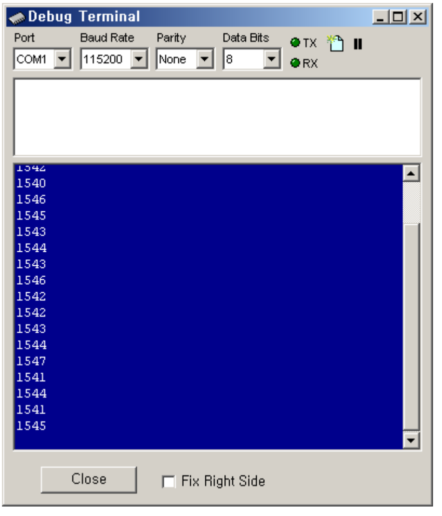
Pin	Function	I/O Direction	Explanation
CS	Chip Select	Input	Low for data communication
CLK	Clock	Input	Clock signal
DI	Data Input	Input	Data input from MCP3202
DO	Data Output	Output	Data output from MCP3202

<Filename: mcp3202.cul>

```
Const Device = CB280
Const iodi = 7
Const iodo = 6
Const ioclk = 5
Const iocs = 4
Dim I As Byte
Dim ad As Integer
Do
      Low iocs
      i = &b1011 'Channel 0
      'i = &h1111 'Channel 1
      Shiftout ioclk,iodi,0,i,4
      ad = Shiftin(ioclk,iodo,3,12)
      High iocs
      Debug Dec ad,cr
      Delay 100
Loop
```

The MCP3202 will convert voltage coming into CH0 and CH1 ports to a data value and retain it. The user can simply use SPI communication to read the value that the MCP3202 has converted.

The voltage inputted to the MCP320 CH0 and CH1 pins must not be greater than the voltage supplied to the MCP3202. The result of A/D conversion is displayed to the DEBUG window.



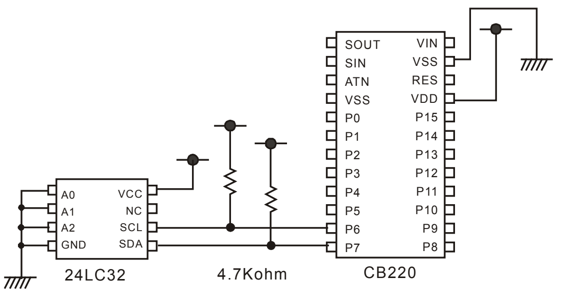
<END>

NOTE 9.
Read and write to the EEPROM

With the EEPROM, you can store between 0.5 to 64 KB of data. Data is retained even after powering off, allowing it to act almost as a small hard drive. If you want to retain a temperature setting for a temperature controller, you can simply store the value of the temperature in the EEPROM in case of power-outs.

CUBLOC has an internal EEPROM of 4KB. For small and simple data, you may use this internal EEPROM. In the case of larger data, you can use an EEPROM like 24LC512 to store up to 64KB of data.

Here we will show you how to access the 24LC32 4KB EEPROM through I2C protocol. The serial EEPROMs usually support either SPI or I2C. I2C EEPROMs name starts with 24XXXX and SPI EEPROMs name starts with 93XXX.



<Filename: eeprom.cul>

```
Const Device = CB280
Dim adr As Integer
Dim data As Byte
Dim a As Byte
data = &ha6
adr = &h3
Set I2c 7,6
Do
       I2cstart
       If I2cwrite(&b10100000)= 1 Then Goto err_proc
       a=I2cwrite(adr.byte1)
       a=I2cwrite(adr.lowbyte)
```

```
              a=I2cwrite(data)
              I2cstop
              Delay 1000
              I2cstart
              a=I2cwrite(&b10100000)
              a=I2cwrite(adr.byte1)
              a=I2cwrite(adr.lowbyte)
              I2cstart
              a=I2cwrite(&b10100001)
              a=I2cread(0)
              I2cstop
              Debug Hex a,cr
              ADR = ADR + 1
              DATA = DATA + 1
       Loop

err_proc:
       Debug "Error !"
       Do
       Loop
```

This example program will write a number to EEPROM and read from it. When this program runs correctly, numbers will increment on the DEBUG screen. You can easily modify this code to support other EEPROMs.

Note: Please wait at least 5ms after a write to the EEPROM.

<END>

MEMO

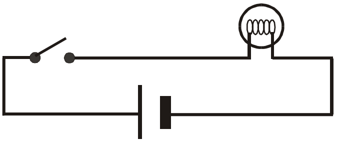
Chapter 12
Ladder Logic

WARNNING

If you do not use SET LADDER ON command, Ladder Logic will not be executed.

LADDER Basics

The following is an example of one switch and a lamp.

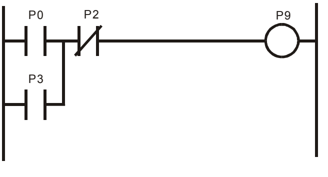


If you take out the power, the following results:

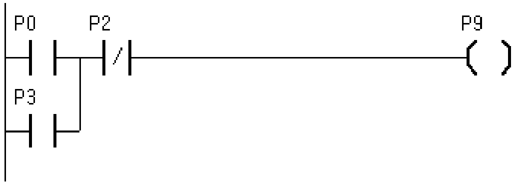
If you express the above circuit diagram as Ladder Logic, the following results:

As you can see, LADDER is simply an easy way to express circuit diagrams. A switch is comparable to the P0 port and P9 is comparable to the LAMP.

There are many ways to connect other devices such as timers, counters, and etc… The following is an OR and AND connection in Ladder Logic:



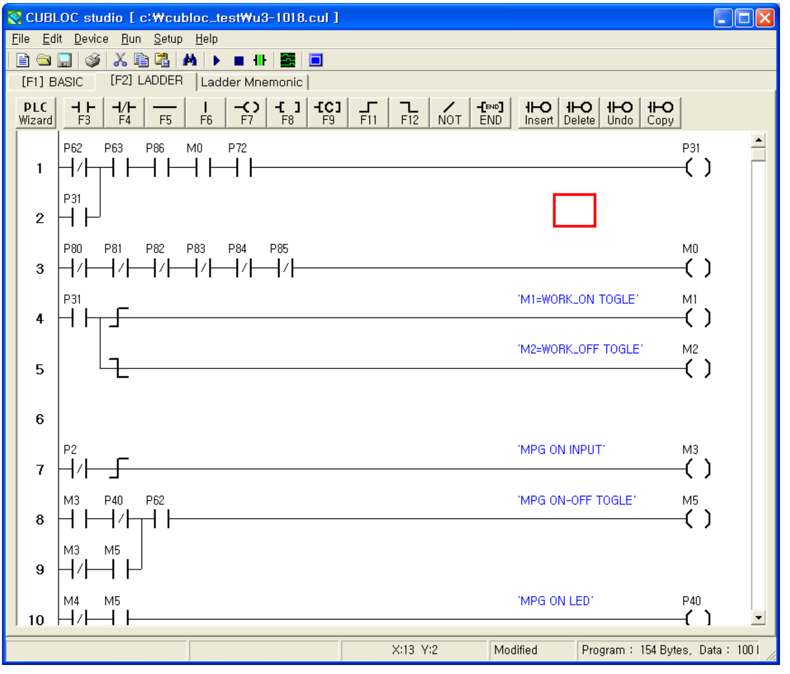
In this circuit diagram, P0 and P2 and connected in logical combination of AND. P0 and P3 are ORed. (Which mean either P0 or P3 has to be on) If you express the above circuit diagram in Ladder Logic, it will be as follows:



In CUBLOC STUDIO, the right side is not shown. In the Ladder Logic of CUBLOC, P0, P1, P2 are called “Registers”.

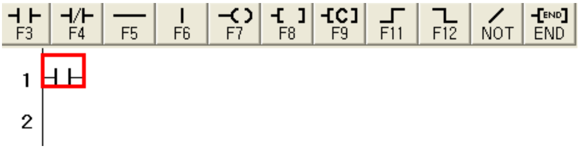
Creating LADDER

The below screen shows you how Ladder Logic is created in CUBLOC STUDIO.

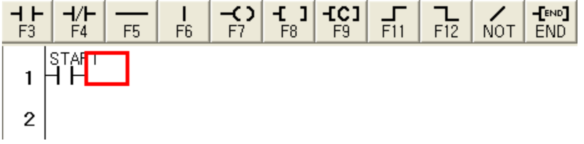


The red box shown above is the cursor for Ladder Logic. You may use the keyboard up, down, left, and right keys or the mouse to control the red box. After moving to the desired position, you can use keys F3 to F12 to put the desired symbol. You can also enter text for those required symbols.

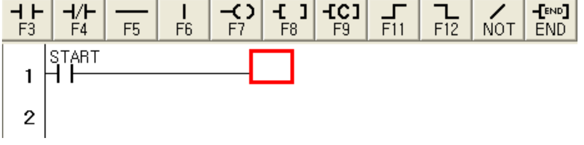
1. Press F3 to make a contact.



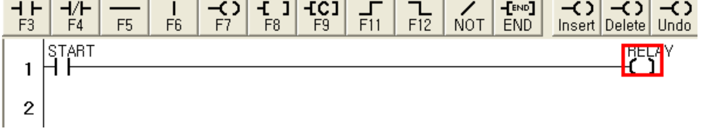
2. Type “START” and press ENTER.



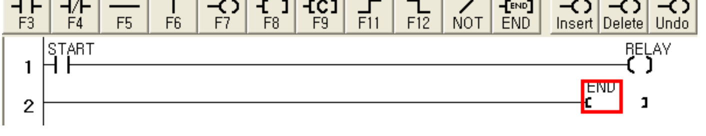
3. Press F5 couple times and you will see that it creates a line.



4. Press F7 and type RELAY.



5. Go to the next rung (line) and press END.

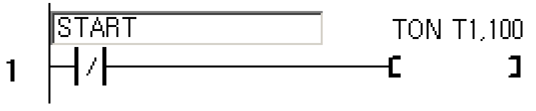


Please press the ENTER key at the end of entering TEXT. At the very end of the Ladder Logic, you must put an END command.

Editing LADDER Text

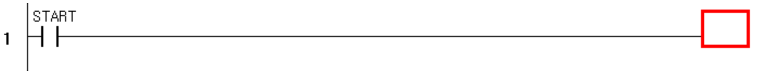
Editing Text

To edit an existing TEXT, please place the cursor in the desired location and press ENTER. Now you can edit the TEXT freely as you like.

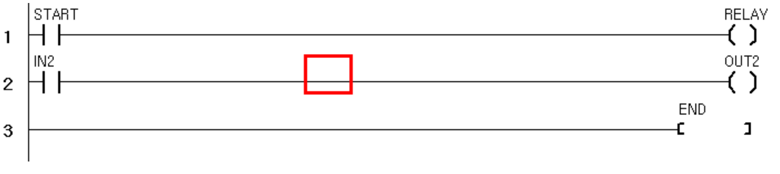


Erasing a Cell

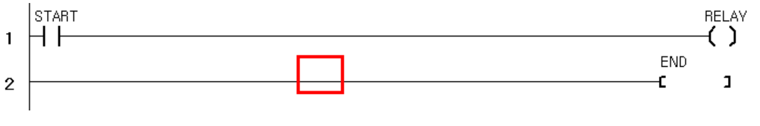
Enter SPACE key.



Erasing a Rung (one line)

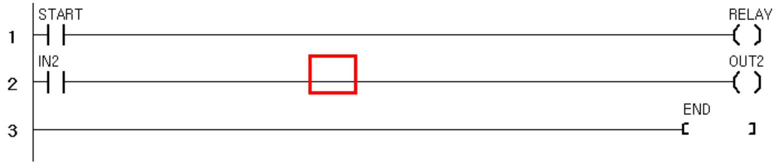


A rung is a row in Ladder. You can press CTRL-D to erase a rung. This actually moves the rung to a buffer

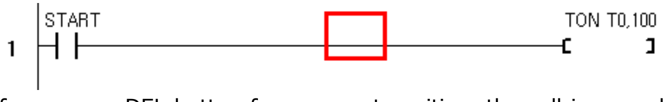


Rung Recovery

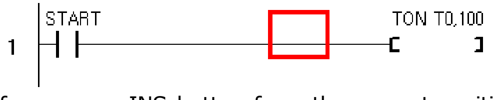
To recover an erased rung, press CTRL-U.



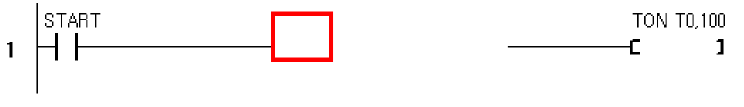
Cell Insert and Delete



If you press DEL button from current position, the cell is erased and items on the right are pulled one cell to the left.

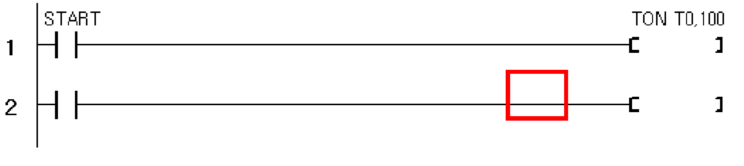


If you press INS button from the current position, a blank cell is inserted and items on the right are moved one cell right.



Rung Copy

When same style of rung is needed, you can press CTRL-A and it will copy the above rung except text will not be copied.

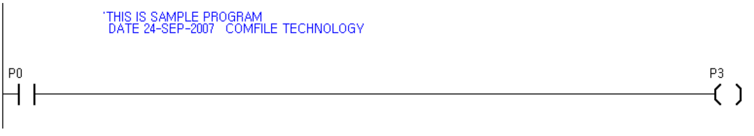


Comments

You can enter comments by adding an apostrophe (‘).

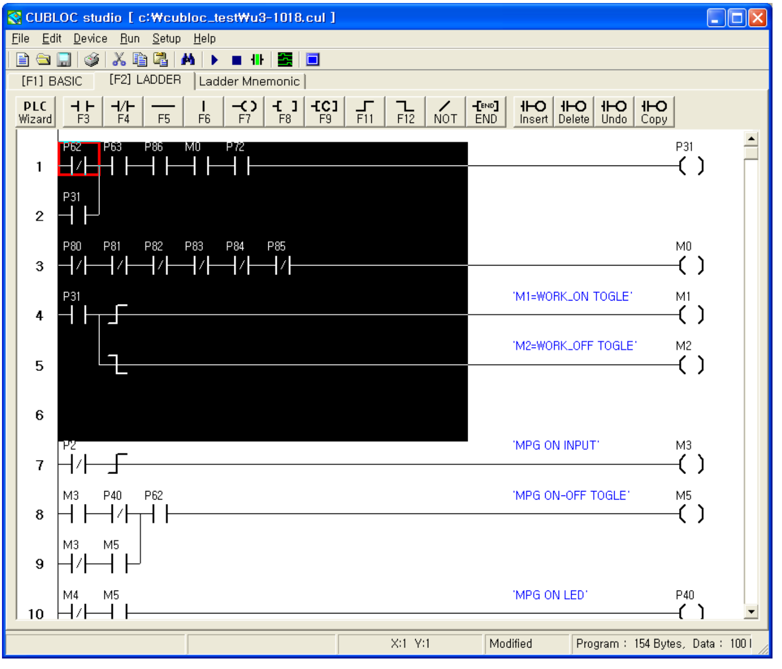
You can use a semi-colon (;) to display to the next line.
For example:

“This is Sample Program ; Date 24-Sep-2007 Comfile Technology”



LADDER BLOCK COPY and PASTE

You can make a selection of a block to copy and paste to different parts of the LADDER.



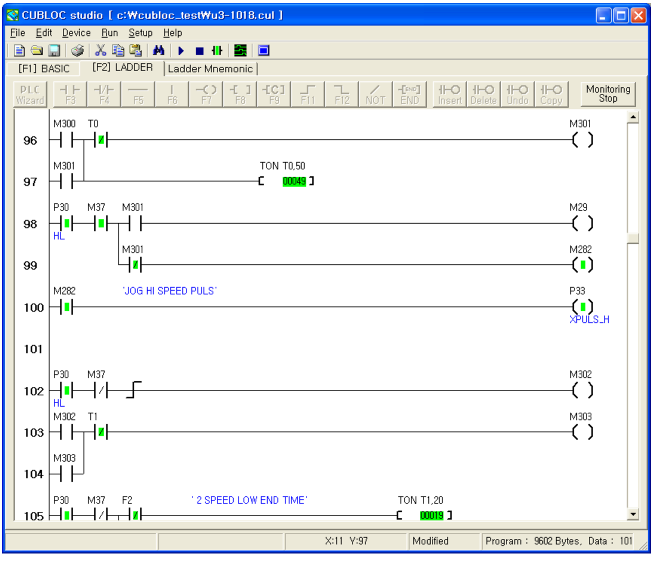
Use the mouse to click and drag to select the desired copy area. Press CTRL-C to copy and CTRL-V to paste. Similar to text editing, you can press CTRL-X to cut and paste also.

*Please be aware that in LADDER editing, UNDO is not supported.

Monitoring

CUBLOC STUDIO supports real-time monitoring of Ladder Logic.

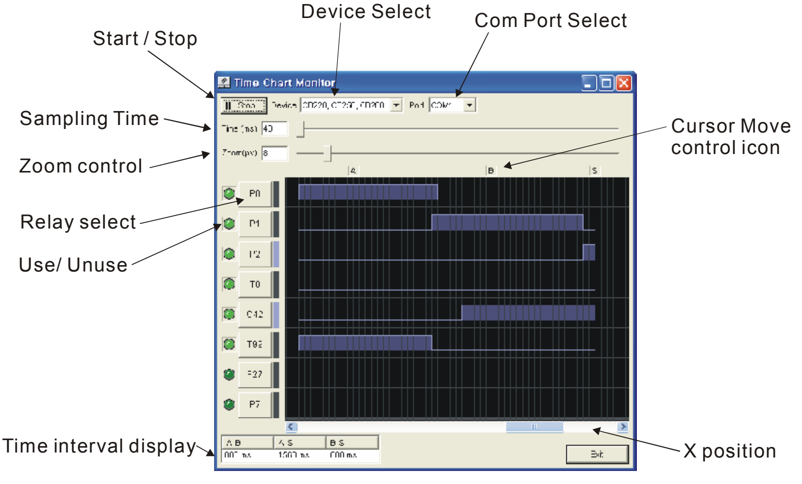
Status of contacts that are ON will be displayed **GREEN**. Timer and counter values will be displayed as decimal values. You can control the monitoring speed by going to **Setup Menu-> Studio option-> Monitoring speed**. When the monitoring speed is too fast, it can affect CUBLOC's communications as monitoring takes up resources. We recommend value of 5 for the monitoring speed.



*Please make sure to stop monitoring before editing or downloading.

Time Chart Monitoring

With Time Chart Monitoring, you will be able to see Ladder Logic contacts as a time chart. The minimum width of the time chart is 40ms. You can use the Zoom control function to measure the width of each pulse after stopping. Up to 8 Registers can be monitored at one time.



To use the Time Chart Monitor, you must set Debug off in Basic. To do this, simple add "Set Debug Off" command at the very beginning of your code.

```
Set Debug Off
```

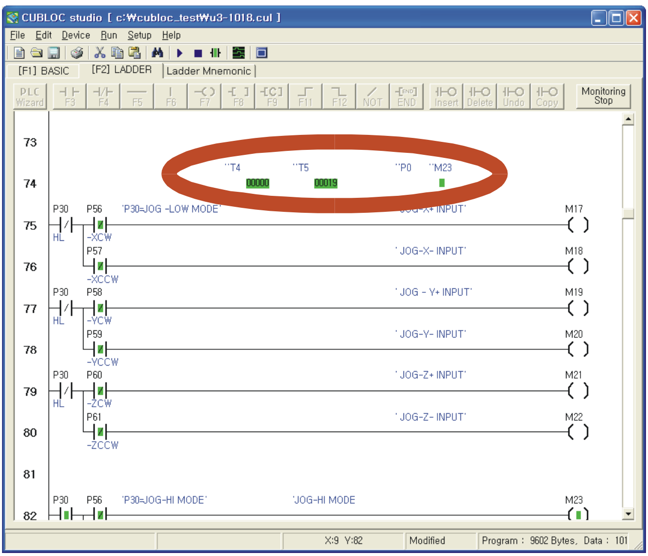
While using Time Chart Monitor, Ladder Monitoring may not be used either.

WATCH POINT

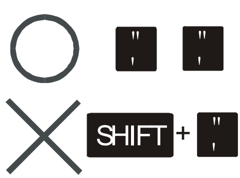
When you want to watch the status of Registers and timers outside the current Ladder Monitoring screen, you can use Watch Point feature.

You can use two apostrophes (‘’) to add a WATCH POINT. For example, you want to see P0 right next to some other Register that is on exact opposite side of the screen.

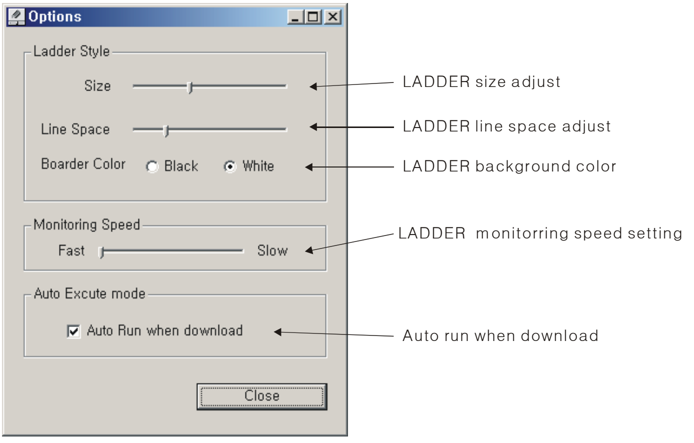
Examples:
‘’P0 ‘’P1 ‘’D0



* Please be aware that it’s two APOSTROPHES(‘’), not a QUOTATION MARK(“).



Options Window



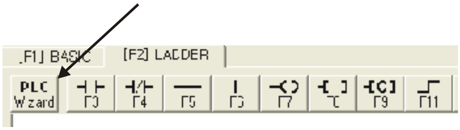
If you select to use "Auto Run when download", the program will automatically reset itself after downloading. This can become a problem for machines that are sensitive to resets. By turning this option OFF, you will be able to control when the program is resetted after downloading.

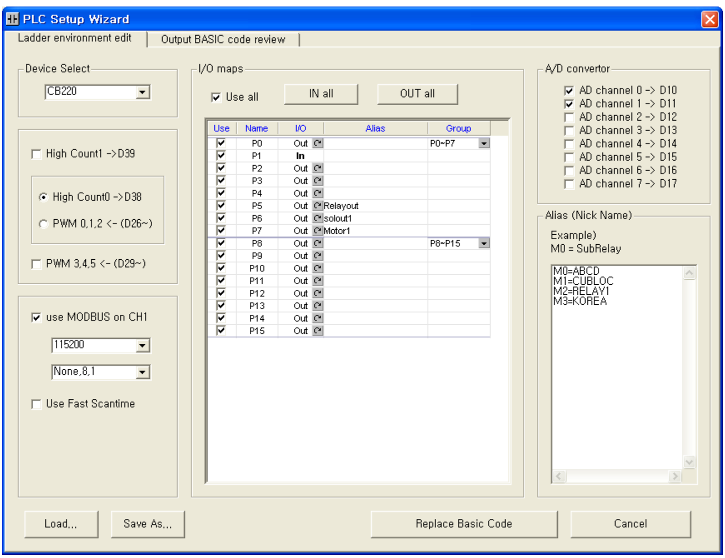
In the help menu, you will find Upgrade information, and the current version of CUBLOC Studio.

PLC Setup Wizard

To use Ladder Logic in CUBLOC, you must create the most basic BASIC code. Although very simple, this can be hard for first-timers. You can use the PLC Setup Wizard and setup the I/Os you will be using and create the BASIC source automatically.

PLC SETUP WIZARD

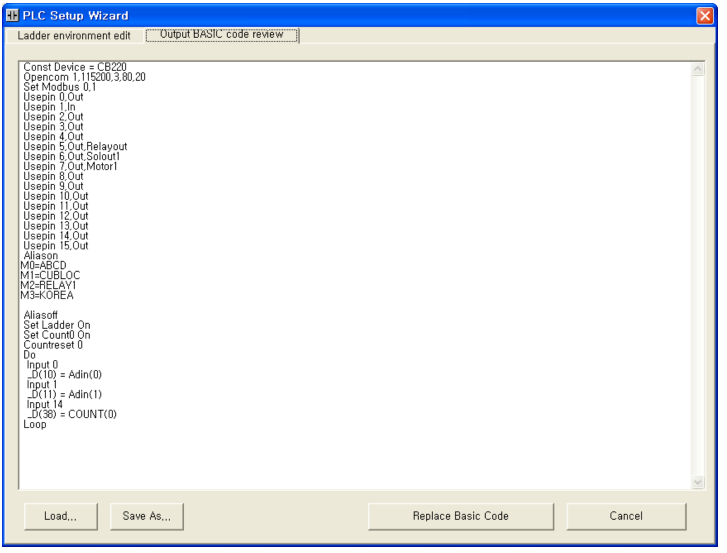




As you can see in above screen, Device name, I/O status, alias, and other features can be set simply by clicking.

You can set aliases for Registers, set Modbus to be ON, and set the baud rate for the Modbus.

You can always review the current BASIC code generated in real-time by pressing [Output BASIC code review] tab.



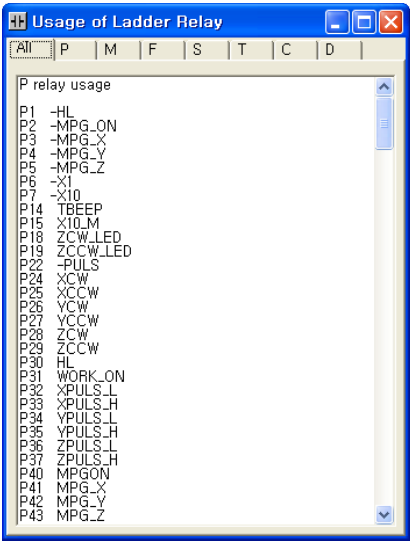
For using A/D, PWM, or COUNT, you can simply read from the D Registers for the results. For ADC0, the AD value is stored in D(10). The user can simply read from Register D10 to find the value of AD0.

For PWM3, the user can simply write to Register D29 to output PWM.
For HIGH COUNT1, simply read Register D39. If the user wishes, he can change the Register to store or write values by changing the BASIC code.
Please press [Replace Basic Code] when you are done to product the final BASIC code. Please be aware that older code will be deleted at this point.

You can also save the setup to a file by clicking on [SAVE AS..]. Click on [LOAD…] to bring back saved setup values.

Usage of Ladder Register

With this feature, the user can see alias of all Registers. By using this feature, the user will be able to save a great deal of time while debugging and developing the final product. Please go to **Run->View Register Usage** to open this window.



Register Expression

CB220, CB280 Registers

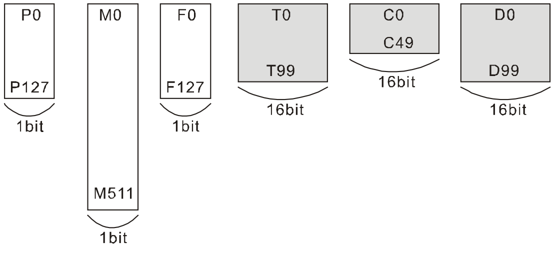
The following is a chart that shows CB220, CB280 Registers.

Register Name	Range	Units	Feature
Input/Output Register P	P0 to P127	1 bit	Interface w/ External devices
Internal Registers M	M0 to M511	1 bit	Internal Registers
Special Register F	F0 to F127	1 bit	System Status
Timer T	T0 to T99	16 bit (1 Word)	For Timers
Counter C	C0 to C49	16 bit (1Word)	For Counters
Step Enable S	S0 to S15	256 steps (1 Byte)	For Step Enabling
Data Memory D	D0 to 99	16bit (1 Word)	Store Data

P, M, and F Registers are in bit units whereas T, C, and D are in word units. To access P, M, and F Registers in word units, you can use WP, WM, or WF.

Register Name	Range	Units	Feature
WP	WP0 to 7	16 bit (1 Word)	Register P Word Access
WM	WM0 to WM31	16 bit (1 Word)	Register M Word Access
WF	WF0 to WF7	16 bit (1 Word)	Register F Word Access

WP0 contains P0 through P15. P0 is located in the LSB of WP0 and P15 is located in the MSB of the WP0. These Registers are very useful to use with commands like WMOV.



CB290, CB405 Registers

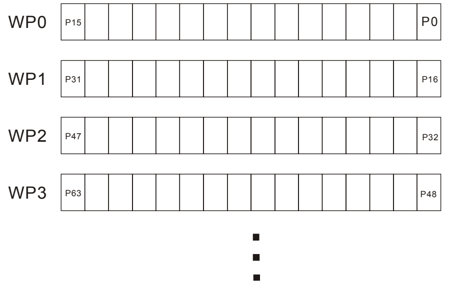
The following is a chart that shows CB290 Registers. CB290 has more M, C, T, and D Registers than CB220 and CB280.

Register Name	Range	Units	Feature
Input/Output Register P	P0 to P127	1 bit	Interface w/ External devices
Internal Registers M	M0 to M2047	1 bit	Internal Registers
Special Register F	F0 to F127	1 bit	System Status
Timer T	T0 to T255	16 bit (1 Word)	For Timers
Counter C	C0 to C255	16 bit (1 Word)	For Counters
Step Enable S	S0 to S15	256 steps (1 Byte)	For Step Enabling
Data Memory D	D0 to 511	16 bit (1 Word)	Store Data

P, M, and F Registers are in bit units whereas T, C, and D are in word units. To access P, M, and F Registers in word units, you can use WP, WM, or WF.

Register Name	Range	Units	Feature
WP	WP0 to 7	16 bit (1 Word)	Register P Word Access
WM	WM0 to WM63	16 bit (1 Word)	Register M Word Access
WF	WF0 to WF7	16 bit (1 Word)	Register F Word Access

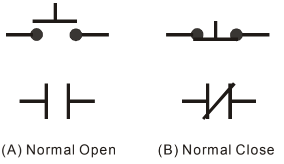
WP0 contains P0 through P15. P0 is located in the LSB of WP0 and P15 is located in the MSB of the WP0. These Registers are very useful to use with commands like WMOV.



Ladder symbols

Contact A, Contact B

Contact A is "Normally Open" and closes when a signal is received. On the other hand, Contact B is "Normally Closed" and opens when a signal is received.



Input, Output Register Symbol

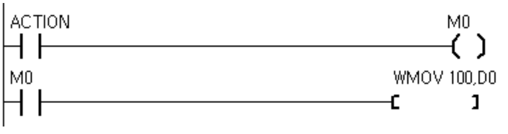
Input/Output Registers are the most basic symbols among the Registers in Ladder Logic.

Function Registers

Function Registers include timers, counters, and other math operation Registers.

Internal Register

Internal Register (M) only operates within the program. Unless connected to an actual external port, it is only used internally. You may use M Register as input or output symbol.



P Registers that are not used as I/O ports

CUBLOC supports P Registers from P0 to P127. P Register is directly connected to I/O ports 1 to 1. But most models of CUBLOC have less than 128 I/O ports. In this case, you may use the unused portion of P Registers like M Registers.

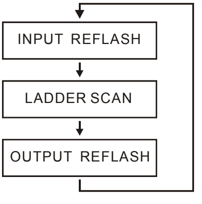
Using I/Os

CUBLOC I/O ports can be used by both BASIC and LADDER. Without defined settings, all I/O ports are controlled in BASIC. To control I/O ports in LADDER, you must use the "Usepin" command and set the I/O ports to be used in LADDER.

```
USEPIN 0,IN
USEPIN 1,OUT
```

The above code sets P0 as input and P1 as output for use in LADDER.

The inner processes require that USEPIN will be re-flashed in LADDER. Re-flashing means that the Ladder will read I/O status beforehand and store the status in P Registers. After scanning, LADDER will re-write the status of I/O ports into P Registers.



In BASIC, IN and OUT commands can be used to control I/O ports. This method directly accesses the I/O ports, whether it is read or writes. In order to avoid collision among the two, the I/Os used in BASIC and LADDER should be specified.

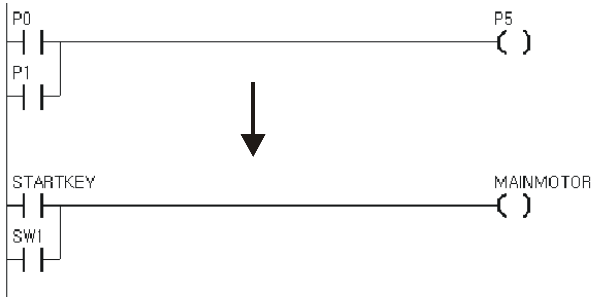
One a port is declared with USEPIN command, it can only be used in LADDER and cannot be accessed in BASIC.

```
USEPIN 0,IN, START
USEPIN 1,OUT, RELAY
```

You can also add an alias such as START or RELAY as shown above for easy reading of the Ladder Logic.

Use of Aliases

When creating Ladder Logic using “Register numbers” such as P0, P1, and M0, the user can use alias to help simplify their programs.



In order to use alias, you need to declare them in BASIC. You can simply use ALIAS command to use ALIAS for Registers you desire to use.

```
ALIAS M0 = MAINMOTOR
ALIAS M2 = STATUS1
ALIAS M4 = MOTORSTOP
```

You have an option of either using USEPIN or ALIAS command to use aliases in LADDER.

Beginning of LADDER

CUBLOC executes BASIC first. You can set LADDER to start by using the command "SET LADDER ON". When this command is executed, LADDER is executed consistently within the specified scan time of 10 milliseconds.

If you do not use SET LADDER ON command, Ladder Logic will not be executed.

```
SET LADDER ON
```

Declare devices to use

You must declare the device to be used so the compiler knows. The following are examples of how to use the CONST DEVICE command.

```
CONST DEVICE = CB220        ` Use CB220.
```

or

```
CONST DEVICE = CB280        ` Use CB280.
```

This command must be placed at the very start of the program.

To Use Ladder Only, without BASIC

You must at least do a device declaration, port declaration, and turn on the LADDER for BASIC even if you are going to only use Ladder.

The following is an example of such minimal BASIC code:

```
Const Device = CB280       'Device Declaration

Usepin 0,In,START          'Port Declaration
Usepin 1,In,RESETKEY
Usepin 2,In,BKEY
Usepin 3,Out,MOTOR

Alias M0=RELAYSTATE 'Aliases
Alias M1=MAINSTATE

Set Ladder On              'Start Ladder

Do
Loop                       'BASIC program will run in infinite loop/
```

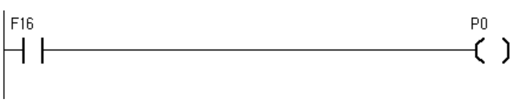
Enable Turbo Scan Time Mode

In order to use both BASIC and LADDER, a scan time of 10ms is supported for LADDER. If you would like to enable Turbo Scan Time Mode when not using BASIC, you can follow the example below.

LADDERSCAN command can be used inside a DO…LOOP to enable Turbo Scan Time Mode.
Depending on the size of the Ladder program, this scan time MAY change. For small programs less than 50 rungs, a scan time of 500us to 1ms are possible.

```
Const Device = CB280        'Device Declaration
Usepin 0,In,START           'Port Declaration
Usepin 1,In,RESETKEY
Usepin 2,In,BKEY
Usepin 3,Out,MOTOR
Alias M0=RELAYSTATE         'Aliases
Alias M1=MAINSTATE
Do
     LadderScan
Loop
```

F16 is a special Register for checking the current scan time. You can connect it to an I/O port as shown below and check it with an oscilloscope.



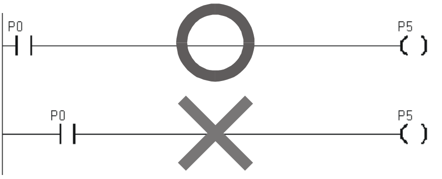
Below is an example of a conditional case where Turbo Scan Time is used. Only when Register M0 is ON, will the Turbo Scan Time be enabled.

.

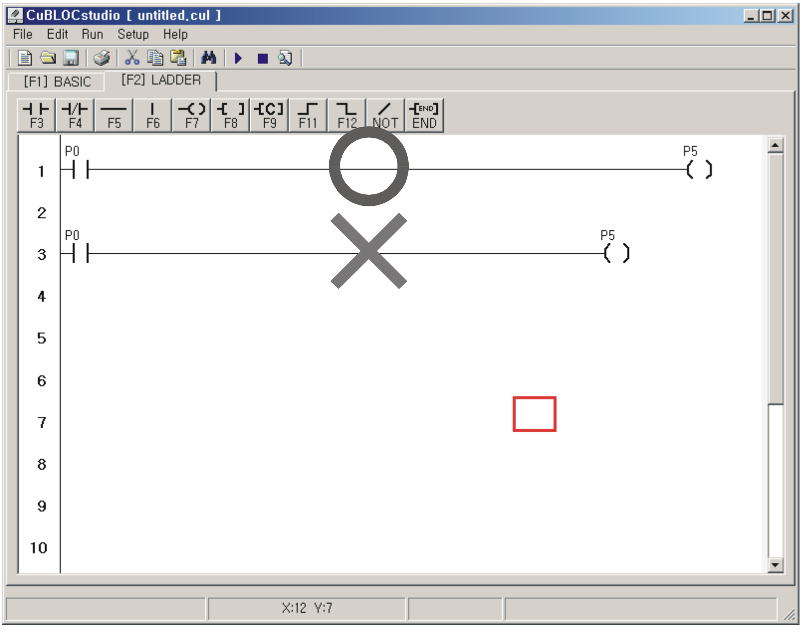
```
     Do
         Set Ladder On    ’10 ms Scan when M0 is OFF
           Do While _M(0) = 1
             LadderScan   ‘Only Execute when M is ON
           Loop
     Loop
```

Things to Remember in LADDER

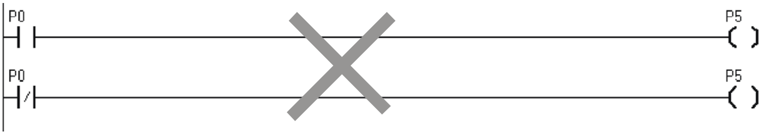
Input symbol must be placed at the very left side of the Ladder Logic.



* Output symbol must be placed at the very right side of the Ladder Logic.

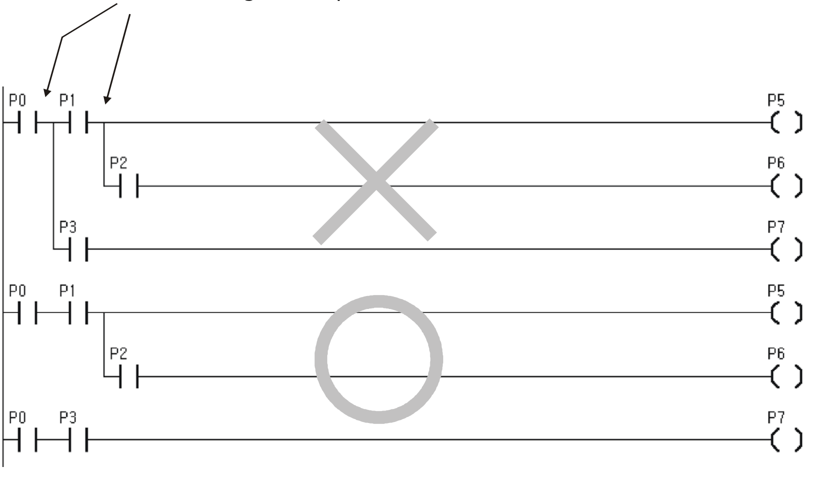


Identical outputs must not collide.

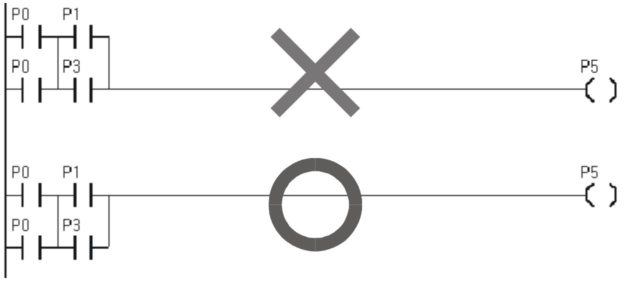


You may not use more than one vertical line as shown below.

More than 1 division will give compile error

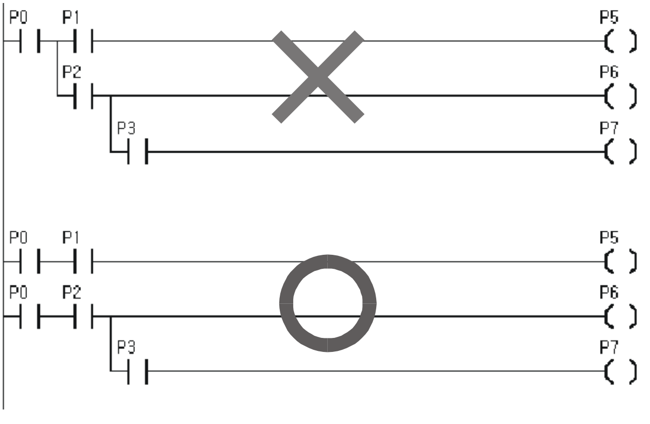


Ladder Logic moves from top to bottom.



Function Register can not be on the left side of the Ladder Logic.

When a Ladder Logic becomes complex, simply divide them so you can see and understand them better as shown below.



ladder instructions

Ladder low level instructions

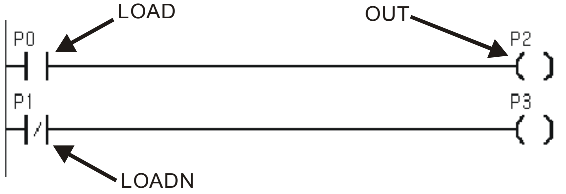
Command	Symbol	Explanation
LOAD	| |—| |—	Contact A (Normally Open)
LOADN	| |—|/|—	Contact B (Normally Closed)
OUT	—( )	Output
NOT	— / —	NOT (Inverse the result)
STEPSET	-[ ]	Step Controller Output (Step Set)
STEPOUT	-[ ]	Step Controller Output (Step Out)
MCS	-[ ]	Master Control Start
MCSCLR	-[ ]	Master Control Stop
DIFU	⌐	Set ON for 1 scan time when HIGH signal received
DIFD	⌙	Set ON for 1 scan time when LOW signal received
SETOUT	-[ ]	Maintain output to ON
RSTOUT	-[ ]	Maintain output to OFF
END	-[ ]	End of Ladder Logic
GOTO	-[ ]	Jump to specified label
LABEL	-[ ]	Label Declaration
CALLS	-[ ]	Call Subroutine
SBRT		Declare subroutine
RET		End Subroutine
TND		conditional exit command

High level instructions

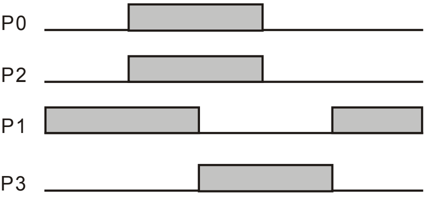
Command	Parameter	Explanation
Data Transfer Commands		
WMOV	s,d	Word Data Move
DWMOV	s,d	Double Word Data Move
WXCHG	s,d	Word Data Exchange
DWXCHG	s,d	Double Word Data Exchange
FMOV	s,d,n	Data fill command
GMOV	s,d,n	Group move command
Increment/Decrement Commands		
WINC	d	Increment 1 to the Word
DWINC	d	Increment 1 to the Double Word
WDEC	d	Decrement 1 to the Word
DWDEC	d	Decrement 1 to the Double Word
Math Commands		
WADD	s1,s2,d	Word Add
DWADD	s1,s2,d	Double Word Add
WSUB	s1,s2,d	Word Subtract
DWSUB	s1,s2,d	Double Word Subtract
WMUL	s1,s2,d	Word Multiplication
DWMUL	s1,s2,d	Double Word Multiplication
WDIV	s1,s2,d	Word Division
DWDIV	s1,s2,d	Double Word Division
Logical Operation Commands		
WAND	s1,s2,d	Word AND
DWAND	s1,s2,d	Double Word AND
WOR	s1,s2,d	Word OR
DWOR	s1,s2,d	Double Word OR
WXOR	s1,s2,d	Word XOR
DWXOR	s1,s2,d	Double Word XOR
Bit Shift Commands		
WROL	d	Word 1 bit Shift Left
DWROL	d	Double Word 1bit Shift Left
WROR	d	Word 1 bit Shift Right
DWROR	d	Double Word 1 bit Shift Right

LOAD,LOADN,OUT

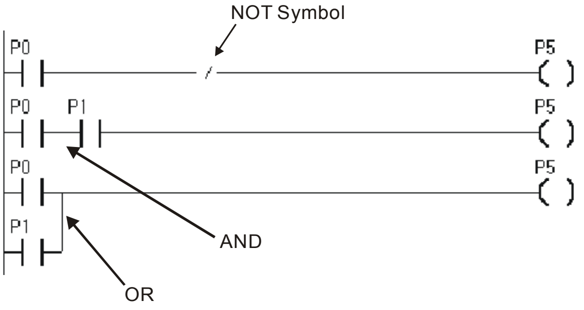
LOAD is for Normally Open Contacts and LOADN is for Normally Closed Contacts.



Registers that can be used	P	M	F	S	C	T	D	Constants
LOAD LOADN	O	O	O	O	O	O		
OUT	O	O						



NOT, AND,OR

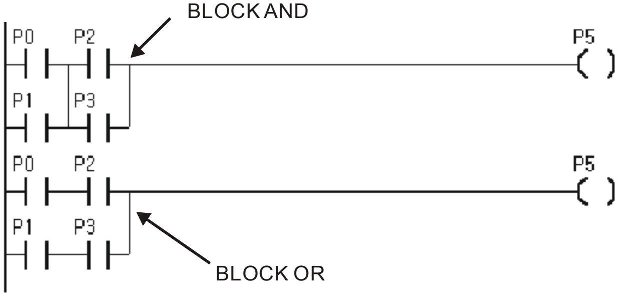


NOT symbol inverses the results. If P0 is ON then P5 will be OFF.

AND is when two Registers are horizontally placed next to each other. Both Registers P0 and P1 must be True(ON) in order for P5 to be True (ON).

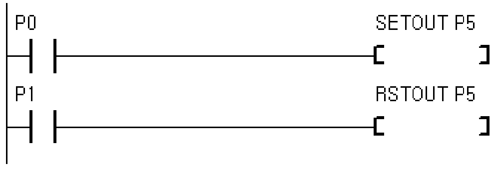
For OR operation, two Registers are vertically placed next to each other. When either P0 or P1 is ON, P5 will be ON.

The following is an example of BLOCK AND and BLOCK OR.

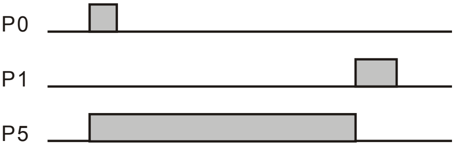


SETOUT, RSTOUT

SETOUT will turn ON P5 when P0 turns ON and will keep P5 ON even if P0 turns off.
On the other hand, RSTOUT will output OFF when P1 is ON and will keep P5 off even when P1 turns OFF.

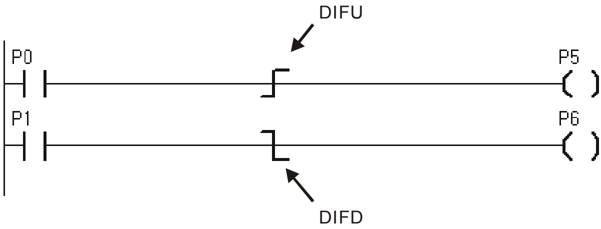


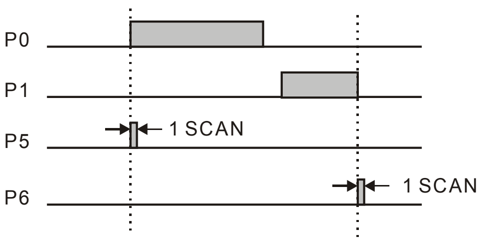
Registers that can be used	P	M	F	S	C	T	D	Constants
SETOUT	O	O	O					
RSTOUT	O	O	O					



DIFU, DIFD

This command DIFU turns ON the output 1 scan time when input goes from OFF to ON.
Conversely, DIFD turns OFF the output 1 scan time when input goes from ON to OFF.

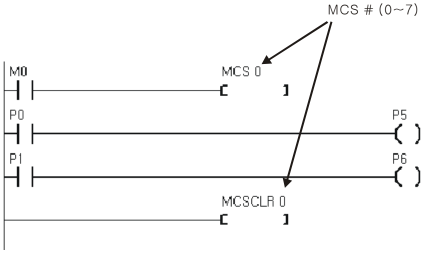




MCS, MCSCLR

The command MCS and MCSCLR allow for the Ladder Logic between MCS X and MCSCLR X to be executed when turned ON. If MCS is OFF, the Ladder Logic in between MCS X and MCSCLR X will not be executed.

By using this command, the user is able to control a whole block of Ladder Logic.



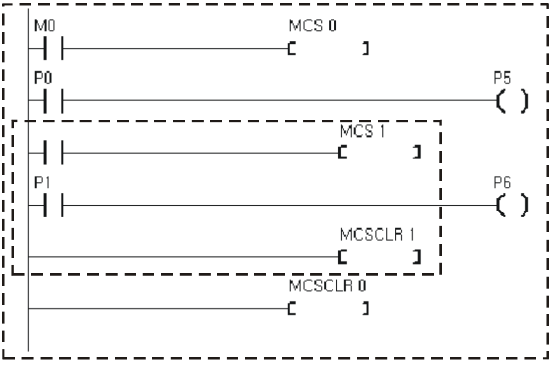
In the above example, when M0 turns ON, Ladder Logic between MCS 0 and MCSCLR are executed normally. If M0 is OFF, P5 and P6 will turn OFF.

MCS number can be used from 0 to 7. MCS number should be used from 0 increasingly to 1, 2, 3, etc… MCS 1 must exist inside MCS 0 and MCS 2 must exist inside MCS 0. Likewise up to 7 MCS blocks can be used. When MCS 0 is OFF, all MCS inside MCS 0 will turn OFF.

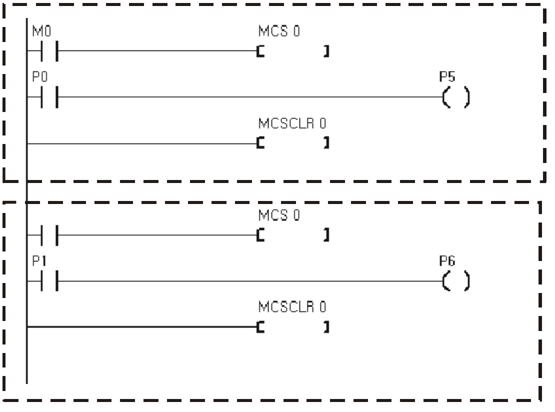
When MCS turns OFF, all outputs within that MCS block will turn OFF, Timer will be resetted, Counter will be stopped.

Command	When MCS is ON	When MCS is OFF
OUT	Normal Operation	OFF
SETOUT	Normal Operation	Maintain status after MCS turned OFF
RSTOUT	Normal Operation	Maintain status after MCS turned OFF
Timer	Normal Operation	Reset to default value
Counter	Normal Operation	Maintain status after MCS turned OFF
Other Commands	Normal Operation	Stop Operation

The following screenshot shows MCS used within another MCS.

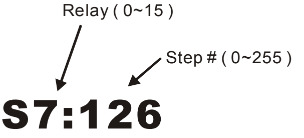


*You may simply re use MCS 0 if no additional MCS needs to reside within MCS.



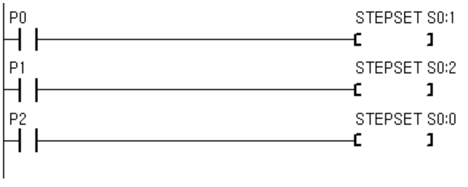
Step Control

S Register are used for step control. The following is the correct format for step control.

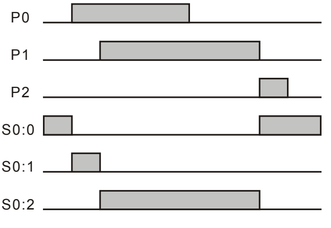


In Step Control, there's "normal step" and "reverse step". For normal step, we can simply use the STEPSET command.

STEPSET

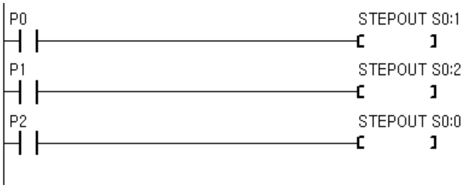


This command STEPSET will turn ON the current step if the previous step was ON. Since it operates in one step at a time, we call it STEPSET. For example, in the above ladder diagram, when P1 turns ON, S0:2 is turned ON if S0:1 is turned ON. S0:1 is turned OFF. When P2 turns ON, S0:0 is turned ON and other steps are turned off. S0:0, or step 0 is used for reset. Otherwise STEPSET will move in order.

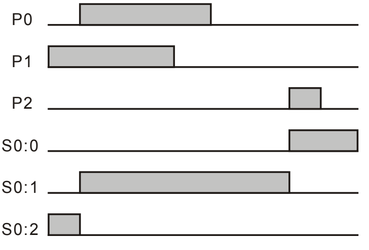


STEPOUT

This command STEPOUT will only 1 step to be enabled at all times. The last step to be turned ON will be the step to be enabled at any given moment.



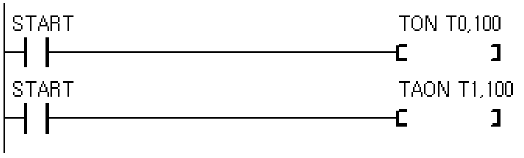
When P1 turns ON, S0:2 turn ON. When P0 turns on S0:1 turns ON. A step will be kept on until another step is turned ON.



TON, TAON

When input turns ON, timer value is decremented and output turns on when timer is done. There are two kinds of timers, one that works in 0.01 second units and another that works in .1 second units.

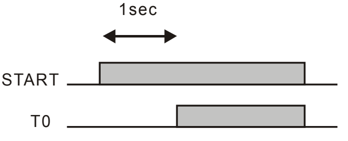
Type of Timer	Time units	Maximum Time
TON	0.01 sec	655.35 sec
TAON	0.1 sec	6553.5 sec



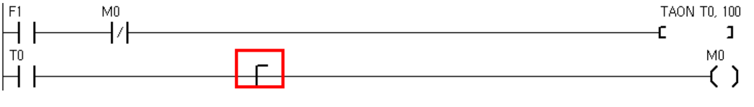
There are 2 parameters with commands TON, TAON. For the first parameter, you can choose between T0 to T99 and for the second parameter, you may use a number or a data memory such as D0.

Usable Registers	P	M	F	S	C	T	D	Constants
TON, TAON					O	O	O	O

In the above LADDER diagram, when START turns ON, T0 Timer will start from zero to 100. When 100 is reached, T0 will turn on. Here, 100 is equal to 1 second for TON and 10 seconds for TAON.



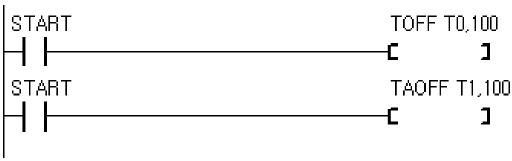
When START turns OFF, the timer is reset to original set value of 100 and T0 turn off too. TON, TAON commands will reset its timer values upon powering OFF. To use the features of battery backup, you can use KTON, KTAON which will maintain its values when powered OFF. Below is an example of how to reset TAON.



TOFF, TAOFF

When input turns ON, output turns ON immediately. When the input turns OFF, the output is kept ON until set amount of time. Like TON and TAON, there are 2 commands for two different time units.

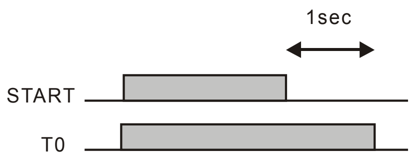
Type of Timer	Time units	Maximum Time
TOFF	0.01 sec	655.35 sec
TAOFF	0.1 sec	6553.5 sec



There are 2 parameters with commands TOFF, TAOFF For the first parameter, you can choose between T0 to T99 and for the second parameter, you may use a number or a data memory such as D0.

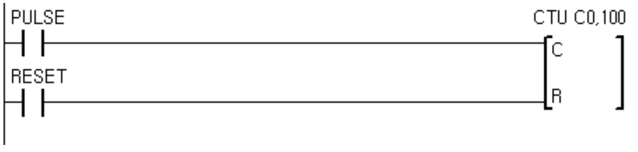
Usable Registers	P	M	F	S	C	T	D	Constants
TOFF, TAOFF					O	O	O	O

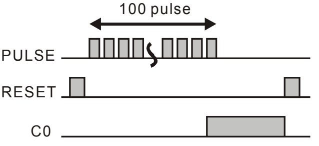
In the above LADDER diagram, when START turns ON, T0 Timer will immediately turn ON. After START turns OFF, timer will start decreasing from 100 to 0. When 0 is reached, T0 will turn OFF.
Here, 100 is equal to 1 second for TON and 10 seconds for TAOFF.



CTU

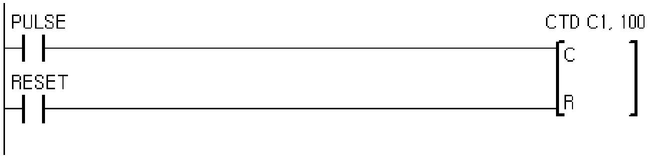
This command is an UP Counter. When input is received the counter is incremented one. When the counter counts to a specified value, the set Register will turn ON at that point. There is a Reset input so the counter can be reset as needed.

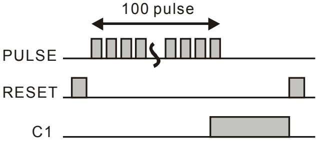




CTD

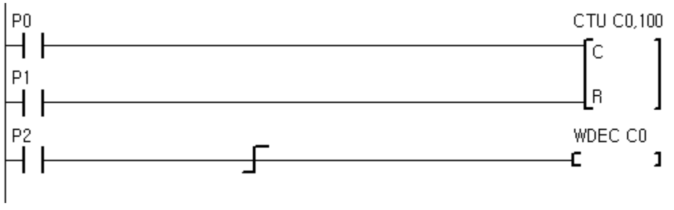
This command is a DOWN Counter. When input is received the counter is decremented one. When the counter reaches 0, the set Register will turn ON at that point. There is a Reset input so the counter can be reset as needed.



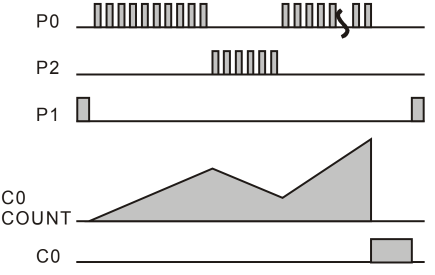


UP/DOWN COUNTER

Below is a simple way of how UP Counter can be used to make a UP/DOWN Counter.

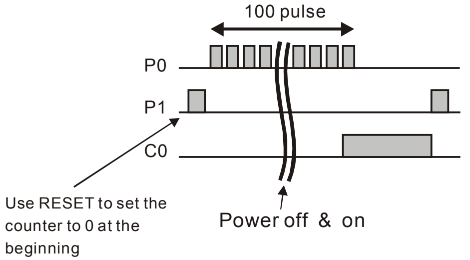


P0 is for counting UP, P2 is for counting DOWN, and P1 is for resetting the COUNTER. When Counter reaches 100, C0 turns ON.



KCTU

This command is exactly same as CTU command except, this command will be able to remember counter value when module is powered off. The module used for this command MUST support battery backup(CB290). In comparison, CTU command will lose its count value when the module is powered off.



When using this command for the very first time, please use the RESET signal to reset the counter value. Otherwise counter will start at the last value it was set. (random if not set before)

KCTD

This command is exactly same as CTD command except, this command will be able to remember counter value when module is powered off. The module used for this command MUST support battery backup(CB290). In comparison, CTD command will lose its count value when the module is powered off.

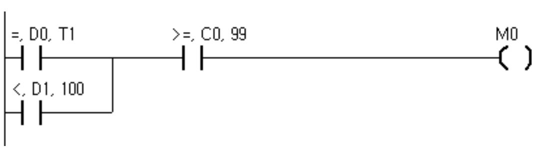
KCTU, KCTD must be used with modules that support "Battery-Backup" such as the CB290.

Comparison Logic

Compare 2 Words(16 bit) or 2 Double Words(32 bit) values and turn on Output when the conditions are satisfied.

Comparison Command	Data Types	Explanation
=, s1, s2	Word(16 bit)	When s1 and s2 are same Output turns ON.
<>, s1, s2	Word(16 bit)	When s1 and s2 are different, Output turns ON.
>, s1, s2	Word(16 bit)	When s1 > s2, Output turns ON.
<, s1, s2	Word(16 bit)	When s1 < s2, Output turns ON.
>=, s1, s2	Word(16 bit)	When s1 >= s2, Output turns ON.
<=, s1, s2	Word(16 bit)	When s1 <= s2, Output turns ON.
D=, s1, s2	DWord(32 bit)	When s1 and s2 are same Output turns ON.
D<>, s1, s2	DWord(32 bit)	When s1 and s2 are different, Output turns ON.
D>, s1, s2	DWord(32 bit)	When s1 > s2, Output turns ON.
D<, s1, s2	DWord(32 bit)	When s1 < s2, Output turns ON.
D>=, s1, s2	DWord(32 bit)	When s1 >= s2, Output turns ON.
D<=, s1, s2	DWord(32 bit)	When s1 <= s2, Output turns ON.

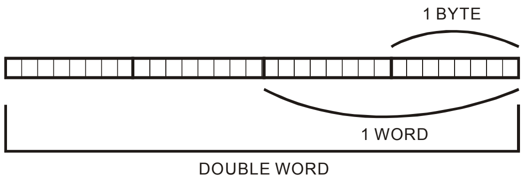
You can mix different comparisons as shown below:



When either D0=T1 or D1<100 and if C0>=99, M0 will turn ON. In other words, either D0 has to equal to value of T1 or D1 has to be less than 100 while C0 must be larger or equal to 99.

How to store Words and Double Words

Byte is 8 bits, Word is 16 bits, and Double Word is 32 bits.



There are 2 ways to store Word of Double Word size of data. A Word or Double Word can be stored starting from the LOW BYTE or from the HIGH BYTE. In CUBLOC, it is stored from the LOW BYTE or LSB(Least Significant Byte).

As you can see below, 1234H is stored in Memory Address 0 and 12345678H is stored in Memory Address 5. In every Memory Address, 1 byte of data is stored.

0	34
1	12
2	
3	
4	
5	78
6	56
7	34
8	12
9	

The Registers C, T, D are in units of Words. To store a Double Word data, 2 Word spaces will be required, meaning two Register spaces. Below is an example of store a Double Word data, 12345678H. D1 gets 1234H and D0 gets 5678H.

D0	5678
D1	1234
D2	
D3	
D4	

Binary, Decimal, Hexadecimal

To program well, we need to know binary decimal, and hexadecimal numbers. The following chart shows the relationships between these three types of number representation.

Decimal	Binary	Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

In CUBLOC's Ladder Logic, we express binary and hexadecimal numbers in the following manner:

Binary: 00101010B
Hexadecimal: 0ABCDH

We put a B at the end of the binary number and an H for hexadecimal numbers. To clearly identify that ABCD is a number, we can put a 0 in front of the hexadecimal number.
(E.g. : 0ABH, 0A1H, 0BCDH)

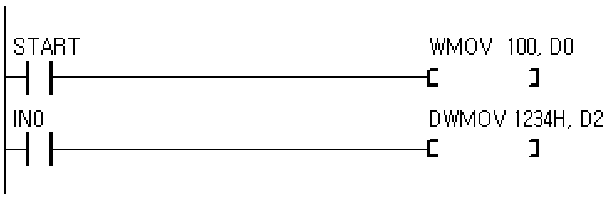
*In BASIC, it is slightly different from LADDER in the way you express binary and hexadecimal numbers. We use &B100010 or &HAB to express those type of numbers.

WMOV, DWMOV

WMOV   s, d
DWMOV   s, d

The command WMOV moves 16 bit data from s to d. DWMOV can be used for 32 bit data.

Usable Register	P	M	F	S	C	T	D	Constants
s (Source)					O	O	O	O
d (Destination)					O	O	O	



When input START turns ON, D0 will get 100. When IN0 turns ON, D2 will get 1234H.

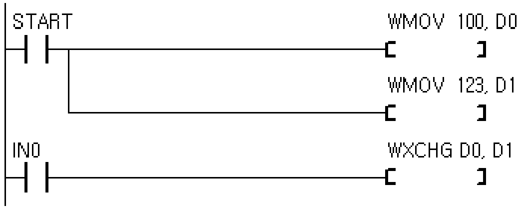
D0	100
D1	
D2	1234H
D3	0
D4	

WXCHG, DWXCHG

WXCHG s, d
DWXCHG s, d

The command WXCHG exchanges data between s and d. WXCHG is for exchanging 1 Word and DWXCHG is for exchanging Double Word.

Usable Registers	P	M	F	S	C	T	D	Constants
s					O	O	O	
d					O	O	O	



When START turns ON, D0 gets 100 and D1 gets 123. When IN0 turns ON, D0 and D1 exchange their data. The result is as shown below:

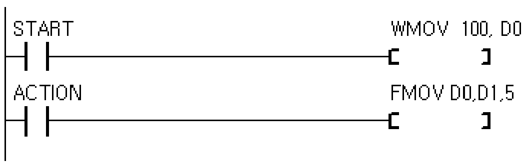
D0	123
D1	100
D2	
D3	
D4	

FMOV

FMOV   s, d, n

Store value in s to d and n number of times after that to additional locations. This command is usually used for initializing or clearing memory.

Usable Registers	P	M	F	S	C	T	D	Constants
s					O	O	O	
d					O	O	O	
n								O



Below is result of LADDER execution:

D0	100
D1	100
D2	100
D3	100
D4	100
D5	100

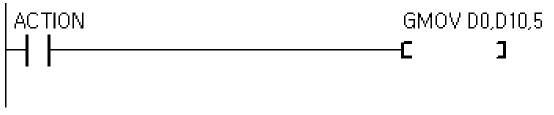
*Notice: Please Set n less than 255.

GMOV

GMOV   s, d, n

Store value starting at s to d by n memory locations.   Please make sure not to overlap memory locations as this could cause data collisions.

Usable Registers	P	M	F	S	C	T	D	Constants
s					O	O	O	
d					O	O	O	
n								O



Below is result of LADDER execution:

D0	12
D1	34
D2	56
D3	78
D4	90
D5	
D6	
D7	
D8	
D9	
D10	12
D11	34
D12	56
D13	78
D14	90
D15	
D16	

*Notice: Please Set n less than 255.

WINC, DWINC, WDEC, DWDEC

WINC d
DWINC d
WDEC d
DWDEC d

WINC increments Word value in d by one.
DWINC increments Double Word value in d by one.
WDEC decrements Word value in d by one.
DWDEC decrements Double Word value in d by one.

Usable Registers	P	M	F	S	C	T	D	Constants
d					O	O	O	

Below is result of LADDER execution:

D0	99
D1	
D2	
D3	

WADD, DWADD

WADD   s1, s2, d
DWADD   s1, s2, d

Add s1 and s2 and store result in d.
WADD is for Word values and DWADD is for Double Word Values.

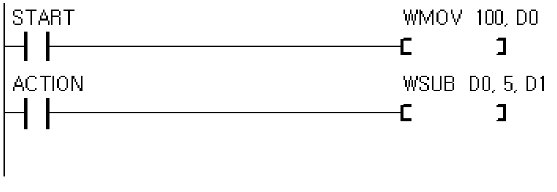
Usable Registers	P	M	F	S	C	T	D	Constants
s1					O	O	O	O
s2					O	O	O	O
d					O	O	O	

WSUB, DWSUB

WSUB   s1, s2, d
DWSUB   s1, s2, d

Subtract s2 from s1 and store result in d.
WSUB is for Word values and DWSUB is for Double Word Values.

Usable Registers	P	M	F	S	C	T	D	Constants
s1					O	O	O	O
s2					O	O	O	O
d					O	O	O	



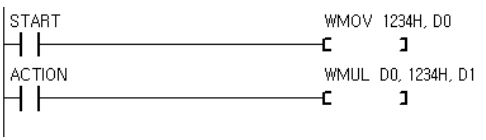
D1 gets 95 in the above LADDER diagram.

WMUL, DWMUL

WMUL   s1, s2, d
DWMUL   s1, s2, d

Multiply s1 and s2 and store result in d.
WMUL is for Word values and DWMUL is for Double Word Values.

Usable Registers	P	M	F	S	C	T	D	Constants
s1					O	O	O	O
s2					O	O	O	O
d					O	O	O	



The result of 1234H * 1234H is stored in D1 as a double word of 14B5A90H.

D0	1234H
D1	5A90H
D2	14BH

The result of 123456H * 1234H is stored as 4B60AD78H in D2

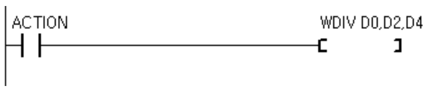
D0	3456H
D1	0012H
D2	0AD78H
D3	4B60H
D4	0
D5	0

WDIV, DWDIV

WDIV   s1, s2, d
DWDIV   s1, s2, d

Divide s1 by s2 and store the result in d and leftover in d+1.
WDIV is for Word values and DWDIV is for Double Word Values.

Usable Registers	P	M	F	S	C	T	D	Constants
s1					O	O	O	O
s2					O	O	O	O
d					O	O	O	



D0	1234H
D1	
D2	3
D3	
D4	611H
D5	1

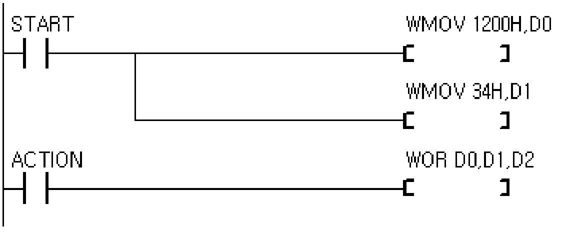
D0	5678H
D1	1234H
D2	7
D3	0
D4	0C335H
D5	299H
D6	5
D7	0

WOR, DWOR

WOR   s1,   s2,   d
DWOR   s1,   s2,   d

Do Logical operation OR on s1 and S2 and store result in d.
WOR is for Word values and DWOR is for Double Word Values.

Usable Registers	P	M	F	S	C	T	D	Constants
s1					O	O	O	O
s2					O	O	O	O
d					O	O	O	



The result of above ladder diagram:

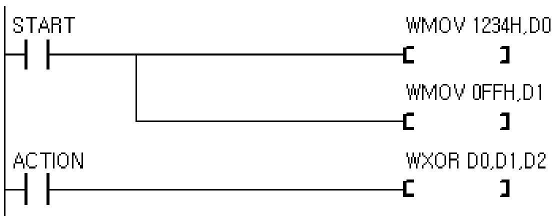
D0	1200H
D1	34H
D2	1234H

WXOR, DWXOR

WXOR s1, s2, d
DWXOR s1, s2, d

Store result of s1 XOR s.
WXOR is for logical operation XOR in WORD units whereas DWXOR is for DOUBLE WORD units.

Usable Registers	P	M	F	S	C	T	D	Constants
s1					O	O	O	O
s2					O	O	O	O
d					O	O	O	



The following is result of above LADDER:

D0	1234H
D1	0FFH
D2	12CBH

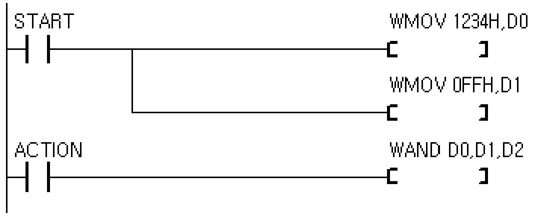
When you want to invert specific bits, you can use XOR logical operation.

WAND, DWAND

WAND s1, s2, d
DWAND s1, s2, d

Store result of s1 AND s2. WAND is for logical operation AND in WORD units whereas DWAND is for DOUBLE WORD units.

Registers that may be used	P	M	F	S	C	T	D	Constants
s1					O	O	O	O
s2					O	O	O	O
D					O	O	O	



The results of execution of LADDER above:

D0	1234H
D1	0FFH
D2	34H

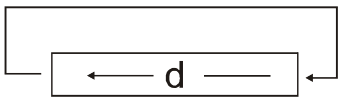
You can use AND operation when you want to use specific bits only.

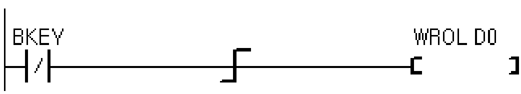
WROL, DWROL

WROL d
DWROL d

Rotate the value on Register d 1 (double) word to the left. The value left gets stored in the Carry flag. WROL moves one word whereas DWROL moves double word.

Registers that may be used	P	M	F	S	C	T	D	Constants
d					O	O	O	





If D0 has 8421H, the following results:

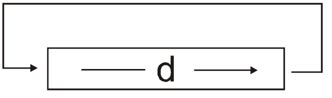
D0	0843H
D1	

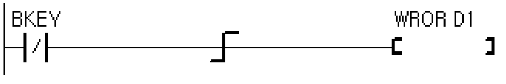
WROR, DWROR

WROR d
DWROR d

Rotate the value on Register d 1 (double) word to the right. The value left gets stored in the Carry flag. WROL moves one word whereas DWROL moves double word.

Registers that may be used	P	M	F	S	C	T	D	Constants
d					O	O	O	





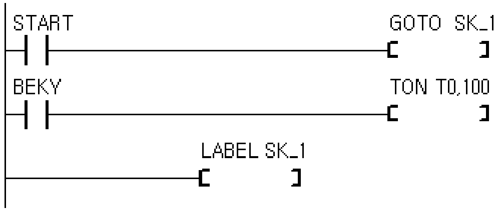
If D1 has 8421H, the following results:

D0	
D1	0C210H

GOTO, LABEL

GOTO label
LABEL label

The command GOTO will jump to the specified label. Label is for declaring labels.



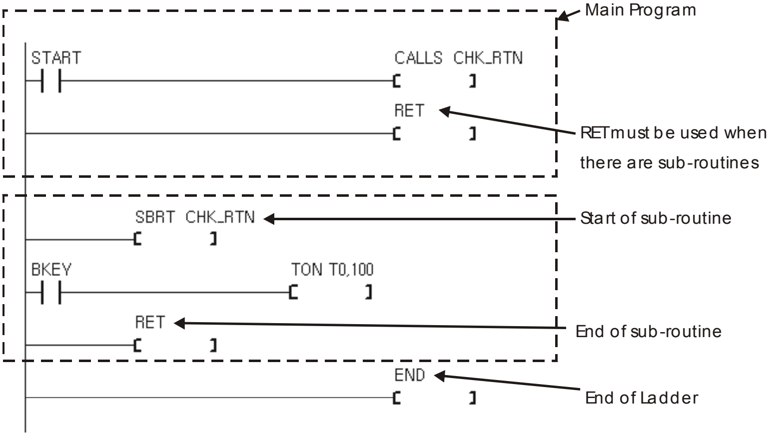
When START turns ON, the LADDER program will jump to label SK_1

In the below example LADDER diagram, when D0 equals C0, the program will jump to SK_1.

CALLS, SBRT, RET

CALLS   label
SBRT   label

CALLS will call a sub-routine.
SBRT is the starting point for a sub-routine.
RET is the ending point for a sub-routine.



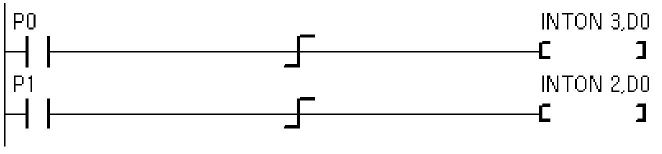
Please be aware that when adding sub-routines to your program, you need to add RET to the end of main program to differentiate from sub-routines. END goes at the very end of main program and sub-routines in this case.

INTON

INTON   s,d

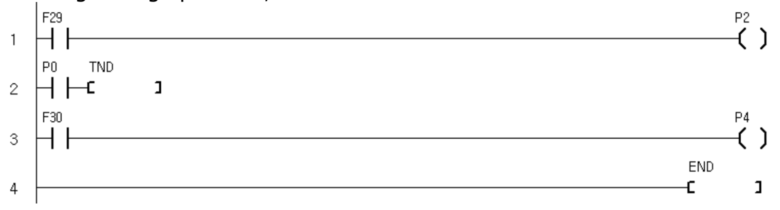
INTON is same as WMOV command except it can cause an interrupt in BASIC part of CUBLOC.

Usually Registers	P	M	F	S	C	T	D	Constants
s (Source)					O	O	O	O
d (Destination)					O	O	O	



TND

TND is a conditional exit command. When the user wants to abort Ladder scanning during operation, TND can be used.



When P0 turns ON, Ladderscan will abort.

You can also use it for exiting from sub-routines when a certain condition is met. In the above example, when P1 turns ON, the subroutine will be aborted, but Ladder scanning will keep executing.

Special Registers

You can use special Registers to find out about the current status of CUBLOC or use them for timing functions and applications.

Special Register	Explanation
F0	Always OFF
F1	Always ON
F2	Turn on 1 SCAN time at POWER UP (Set Ladder On).
F3	
F4	
F5	
F6	
F7	
F8	1 SCAN On every 10ms
F9	1 SCAN On every 100ms
F10	
F11	
F12	
F13	
F14	
F15	
F16	Repeat ON/OFF every 1 Scan time.
F17	Repeat ON/OFF every 2 Scan times.
F18	Repeat ON/OFF every 4 Scan times.
F19	Repeat ON/OFF every 8 Scan times.
F20	Repeat ON/OFF every 16 Scan times.
F21	Repeat ON/OFF every 32 Scan times.
F22	Repeat ON/OFF every 64 Scan times.
F23	Repeat ON/OFF every 128 Scan times.
F24	Repeat ON/OFF every 10ms
F25	Repeat ON/OFF every 20ms
F26	Repeat ON/OFF every 40ms
F27	Repeat ON/OFF every 80ms
F28	Repeat ON/OFF every 160ms
F29	Repeat ON/OFF every 320ms
F30	Repeat ON/OFF every 640ms
F31	Repeat ON/OFF every 1.28 seconds
F32	Repeat ON/OFF every 5.12 seconds
F33	Repeat ON/OFF every 10.24 seconds
F34	Repeat ON/OFF every 20.48 seconds
F35	Repeat ON/OFF every 40.96 seconds
F36	Repeat ON/OFF every 81.92 seconds
F37	Repeat ON/OFF every 163.84 seconds
F38	Repeat ON/OFF every 327.68 seconds
F39	Repeat ON/OFF every 655.36 seconds
F40	Call LADDERINT in BASIC
F41	
F42	

* If you write 1 to F40, you can create a LADDERINT in BASIC. Please refer to ON LADDERINT GOSUB command for details.

* F2 causes 1 Scan ON at the time of BASIC's SET LADDER ON command.

*Blank special Registers are reserved. Please do not use them.

Integrated Touch Screen Controller

CUTOUCH

User Manual

"Everything for Embedded Control"

COMFILE TECHNOLOGY

Comfile Technology Inc.
www.comfiletech.com

Preface

CUTOUCH is a complete integration of a Touch panel, graphic LCD, and CUBLOC embedded computer. In the recent years, there has been increase of use of touch screens in the industrial field. But to use one, the user required connecting to a PLC and learning complex methods in order to use it. In addition, cost of touch screen has been very expensive.

Our CUTOUCH is a new type of embedded controller that integrates Touch screen, PLC, and graphic LCD, all into one.

The biggest difference between CUTOUCH and other touch screens is that it's the only Visual Touch screen controller that can be programmed with BASIC and LADDER in the world today.

BASIC language can be used to draw graphics and print characters to the LCD and receive input from the touch screen before processing the x and y positions. Sensor input through I/O, turning relays on/off, AD/DA conversion, and RS232 communication are very easy to implement in comparisons to traditional non-BASIC PLCs. With the Ladder Logic side of CUBLOC, the user may do sequential processing and real-time logic processing as in traditional PLCs.

CUTOUCH has a flash memory for BASIC and LADDER programs. A serial port can be used to download and debug. After downloading is done, it can run in a "Stand-alone" state.

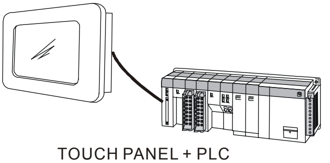
If you are thinking about developing a device that uses a touch screen, please review CUTOUCH and we guarantee you that you will ultimately spend more time designing and less time developing.

Comfile Technology Inc.

What is CUTOUCH?

CUTOUCH is different from the traditional Touch-screens you may associate with. Traditional Touch-screens are not a complete integrated solution to your application. They are usually Touch-screen panels that will only process graphics and touch input. In other words, most Touch-screens can not be used as a industrial controller as well as graphic LCD and touch input.

CUTOUCH is complete integration of a traditional PLC with a Touch-screen graphic LCD. By integrating user input, display output, and control, developers now can put one Touch panel as a control system.



TOUCH PANEL + PLC

CUTOUCH

CUTOUCH Specifications

Processor	CUTOUCH CT1720	CUTOUCH CT1721
Microprocessor	Dual Core Atmega128 @ 18.432Mhz	Dual Core Atmega128 @ 18.432Mhz
Program Memory (Flash)	80KB	80KB
Data Memory (RAM)	24KB(BASIC)+4KB(Ladder Logic)	24KB(BASIC)+4KB(Ladder Logic)
EEPROM	4KB EEPROM	4KB EEPROM
Program Speed	36,000/sec	36,000/sec
General Purpose I/O	- 82 I/O lines (ALL 5V TTL) (33 input only + 32 output only + 17 input/output configurable)	- 82 I/O lines (TTL & 24V DC) (1 TTL input, 32 24V opto-isolated inputs + 32 24V TR outputs + 17 TTL input/output configurable)
Serial Ports for Communication	- 2 High-speed hardware-independent serial ports (Channel 0 & 1 : RS232C 12V) - Configurable Baud rates: 2400bps to 230,400 bps	- 2 High-speed hardware-independent serial ports (Channel 0 & 1 : RS232C 12V) - Configurable Baud rates: 2400bps to 230,400 bps
Analog Inputs	8 channel 10-bit ADCs Input Voltage Range: **0 to 5V**	8 channel 10-bit ADCs Configurable Voltage: **0 to 5V** OR **0 to 10V**
Analog Outputs	- 6 Channel 16-bit PWMs (DACs) - Output Voltage Range: **0 to 5V** - Configurable Frequency: **35hz to 1.5Mhz**	- 6 Channel 16-bit PWMs (DACs) - Output Voltage Range: **0 to 5V** - Configurable Frequencies: **35hz to 1.5Mhz**
External Interrupts	4 Channels	4 Channels
High Speed Counters	2 Channel 16-bit Counters (**up to 2Mhz**)	2 Channel 16-bit Counters (**up to 2Mhz**)
Power	- Required Power: **9-24V DC** - Current Consumption w/ ports unloaded: @ 24V w/ Backlight ON: 170mA @ 24V w/ Backlight OFF: 70mA @ 12V w/ Backlight ON: 340mA 12V w/ Backlight OFF: 130mA	- Required Power: **24V DC** - Current Consumption w/ ports unloaded: @ 24V w/ Backlight ON: 170mA @ 24V w/ Backlight OFF: 70mA @ 12V w/ Backlight ON: 340mA 12V w/ Backlight OFF: 130mA
RTC (Real Time Clock)	Yes	Yes
Timers	– 1 User Configurable Timer - Configurable Interval Units = 10ms	– 1 User Configurable Timer - Configurable Interval Units = 10ms
Data Memory Back-up	*Yes, a 1 Farad rechargeable Super-Capacitor **is included**.	*Yes, a 1 Farad rechargeable Super-Capacitor **is included**.
Operating Temperature	0 °C to 70 °C	0 °C to 70 °C
Package	Integrated Touch-screen Panel w/ 2mm Headers and 2.5mm RCABLE Headers	Integrated Touch-screen Panel w/ 2mm Headers and 2.5mm RCABLE Headers
Size	- 7.17" x 5.17" x 0.98" - (182.2 x 131.4 x 25 mm) - Viewing Area (Touch-sensitive): 4.5" x 3.4" (5.6" diagonal)	- 7.17" x 5.17" x 0.98" - (182.2 x 131.4 x 25 mm) - Viewing Area (Touch-sensitive): 4.5" x 3.4" (5.6" diagonal)

Hardware Requirements

To use CUTOUCH, the user may use a Windows XP, 2000, or 98 operating system equipped computer. If you would like to use it in Linux/Unix/Macintosh environment, you will need to install a virtual machine software of some type (such as VMware, etc…) that allows Windows operating system to run on it.
An **RS232 port** is also required or you may use a **USB-to-RS232C converter**. Download and Monitoring is possible when connected with the PC.

When CUTOUCH is disconnected from the PC, it goes into a STAND-ALONE state. The main program is stored in CUTOUCH's flash memory, and will be retained even with no power. The user may download new programs and erase them as many times as he or she wishes.

(Above: Picture of CUTOUCH ready for programming)

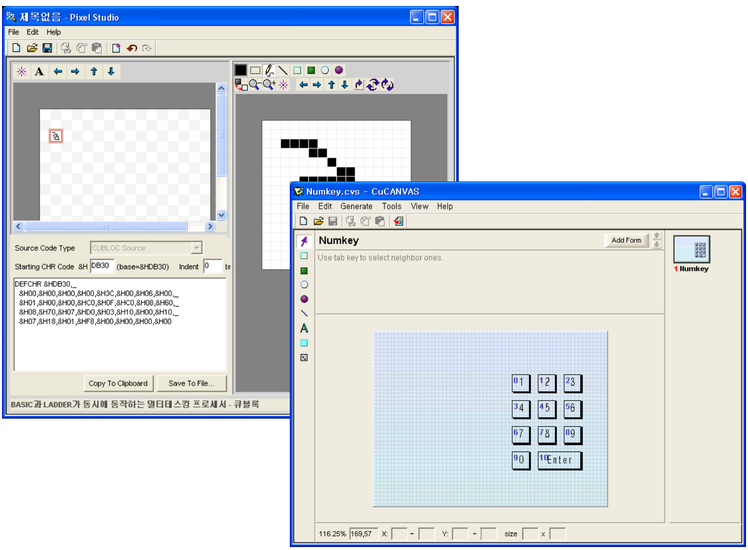
Software
Development Environment

CUTOUCH uses **CublocStudio** as its main development environment. For graphics, we have ***automatic code-generating GUI (Graphic User Interface) software*** called **CuCANVAS** and **PixelStudio**.

CublocStudio is used for ***BASIC and Ladder Logic programming*** on the CUTOUCH.

CuCANVAS is mainly used for ***creating boxes, circles, and menu buttons*** while **PixelStudio** allows the user to create ***up to 200 custom characters***.

All development software can be downloaded on our website under **Download->Integrated**.

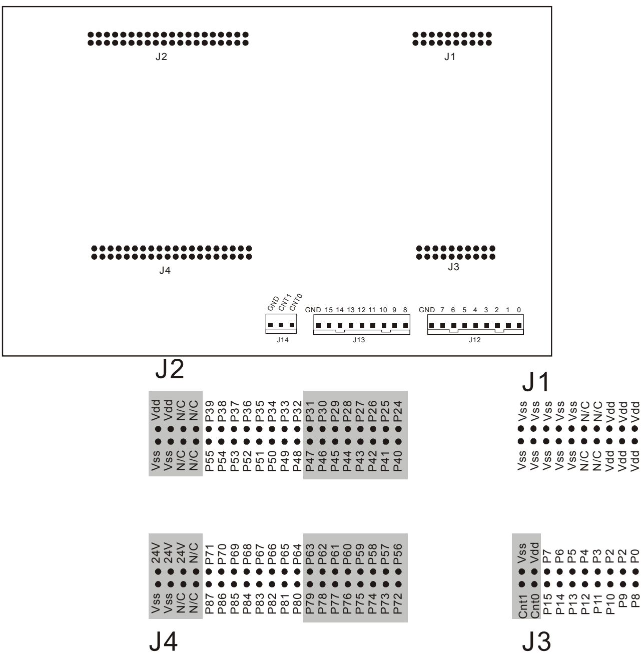


CUTOUCH I/O Ports

Model Name	CT1720
Input Only	33
Output Only	32
A/D Input (or I/O)	8
High Counter Input (or I/O)	2
Other I/Os	8
Total	82

CT1720

The 82 I/O ports on the CT1720 can be accessed using the connectors shown here:



*J1, J2, J3, J4 are 2mm pitch. A PCB board is recommended for TTL access. J12, J13, J14 are 2.5mm pitch RCABLE headers. Comfile RCABLE connectors can be used.

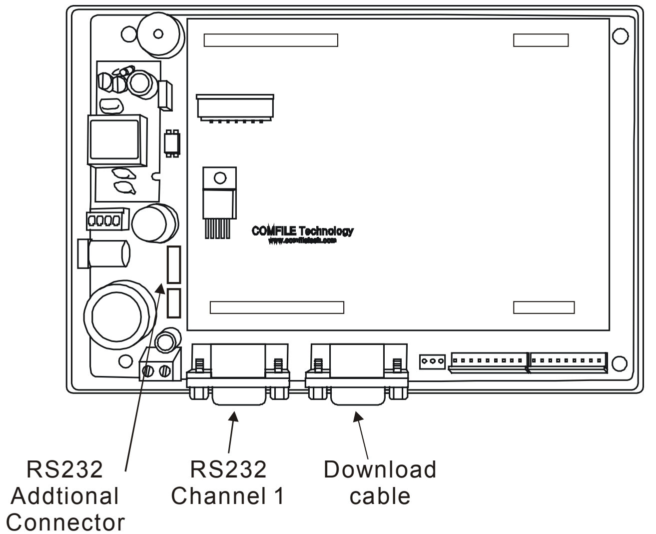
Connector	Name	I/O	Port Block	Explanation
J12 (J3)	P0	I/O	Block 0	ADC0
	P1	I/O		ADC1
	P2	I/O		ADC2
	P3	I/O		ADC3
	P4	I/O		ADC4
	P5	I/O		ADC5
	P6	I/O		ADC6
	P7	I/O		ADC7
J13 (J3)	P8	I/O	Block 1	PWM0
	P9	I/O		PWM1
	P10	I/O		PWM2
	P11	I/O		PWM3
	P12	I/O		PWM4 / INT0
	P13	I/O		PWM5 / INT1
	P14	I/O		INT2
	P15	I/O		INT3
J14	P16	I/O		HIGH COUNT INPUT 0
	P17	IN		HIGH COUNT INPUT 1
	P18	OUTPUT		Internally connected to Piezo BUZZER (Cannot be accessed from Ladder)
	P19 to P23			N/C
J2	P24 to 31	OUTPUT	Block 3	8 Output Ports
	P32 to 39	OUTPUT	Block 4	8 Output Ports
	P40 to 47	OUTPUT	Block 5	8 Output Ports
	P48 to 55	OUTPUT	Block 6	8 Output Ports
J4	P56 to 63	INPUT	Block 7	8 Input Ports
	P64 to 71	INPUT	Block 8	8 Input Ports
	P72 to 79	INPUT	Block 9	8 Input Ports
	P80 to 87	INPUT	Block 10	8 Input Ports

N/C = No Connection

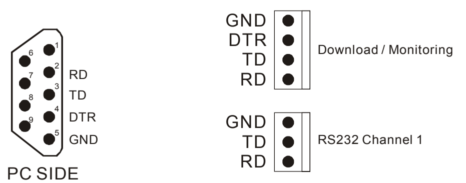
The CUTOUCH CT1720 I/O Ports are TTL 5V.
The CUTOUCH Add-On Board allows opto-isolated 24V DC inputs and 24V TR outputs for J1 to J4.
The CUTOUCH CT1721 is a combination of CT1720 and the Add-On Board.

*Please be careful to not input more than 5V into a CUTOUCH TTL ports as it can damage the product.

There are extra RS232 connectors as shown below so you have the flexibility to be able to access CUTOUCH when in an enclosed area.



The Download RS232 Channel is a 4-pin type connector and RS232 Channel 1 is a 3 pin type connector as shown below. You can connect them to the PC SIDE RS232 Pins as shown below:



Backup Battery

CUTOUCH will maintain data in its data memory after power OFF by using its backup battery. If backup is not needed, the program must clear the memory at the beginning of the program. Use RAMCLEAR at the beginning of your BASIC code section to clear all data memory at the start of the program.

*The CUTOUCH comes with a self-charging 1.0F super-capacitor which can last about a day (to 30hrs). You can replace it with a 10.0F super-capacitor to extend the duration to about 300 hours(12.5 days). Adding a battery can add up to 5+ years of backup depending on the battery capacity. For adding backup battery, please connect to the pins labeled, "External Battery," under the super-capacitor.

```
'
'   DEMO FOR CUTOUCH
'
Const Device = CT1720
Dim TX1 As Word, TY1 As Word
TX1 = 0
TY1 = 0      ` Clear just this variable
RAMCLEAR     ` Clear all RAM
```

For LADDER, all Registers S, M, C, T, and D are backed up by the backup battery. Register P is cleared at power ON by default. If you only want to clear parts of the Register, not all Registers, you can use the following method to clear:

```
Const Device = CT1720
Dim I As Integer
For I=0 to 32       ` Clear only Register M0 to M32
      _M(I) = 0
Next
Set Ladder On
```

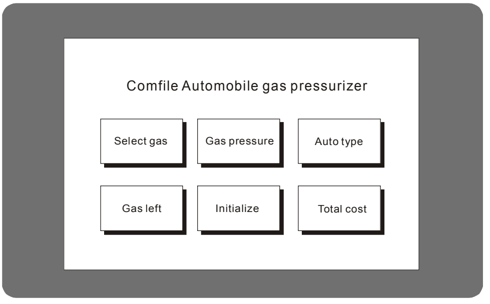
Most traditional PLCs have KEEP memory for storing and restoring data in case of power down. CUTOUCH also has this feature by using a super capacitor, which recharges itself and acts as a backup battery. You also have the option of using larger capacity capacitor or an actual battery.

KEEP Timer and KEEP Counter

KEEP timer will retain its data values when powered off and restart from the data values when power is turned on. KCTU and KCTD commands can be used in place of CTU and CTD commands in order to make use of this KEEP timer and KEEP counter. Please refer to KCTU, KCTD commands for detailed information.

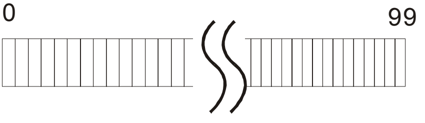
Menu System Library

CUTOUCH supports extra commands for easy-to-use menus. These commands make for easy creation and manipulation of the menus. With the menu system library, a menu system shown in the below picture can be made in less than 5 minutes.



MENU Commands

CUTOUCH has memory space for about 100 MENU buttons. Use MENUSET command to set the x and y axis positions and the style of the MENU. Then MENUTITLE command can be used to name the MENU. When touch input is received, MENUCHECK command can be used to decide which MENU button was pressed.



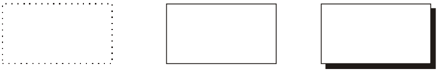
Each MENU button can be reset to another x and y axis positions and style by using MENUSET command. The only restriction is that up to 100 button can be inputted at time in one screen. But the user is free to reset each button to another usage after each screen, allowing infinite buttons.

Menuset

MENUSET   index, style, x1, y1, x2, y2

Index : Menu Index Number
Style : Button Style; 0=none, 1=Box, 2=Box with Shadow
X1,y1,x2,y2 : Menu Button location

Index value must be between 0 to 99. Style is the shape of the button, where 0 is for no box, 1 is for a box, and 2 is for a showed box.



0   1   2

x1,y1, x2, y2 are the x and y axis positions of the left upper and lower right corners. When this command is executed, the set part of the screen becomes part of the button's area.

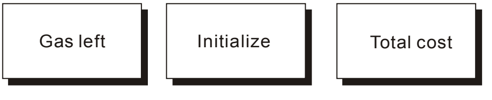
Menutitle

MENUTITLE   index, x, y, string

Index :Menu index number
X,y : Title location based on left upper corner of button
string : Name of the menu

Menuset only draws the box itself. Use Menutitle command to set the name of the menu like shown here:

```
Menutitle 0,13,13,"Gas Left"
Menutitle 1,16,13,"Initialize"
Menutitle 2,13,13,"Total Cost"
```



Menucheck( )

Variable = MENUCHECK(index, touchx, touchy)

Variable : Variable to store results (1 if selected, 0 if unselected)
Index : Menu Index Number
Touchx : Touch pad x axis point
Touchy : Touch pad y axis point

Use this command Menucheck to see which menu is selected. Touchx and Touchy are the user’s touchpad input points. If the Menu is selected, 1 is returned, otherwise 0 is returned.

```
If Menucheck(0,TX1,TY1) = 1 Then
      Menureverse 0
      Beep 18,180
End If
```

Menureverse

MENUREVERSE index

Index : Menu index number

Selected menu box is inverted.

Menu( )

Variable = MENU(index, pos)

Variable : Variable to store results (1 = selected, 0 = unselected)
Index : Menu Index
pos : Position (0=x1, 1=y1, 2=x2, 3=y2)

When you need to find the current status of Menu buttons set by Menuset command, you can use Menu() function to return the current status.
0 will read x2, 1 will read y1, 2 will read x2, and3 will read y2. It’s as though the MENU is accessed as 2 dimensional array.

```
If Menu(0,1) < 100 THEN ` If Menu button 0’ s Y1 is less than 100
```

Waitdraw

WAITDRAW

This command will wait for a drawing command to finish before resuming execution.

```
ELFILL  200,100,100,50  ` Fill an ellipse
WAITDRAW                ` Wait until drawing is finished.
```

This command is especially useful for animations and when you have trouble displaying graphics because of the speed.

CUTOUCH has an internal buffer for receiving graphic commands from CUBLOC. If this buffer fills up and data is sent to it, the data could get corrupted. In order to avoid these situations, you can use the WAITDRAW command to wait until the buffer has enough space before sending graphic commands.

If you need to draw graphics repeatedly, we recommend you use WAITDRAW to avoid situations where the LCD might get blurry or received noise.

This command can only be used with CUTOUCH.

Touch Pad Input Example

You can use SET PAD, ON PAD, and GETPAD commands to find out which menus were pressed from the user.

All PAD commands are geared for receiving and processing touch input.

We can use ON PAD interrupts to receive touch inputs. The following is an example program that uses the touch pad:

```
     '
     '  DEMO FOR CUTOUCH
     '
     Const Device = CT1720
     Dim TX1 As Word, TY1 As Word
     Set Pad 0,4,5              '← (1) Activate Touch PAD Input
     On Pad Gosub abc           '← (2) Declare pad interrupts
     Do
     Loop
abc:
     TX1 = Getpad(2)            '← (3) Interrupt Service routine
     TY1 = Getpad(2)
     Circlefill TX1,TY1,10      '← (4) Draw a circle where it
                                '      was touched
Return
```

(1) SET PAD 0, 4, 5 : This command will activate the PAD inputs. (Syntax: SET PAD mode, packet size, buffer size). CUTOUCH has a separate touch controller that will sense touch input and send back to the CPU through SPI protocol. This "touch controller" will create a signal that is equal to mode = 0. (MSB, RISING EDGE sampling) Input packets are 4 bytes each (X and Y each get 2 bytes). Buffer size is 5, 1 more than the actual packet size.

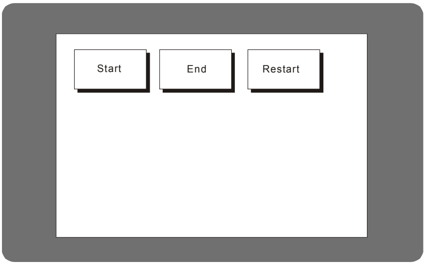
(2) ON Pad Gosub ABC: This command is for PAD interrupt declaration. When PAD input occurs, it will jump to label ABC.

(3) This is interrupt service routine. When PAD input occurs, this is part of the code until return will be executed. Getpad will read the data received from touch pad, 2 bytes for x position and 2 bytes for y position.

(4) Draw a circle where touch input was received.
When this program is executed, you will be able to see that wherever you press on the screen, a circle will appear. Please use this program as a skeleton for your touch programs.
The following is MENU command and ON PAD command example: When

button is pressed, a beep will sound from the piezo and the button will be inversed.

```
        '
        '   DEMO FOR CUTOUCH
        '
        Const Device = CT1720
        Dim TX1 As Integer, TY1 As Integer
        Dim k As Long
        Contrast 550
        Set Pad 0,4,5
        On Pad Gosub abc
        Menuset 0,2,8,16,87,63
        Menutitle 0,13,13,"Start"
        Menuset 1,2,96,16,176,63
        Menutitle 1,13,13,"End"
        Menuset 2,2,184,16,264,63
        Menutitle 2,13,13,"Restart"
        Low 18
        Do
        Loop
abc:
        TX1 = Getpad(2)
        TY1 = Getpad(2)
        Circlefill TX1,TY1,10
        If Menucheck(0,TX1,TY1) = 1 Then
        Menureverse 0
               Pulsout 18,300      ` Send out beep to piezo
        End If
        If Menucheck(1,TX1,TY1) = 1 Then
        Menureverse 1
               Pulsout 18,300
        End If
        If Menucheck(2,TX1,TY1) = 1 Then
        Menureverse 2
        Pulsout 18,300
        End If
        Return
```



CUTOUCH Sample Programs

SAMPLE 1

Let's make a simple counter that will print to the screen. The source files used here are in your CUBLOC Studio installation directory. (Usually C:\Program Files\Comfile Tools\CublocStudio)

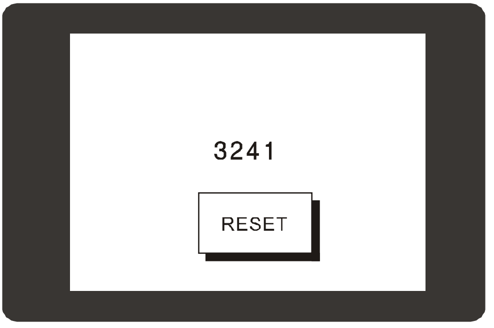
<Filename : CT001.CUL>

```
Const Device = Ct1720
Dim I As Integer
Contrast 550  ' LCD CONTRAST SETTING

Do
      Locate 15,6
      Print DEC5 I
      Incr I
      Delay 200
Loop
```

Please adjust your screen's contrast accordingly using CONTRAST command.
* Depending on the model, you may be able to adjust the contrast using a adjustable knob on the back of CUTOUCH. In this case, you have the option to set the contrast manually.

SAMPLE 2

The following example program will display RESET button and will increment number shown every time the button is pressed.



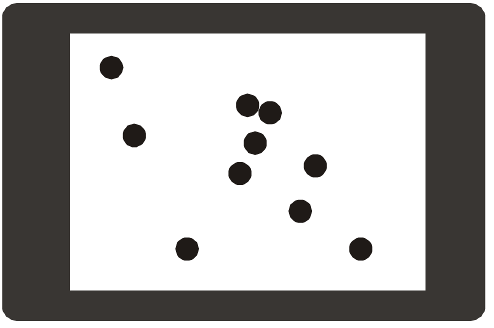
<Filename : CT002.CUL>

```
        Const Device = Ct1720
        Dim I As Integer
        Dim TX1 As Integer, TY1 As Integer
        Contrast 550
        Set Pad 0,4,5
        On Pad Gosub GETTOUCH
        Menuset 0,2,120,155,195,200
        Menutitle 0,20,14,"RESET"

        Do
                Locate 15,6
                Print DEC5 I
                Incr I
                Delay 200
        Loop

GETTOUCH:
        TX1 = Getpad(2)
        TY1 = Getpad(2)
        If Menucheck(0,TX1,TY1) = 1 Then
                Pulsout 18,300
                I = 0
        End If
        Return
```

SET PAD command activates touch input. ON PAD command is used to jump to a label when touch input is received. MENUSET command is used to set the desired touch input area and MENUTITLE command is used to set the name of the button itself. PULSEOUT outputs BEEP sound to the piezo.

SAMPLE 3

Draw a circle where your finger touches.

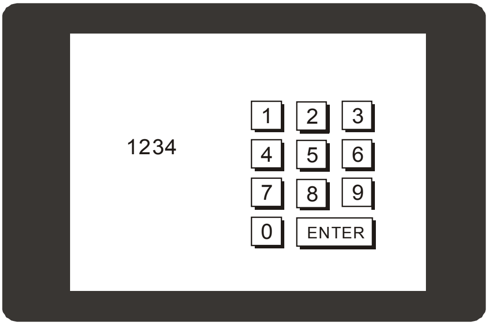


<Filename : CT003.CUL>

```
        Const Device = Ct1720
        Dim TX1 As Integer, TY1 As Integer
        Contrast 550
        Set Pad 0,4,5
        On Pad Gosub GETTOUCH
        Do
        Loop

GETTOUCH:
        TX1 = Getpad(2)
        TY1 = Getpad(2)
        Circlefill TX1,TY1,10
        Pulsout 18,300
        Return
```

SAMPLE 4

Make a virtual keypad and accept numerical values.



<Filename : CT004.CUL>

```
        Const Device = Ct1720
        Dim TX1 As Integer, TY1 As Integer
        Dim I As Integer
        Contrast 550
        Set Pad 0,4,5
        On Pad Gosub GETTOUCH
        Menuset 0,2,165,50,195,75
        Menutitle 0,11,4,"1"
        Menuset 1,2,205,50,235,75
        Menutitle 1,11,4,"2"
        Menuset 2,2,245,50,275,75
        Menutitle 2,11,4,"3"
        Menuset 3,2,165,85,195,110
        Menutitle 3,11,4,"4"
        Menuset 4,2,205,85,235,110
        Menutitle 4,11,4,"5"
        Menuset 5,2,245,85,275,110
        Menutitle 5,11,4,"6"
        Menuset 6,2,165,120,195,145
        Menutitle 6,11,4,"7"
        Menuset 7,2,205,120,235,145
        Menutitle 7,11,4,"8"
        Menuset 8,2,245,120,275,145
        Menutitle 8,11,4,"9"
        Menuset 9,2,165,155,195,180
        Menutitle 9,11,4,"0"
        Menuset 10,2,205,155,275,180
        Menutitle 10,17,4,"ENTER"
        I =0
        Do
        Loop
GETTOUCH:
```

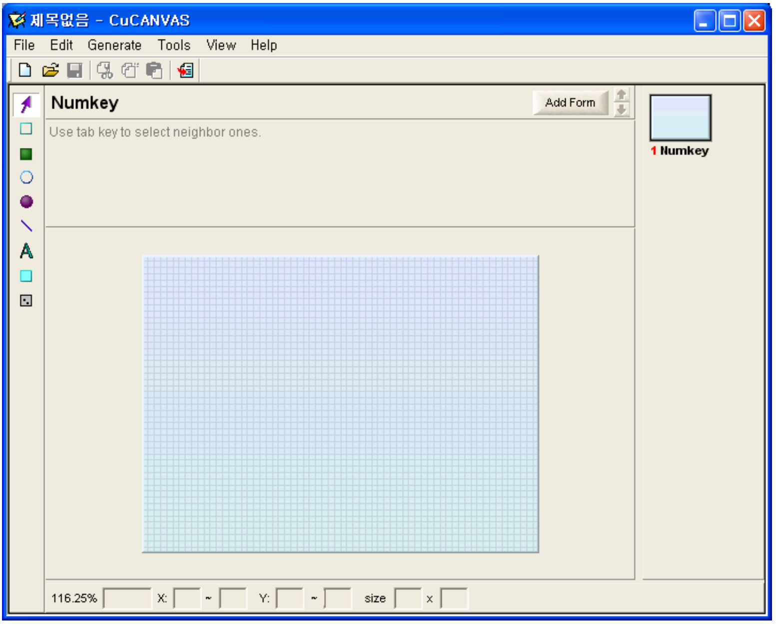
```
TX1 = Getpad(2)
TY1 = Getpad(2)
If Menucheck(0,TX1,TY1) = 1 Then
       I = I << 4
       I = I + 1
       Pulsout 18,300
Elseif Menucheck(1,TX1,TY1) = 1 Then
       I = I << 4
       I = I + 2
       Pulsout 18,300
Elseif Menucheck(2,TX1,TY1) = 1 Then
       I = I << 4
       I = I + 3
       Pulsout 18,300
Elseif Menucheck(3,TX1,TY1) = 1 Then
       I = I << 4
       I = I + 4
       Pulsout 18,300
Elseif Menucheck(4,TX1,TY1) = 1 Then
       I = I << 4
       I = I + 5
       Pulsout 18,300
Elseif Menucheck(5,TX1,TY1) = 1 Then
       I = I << 4
       I = I + 6
       Pulsout 18,300
Elseif Menucheck(6,TX1,TY1) = 1 Then
       I = I << 4
       I = I + 7
       Pulsout 18,300
Elseif Menucheck(7,TX1,TY1) = 1 Then
       I = I << 4
       I = I + 8
       Pulsout 18,300
Elseif Menucheck(8,TX1,TY1) = 1 Then
       I = I << 4
       I = I + 9
       Pulsout 18,300
Elseif Menucheck(9,TX1,TY1) = 1 Then
       I = I << 4
       Pulsout 18,300
Elseif Menucheck(10,TX1,TY1) = 1 Then
       I = 0
       Pulsout 18,300
End If
Locate 3,3
Print HEX4 I
Return
```

The final value I is stored as BCD code, you can use BCD2BIN command to convert back to a binary number.

SAMPLE 5

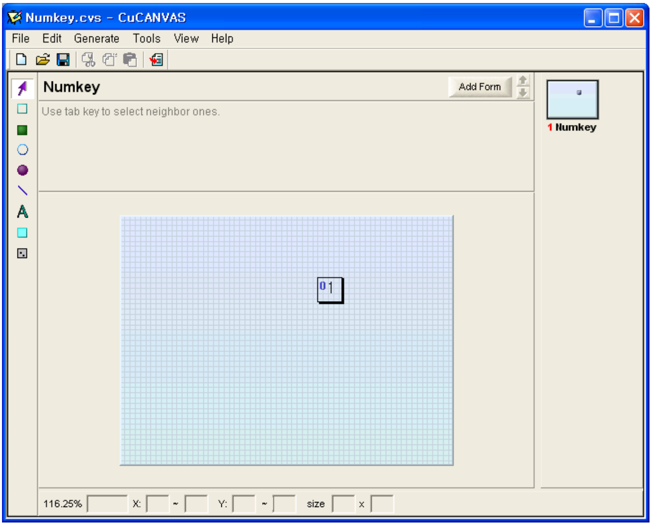
Let's try using CuCANVAS to make some menus. To create the virtual keypad shown in the previous page, it would take a longer time to just code it. We can save ourselves time by using CuCANVAS.

Please run CuCANVAS and press Add Form button on the upper right hand corner. Enter a desired name for your new form. (Here we used NUMKEY)

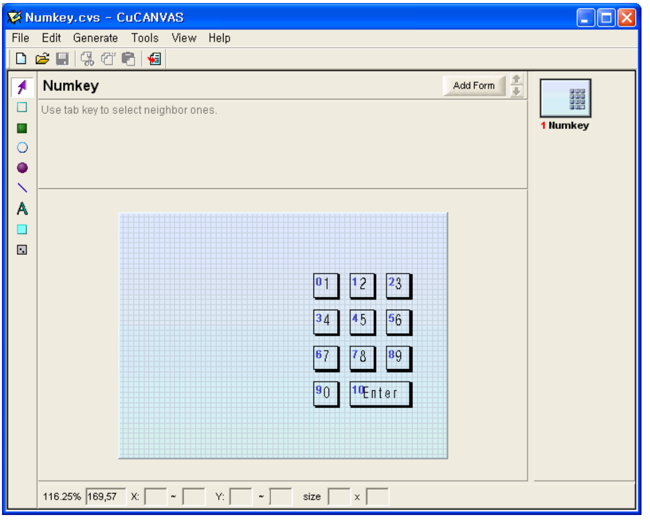


On the left side of CuCANVAS, you will see a tool bar with an arrow, box, filled box, circle, filled circle, line, text, and menu box. Please select the last button, menu box, and draw a small box on the screen.

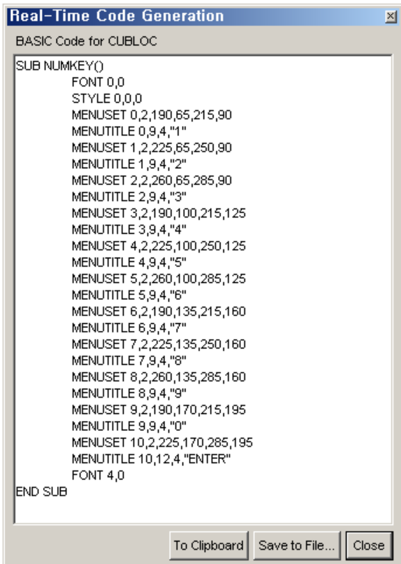
The 0 on the button means the menu number is 0. In the actual screen, this number will not be displayed. Please type "1" in the Title field on the top. You have successfully made a "1" button.



You can make the rest of the buttons and the keypad like the one shown below can be made in less than 5 minutes.



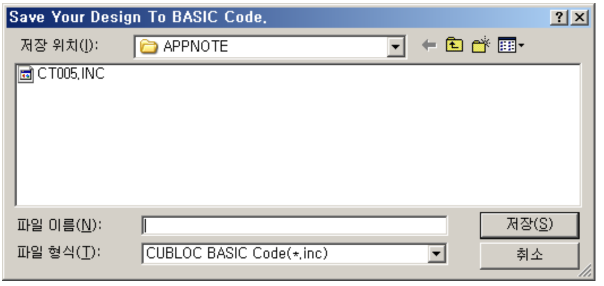
Now is the fun part. Simply click on Generate on the menu bar and click "View Basic Code." CuCANVAS will generate a sub function that includes the button that you have just created. Simply copy(Ctrl+C) and paste(CTRL+V) to CUBLOC Studio and wala! You have a menu in couple minutes. For copying, you can either press Ctrl+C or press on the "To Clipboard" button at the bottom.




```
SUB NUMKEY()
	FONT 0,0
	STYLE 0,0,0
	MENUSET 0,2,190,65,215,90
	MENUTITLE 0,9,4,"1"
	MENUSET 1,2,225,65,250,90
	MENUTITLE 1,9,4,"2"
	MENUSET 2,2,260,65,285,90
	MENUTITLE 2,9,4,"3"
	MENUSET 3,2,190,100,215,125
	MENUTITLE 3,9,4,"4"
	MENUSET 4,2,225,100,250,125
	MENUTITLE 4,9,4,"5"
	MENUSET 5,2,260,100,285,125
	MENUTITLE 5,9,4,"6"
	MENUSET 6,2,190,135,215,160
	MENUTITLE 6,9,4,"7"
	MENUSET 7,2,225,135,250,160
	MENUTITLE 7,9,4,"8"
	MENUSET 8,2,260,135,285,160
	MENUTITLE 8,9,4,"9"
	MENUSET 9,2,190,170,215,195
	MENUTITLE 9,9,4,"0"
	MENUSET 10,2,225,170,285,195
	MENUTITLE 10,12,4,"ENTER"
	FONT 4,0
END SUB
```

You can also use include files instead of copying and pasting for repetitive menu creations.

Click “Save to File” button and save as an include (*.inc) file.



Using the include file, you will be able to save lots of time and be able to make changes to your menus without making it a big copy and paste hassle.

The following program is exactly same as SAMPLE4 except we use include file for the virtual keypad.

<Filename : CT005.CUL>

```
        Const Device = Ct1720
        Dim TX1 As Integer, TY1 As Integer
        Dim I As Integer
        Contrast 550
        Set Pad 0,4,5
        On Pad Gosub GETTOUCH
        NUMKEY          ` Execute the Sub-routine in INCLUDE file
        I =0
        Do
        Loop

GETTOUCH:
        TX1 = Getpad(2)
        TY1 = Getpad(2)
        If Menucheck(0,TX1,TY1) = 1 Then
                I = I << 4
                I = I + 1
                Pulsout 18,300
        Elseif Menucheck(1,TX1,TY1) = 1 Then
                I = I << 4
                I = I + 2
                Pulsout 18,300
        Elseif Menucheck(2,TX1,TY1) = 1 Then
                I = I << 4
                I = I + 3
                Pulsout 18,300
        Elseif Menucheck(3,TX1,TY1) = 1 Then
                I = I << 4
```

```
                I = I + 4
                Pulsout 18,300
        Elseif Menucheck(4,TX1,TY1) = 1 Then
                I = I << 4
                I = I + 5
                Pulsout 18,300
        Elseif Menucheck(5,TX1,TY1) = 1 Then
                I = I << 4
                I = I + 6
                Pulsout 18,300
        Elseif Menucheck(6,TX1,TY1) = 1 Then
                I = I << 4
                I = I + 7
                Pulsout 18,300
        Elseif Menucheck(7,TX1,TY1) = 1 Then
                I = I << 4
                I = I + 8
                Pulsout 18,300
        Elseif Menucheck(8,TX1,TY1) = 1 Then
                I = I << 4
                I = I + 9
                Pulsout 18,300
        Elseif Menucheck(9,TX1,TY1) = 1 Then
                I = I << 4
                Pulsout 18,300
        Elseif Menucheck(10,TX1,TY1) = 1 Then
                I = 0
                Pulsout 18,300
        End If
        Locate 3,3
        Print HEX4 I

        Return

        End

#INCLUDE "CT005.INC"
```

We must include #include command at the end of the code. This is slightly different from other languages such as C++.

CUCANVS can download at www.comfiletech.com. CUCANVAS is free-ware.

APPENDIX

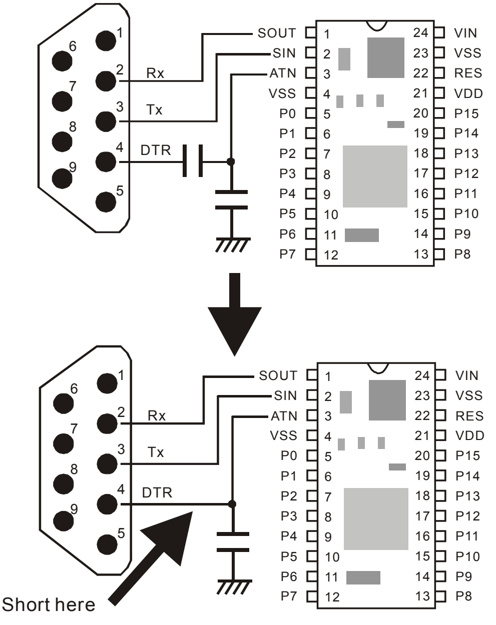
Appendix A. ASCII CODE

Code	char.	Code	char.	Code	char.	Code	char.
00H	NUL	20H	SPACE	40H	@	60H	`
01H	SOH	21H	!	41H	A	61H	a
02H	STX	22H	“	42H	B	62H	b
03H	ETX	23H	#	43H	C	63H	c
04H	EOT	24H	$	44H	D	64H	d
05H	ENQ	25H	%	45H	E	65H	e
06H	ACK	26H	&	46H	F	66H	f
07H	BEL	27H	‘	47H	G	67H	g
08H	BS	28H	(	48H	H	68H	h
09H	HT	29H	)	49H	I	69H	I
0AH	LF	2AH	*	4AH	J	6AH	j
0BH	VT	2BH	+	4BH	K	6BH	k
0CH	FF	2CH	,	4CH	L	6CH	l
0DH	CR	2DH	-	4DH	M	6DH	m
0EH	SO	2EH	.	4EH	N	6EH	n
0FH	SI	2FH	/	4FH	O	6FH	o
10H	DLE	30H	0	50H	P	70H	p
11H	DC1	31H	1	51H	Q	71H	q
12H	DC2	32H	2	52H	R	72H	r
13H	DC3	33H	3	53H	S	73H	s
14H	DC4	34H	4	54H	T	74H	t
15H	NAK	35H	5	55H	U	75H	u
16H	SYN	36H	6	56H	V	76H	v
17H	ETB	37H	7	57H	W	77H	w
18H	CAN	38H	8	58H	X	78H	x
19H	EM	39H	9	59H	Y	79H	y
1AH	SUB	3AH	:	5AH	Z	7AH	z
1BH	ESC	3BH	;	5BH	[	7BH	{
1CH	FS	3CH	<	5CH	\	7CH	|
1DH	GS	3DH	=	5DH	]	7DH	}
1EH	RS	3EH	>	5EH	^	7EH	~
1FH	US	3FH	?	5FH	_	7FH	DEL

Appendix B.
Note for BASIC STAMP users

When using Parallax's Basic Stamp compatible development board, please be aware of the following:

There is a capacitor on the Basic Stamp compatible development boards which causes download error in CUBLOC Studio. Please short (or take out) the extra capacitor connected to the DTR of the board as shown below. CB220 has a this capacitor on the chip itself.



Appendix C. Using Output Port on the CB290 / CT1720

Warning : CB290 rev A/ CT1720 rev A Output ports

Please be aware of the following when using CB290 (rev A) or CT1720 (rev A) with output ports (24 through 55).

When using CB290 or CT1720 with a backup battery (CB290 Proto-Board, Baseboard 64M, and CT1720), the data memory is saved during power OFF. Even the output on the I/O ports are saved to memory.

When powered ON, the output ports will recover from the status it was in at power OFF.

This is to let the modules be able to continue their existing processes in case of power outage.

Please be aware that when there are unknown values and battery backup is used, there can be garbage values at power ON, meaning unknown values outputting on the output ports.

Please use regular I/O ports if you need to make sure that the output needs to be OFF at power ON.

Using Output ports on the CB290 / CT1720 (Rev B)

The CB290/CT1720 (Rev B) output ports (P24-P55) are in high impendence (High-Z) state in order to prevent garbage values outputting at power ON.

You must use “Set OUTONLY ON” command to set the CB290 / CT1720 output ports to output status.

```
Set Outonly On
```

Appendix D. CUBLOC BASIC Command summary

Command	Usage
Adin ( )	Variable = ADIN (Channel) Variable : Variable to store results (No String or Single) Channel : AD Channel Number (not I/O Pin Number)
Alias	ALIAS Registername = AliasName Registername : Register name such as P0, M0, T0 *(Do not use D area)* AliasName : An Alias for the Register chosen *(up to 32 character)*
Arc	ARC x, y, r, start, end
Bcd2bin	Variable = BCD2BIN (bcdvalue) Variable : Variable to store results (Returns LONG*)* bcdvalue : BCD value to convert to binary
Bclr	BCLR channel, buffertype channel : RS232 Channel *(0 to 3)* buffertype : 0=Receive, 1=Send, 2=Both
Beep	BEEP Port, Length Port : Port number *(0 to 255)* Length : Pulse output period *(1 to 65535)*
Bfree	Variable = BFREE (channel, buffertype) Variable : Variable to store results (No String or Single) channel : RS232 Channel number *(0 to 3)* buffertype: 0=Receive Buffer, 1=Send Buffer
Bin2bcd	Variable = BIN2BCD (binvalue) Variable : Variable to store results (Returns Long) binvalue : Binary value to be converted
Blen	Variable = BLEN (channel, buffertype) Variable : Variable to store results (No String or Single) channel : RS232 Channel number *(0 to 3)* buffertype: 0=Receive Buffer, 1=Send Buffer
Bmp	BMP x, y, filenumber, layer X, y : x,y position to display BMP Filenumber : BMP File number Layer : Layer to display BMP

Box	BOX x1, y1, x2, y2
Boxclear	BOXCLEAR x1, y1, x2, y2
Boxfill	BOXFILL x1, y1, x2, y2,logic logic : 0=OR, 1=AND, 2=XOR
Bytein	Variable = BYTEIN (PortBlock) Variable : Variable to store results (No String or Single) PortBlock : I/O Port Block Number *(0 to 15)*
Byteout	BYTEOUT PortBlock, value PortBlock : I/O Port Block Number*. (0 to 15)* value : Value to be outputted between 0 and 255.
Circle	CIRCLE x, y, r
Circlefill	CIRCLEFILL x, y, r
Checkbf	Variable = CHECKBF (channel) Variable : Variable to store results (No String or Single) channel : RS232 Channel *(0 to 3)*
Color	COLOR value
Cls	CLS
Clear	CLEAR layer
Cmode	CMODE value value : 0=BOX type, 1=Underline type
Compare	COMPARE channel, target#, port, targetstate Channel : High Counter channel Target# : Target # of Pulses (CH0: 0 to 65535, CH1: 0 to 255) Port : Output Port (DO NOT USE Input-only Ports) Targetstate : Target Output Port State
Const	CONST name [as type] = value
Const (Array)	CONST type name [as type] = value [,value, value, value…] Type = Byte, Integer, Long, String Single
Contrast	CONTRAST value value : Contrast Value
Count	Variable = COUNT (channel) Variable : Variable to store results. (No String or Single) Channel : Counter Channel number *(0 to 1)*

Countreset	COUNTRESET channel Channel : Counter Channel *(0 to 1)*
Csroff	CSROFF
Csron	CSRON
Dcd	Variable = DCD source Variable : Variable to store results. (No String or Single) Source : source value
Debug	DEBUG data data : data to send to PC
Decr	DECR variable Variable : Variable for decrementing. (No String or Single)
Defchr	DEFCHR code, data Code : Custom character code (&hdb30 to &hdbff) Data : 32byte bitmap data
Delay	DELAY time Time : interval variable or constant
Dim	DIM variable As variabletype [,variable As variabletype] Variabletype : Byte, Integer, Long, Single, String
Dotsize	DOTSIZE value, style
Dp	Variable = DP(Variable, Decimal Places, ZeroPrint) ZeroPrint :If ZeroPrint is set to 1, zeros are substituted for blank spaces.
Dprint	DPRINT string
Dtzero	DTZERO variable Variable : Variable for decrement. (No String or Single)
Eadin	Variable = EADIN (mux) Variable : Variable to store results (No String or Single) mux : AD input Port Combination MUX *(0 to 21)*
Eeread	Variable = EEREAD (Address, ByteLength) Variable : Variable to store result (No String or Single) Address : 0 *to 40*95 ByteLength : Number of Bytes to read *(1 to 4)*
Eewrite	EEWRITE Address, Data, ByteLength Address : 0 to 4095 Data : Data to write to EEPROM (*up to Long type values*) ByteLength : Number of Bytes to write *(1 to 4)*

Ekeypad	Variable = EKEYPAD (portblockIn, portblockOut) Variable : Variable to store results (Returns Byte) PortblockIn : Port Block to receive input (*0 to 15*) PortblockOut : Port Block to output (*0 to 15*)
Ellipse	ELLIPSE x, y, r1, r2
Elfill	ELFILL x, y, r1, r2
Freepin	FREEPIN I/O I/O : I/O PORT Number
Font	FONT fontsize, efontwidth fontsize : 0 to 8 Font Selection efontwidth : 0 = fixed width, 1=variable width
Fp	Variable = FP (Value, , Whole Number Digits, Fractional Number Digits)
Freqout	FREQOUT Channel, FreqValue Channel : PWM Channel *(0 to 15)* FreqValue : Frequency value between 1 and 65535
Get	Variable = GET (channel, length) Variable : Variable to store results (Cannot use String, Single) channel : RS232 Channel *(0 to 3)* length : Length of data to receive (1 *to* 4)
Getcrc	GETCRC Variable, ArrayName, Bytelength variable : String Variable to store results (Integer type) ArrayName : Array with data(Must be a Byte array) Bytelength : # of bytes to calculate CRC
Getstr	Variable = GETSTR (channel, length) Variable : String Variable to store results channel : RS232 Channel length : Length of data to receive
Getstr2	Variable = GETSTR (channel, length, stopchar) Variable : String Variable to store results channel : RS232 Channel length : Length of data to receive Stopchar : Stop character ascii code
Geta	GETA channel, ArrayName, bytelength channel : RS232 Channel *(0 to 3)* ArrayName : Array to store Received data (No String or Single) Bytelength : Number of Bytes to store *(1 to 65535)*

Geta2	GETA channel, ArrayName, bytelength, stopchar channel : RS232 Channel *(0 to 3)* ArrayName : Array to store Received data (No String or Single) Bytelength : Number of Bytes to store *(1 to 65535)* Stopchar : Stop character ascii code
Glayer	GLAYER layernumber Layernumber : Set the graphic layer. (0,1,2)
Glocate	GLOCATE x, y
Gpaste	GPASTE x, y, layer, logic logic =0 : OR logic =1 : AND logic =2 : XOR logic =3 : Clear screen then pop
Gprint	GPRINT string
Gpush	GPUSH x1, y1, x2, y2, layer
Gpop	GPOP x, y, layer, logic logic =0 : OR logic =1 : AND logic =2 : XOR logic =3 : Clear screen then pop
Heap	Variable = HEAP (Address) Variable : Variable to store results Address : HEAP memory address
Heapclear	HEAPCLEAR
Heapw	HEAPW Address, Data Address : HEAP memory address Data : Constant or Variable with data (Byte only)
Hread	Variable = HREAD (Address, ByteLength) Variable : Variable to store results Address : HEAP memory address ByteLength : # of bytes to read, constant or variable
Hwrite	HWRITE Address, Data, ByteLength Address : HEAP memory address Data : Constant or Variable with data (whole numbers only) ByteLength : # of bytes to write
High	HIGH Port Port : I/O Port number
Hpaste	HPASTE x, y, layer

Hp	Variable = DP(Variable, Heximal Places, ZeroPrint) ZeroPrint :If ZeroPrint is set to 1, zeros are substituted for blank spaces.
Hpop	HPOP x, y, layer
Hpush	HPUSH x1, y1, x2, y2, layer
I2cstart	I2CSTART
I2cstop	I2CSTOP
I2cread	Variable = I2CREAD (dummy) Variable : Variable to store results. (No String or Single) dummy : dummy value. *(Normally 0)*
I2creadna	Variable = I2CREADNA (dummy) Variable : Variable to store results. (No String or Single) dummy : dummy value. *(Normally 0)*
I2cwrite	Variable = I2CWRITE data Variable : Acknowledge (*0*=Acknowledged, *1*=No Acknowledgement) data : data to send (Byte value : 0 to 255)
In	Variable = IN (Port) Variable : The variable to store result (No String or Single) Port : I/O Port number *(0 to 255)*
Incr	INCR variable Variable : Variable for increment. (No String or Single)
Input	INPUT Port Port : I/O Port number *(0 to 255)*
Keyin	Variable = KEYIN (Port, debouncingtime) Variable : Variable to store results (No String or Single) Port : Input Port *(0 to 255)* deboucingtime : Debouncing Time *(1 to 65535)*
Keyinh	Variable = KEYINH (Port, debouncingtime) Variable : Variable to store results (No String or Single) Port : Input Port *(0 to 255)* deboucingtime : Debouncing Time *(0 to 65535)*

Keypad	Variable = KEYPAD (PortBlock) Variable : Variable to store results (Returns Byte*,* No String or Single) PortBlock : Port Block *(0 to 15)*
Layer	LAYER layer1mode, layer2 mode, layer3 mode Layer1mode : Set Layer 1 mode (0=off, 1=on, 2=flash) Layer2mode : Set Layer 2 mode (0=off, 1=on, 2=flash) Layer3mode : Set Layer 3 mode (0=off, 1=on, 2=flash)
Ladderscan	LADDERSCAN
Light	LIGHT value value : Back light 0=OFF, 1=ON
Line	LINE x1, y1, x2, y2
Linestyle	LINESTYLE value
Lineto	LINETO x, y
Low	LOW Port Port : I/O Port number *(0 to 255)*
Locate	LOCATE X,Y
Menu	Variable = MENU (index, pos) Variable : Variable to store results (1 = selected, 0 = unselected) Index : Menu Index pos : Position (0=x1, 1=y1, 2=x2, 3=y2)
Memadr	Variable = MEMADR (TargetVariable) Variable : Variable to store results (No String or Single) TargetVariable : Variable to find physical memory address
Menucheck	Variable = MENUCHECK (index, touchx, touchy) Variable : Variable to store results (1 if selected, 0 if unselected) Index : Menu Index Number Touchx : Touch pad x axis point Touchy : Touch pad y axis point
Menu Reverse	MENUREVERSE index Index : Menu index number
Menuset	MENUSET index, style, x1, y1, x2, y2 Index : Menu Index Number Style : Button Style; 0=none, 1=Box, 2=Box with Shadow X1,y1,x2,y2 : Menu Button location

Menutitle	MENUTITLE index, x, y, string Index :Menu index number X,y : Title location based on left upper corner of button string : Name of the menu
Ncd	Variable = NCD source Variable : Variable to store results. (No String or Single) Source : source value *(0 to 31)*
Nop	NOP
Offset	OFFSET x, y
On int	ON INTx GOSUB label x : 0 to 3, External Interrupt Channel
On ladderint	ON LADDERINT GOSUB label
On pad	ON PAD GOSUB label
On recv	ON RECV1 GOSUB label
On timer	ON TIMER (interval) GOSUB label Interval : Interrupt Interval 1=10ms, 2=20ms……65535=655350ms 1 to 65535 can be used
Opencom	OPENCOM channel, baudrate, protocol, recvsize, sendsize channel : RS232 Channel (0 to 3) Baudrate : Baudrate (Do not use variable) protocol : Protocol (Do not use variable) recvsize : Receive Buffer Size (Max. 1024, Do not use variable) sendsize : Send Buffer Size (Max. 1024, Do not use variable)
Out	OUT Port, Value Port : I/O Port number *(0 to 255)* Value : Value to be outputted to the I/O Port (1 or 0)
Output	OUTPUT Port Port : I/O Port number *(0 to 255)*
Outstat	Variable = OUTSTAT (Port) Variable : Variable to store results. (No String or Single) Port : I/O Port Number *(0 to 255)*
Overlay	OVERLAY overmode overmode : Logical Mode (0=or, 1=and, 2=xor)
Paint	PAINT x, y

Pause	PAUSE value
Peek	Variable = PEEK (Address, Length) Variable : Variable to Store Result. (No String or Single) Address : RAM Address. length : Length of Bytes to read *(1 to 4)*
Poke	POKE Address, Value, Length Address : RAM Address Value : Variable to store results *(up to Long type value)* length : length of bytes to read *(1 to 4)*
Print	PRINT String / Variable String : String Variable : When using variables/constants, String representation of the variable/constant will be printed.
Pset	PSET x, y
Pulsout	PULSOUT Port, Period Port : Output Port *(0 to 255)* Period : Pulse Period *(1 to 65535)*
Put	PUT channel, data, bytelength channel : RS232 Channel *(0 to 3)* Data : Data to send (up to Long type value) Bytelength : Length of Data *(1 to 3)*
Puta	PUTA channel, ArrayName, bytelength channel : RS232 Channel. *(0 to 3)* ArrayName : Array Name Bytelength : Bytes to Send *(1 to 65535)*
Puta2	PUTA2 channel, ArrayName, bytelength, Stopchar channel : RS232 Channel. (0 to 3) ArrayName : Array Name Bytelength : Bytes to Send (1 to 65535) Stopchar : Stop character ascii code
Putstr	PUTSTR channel, data… channel : RS232 Channel. (0 to 3) Data : String Data (String variable or String constant)
Pwm	PWM Channel, Duty, *Period* Channel : PWM Channel Number *(0 to 15)* Duty : Duty Value, must be less than the Width. *Period* : Maximum of 65535
Pwmoff	PWMOFF Channel Channel : PWM Channel. (0 to 15)

Ramclear	RAMCLEAR
Reverse	REVERSE Port Port : I/O Port Number. *(0 to 15)*
Set display	SET DISPLAY type, method, baud, buffersize type : 0=*Rs232*LCD, 1=GHLCD GHB3224, 2=CLCD Method : Communication Method 0=CuNET, 1=COM1 baud : Baud rate (CuNET Slave address) Buffersize : Send Buffer Size
Set debug	SET DEBUG On[/Off]
Set i2c	SET I2C DataPort, ClockPort DataPort : SDA, Data Send/Receive Port. *(0 to 255)* ClockPort : SCL, Clock Send/Receive Port. *(0 to 255)*
Set ladder	SET LADDER On [/Off]
Set modbus	S*et* MODBUS mode, slaveaddress, returninterval mode : 0=ASCII, 1=RTU slaveaddress : Slave Address (1 to 254) returninterval : return interval value (1 to 255, default value is 1)
Set outolny	SET OUTONLY On[/Off]
Set Pad	SET PAD mode, packet, buffersize mode : Bit Mode (0 to 255) packet : Packet Size (1 to 255) buffersize : Receive Buffer Size (1 to 255)
Set rs232	SET RS232 channel, baudrate, protocol channel : RS232 Channel (0 to 3) Baudrate : Baudrate (Do not use variable) protocol : Protocol (Do not use variable)
Set until	SET UNTIL channel, packetlength, stopchar channel : RS232 Channel. *(0 to 3)* packetlength : Length of packet *(0 to 255)* stopchar : Character to catch
Set Int	SET INTx mode x : 0 to 3, External Interrupt Channel mode : 0=Falling Edge, 1=Rising Edge, 2=Changing Edge
Set Onglobal	SET ONGLOBAL On[/Off]
Set onint	SET ONINTx On[/Off]
Set onladderint	SET ONLADDERINT On[/Off]

Set onpad	SET ONPAD On[/Off]
Set onrecv	SET ONRECV0 On[/Off] SET ONRECV1 On[/Off] SET ONRECV2 On[/Off] SET ONRECV3 On[/Off]
Set Ontimer	SET ONTIMER On[/Off]
Shiftin	Variable = SHIFTIN (clock, data, mode, bitlength) Variable : Variable to store results. (No String or Single) Clock : Clock Port. *(0 to 255)* Data : Data Port. *(0 to 255)* Mode : 0 = LSB First (Least Significant Bit First), After Rising Edge 1 = MSB First (Most Significant Bit First), After Rising Edge 2 = LSB First (Least Significant Bit First), After Falling Edge 3 = MSB First (Most Significant Bit First), After Falling Edge 4 = LSB First (Least Significant Bit First), Before Rising Edge 5 = MSB First (Most Significant Bit First), Before Rising Edge bitlength : Length of bits (8 to 16)
Shiftout	SHIFTOUT clock, data, mode, variable, bitlength Clock : Clock Port. *(0 to 255)* Data : Data Port. *(0 to 255)* Mode : 0 = LSB First (Least Significant Bit First) 1 = MSB First (Most Significant Bit First) 2 = MSB First(Most Significant Bit First) , Create ACK (For I2C) variable : Variable to store data *(up to 65535)* bitlength : Bit Length (8 to 16)
Steppulse	STEPPULSE Channel, Port, Freq, Qty Channel : StepPulse Channel(0 or 1) Port : Output Port Freq : Output Frequency (Up to 15kHz) Qty : # of pulses to output (up to 2147483647)
Stepstat	Variable = STEPSTAT (Channel) Variable : Variable to store results Channel : StepPulse Channel(0 or 1)
Stepstop	STEPSTOP Channel Channel : StepPulse Channel (0 or 1)
Style	STYLE bold, inverse, underline bold : 0=Normal, 2 or 3 =Bold inverse : 0=Normal, 1=Inverse underline : 0=Normal, 1=Underline
Sys	Variable = SYS (address) Variable : Variable to store results. (No String or Single) address : Address. *(0 to 255)*

Tadin	Variable = TADIN (Channel) Variable : Variable to store results*.* (No String or Single) Channel : AD Channel Number (Not Port number*, 0 to 15)*
Time	Variable = TIME (address) Variable : Variable to store results*.* (No String or Single) address : Address of time value (0 to 6)
Timeset	TIMESET address, value address : Address of time value (0 to 6) value : time value*. (0 to 255)*
Udelay	UDELAY time time : interval (1 to 65535)
Usepin	USEPIN I/O, In/Out, AliasName I/O : I/O Port Number*. (0 to 255)* In/Out : "In" or "Out" AliasName : Alias for the port (Optional)
Utmax	UTMAX variable Variable : Variable for decrement. (No String or Single)
Wait	WAIT time time : delay time (mS) 10 to 2147483640
Waittx	WAITTX channel channel : RS232Channel*. (0 to 3)*
Wmode	WMODE value value : 0=FAST, 1=SLOW

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