Colour MMBasic on the UBW32 Board Implementation Manual

Geoff Graham

For updates to this manual and more information on MMBasic for the UBW32
go to http://geoffg.net/ubw32.html

UBW32 and Colour MMBasic

This is the user manual describing the technical details of running Colour MMBasic on the UBW32 experimenter board.

For details of the language download the MMBasic Language Manual from http://geoffg.net/maximite.html

The UB32 is a small board holding a PIC32 microcontroller from Microchip. Almost all of the connections to the microcontroller are brought out as solder pads on the edge of the board making it easy to use the board as a high performance embedded controller.

UBW32 board can be purchased from http://sparkfun.com.

MMBasic

MMBasic is a full featured BASIC interpreter with floating point and string variables, long variable names, arrays of floats or strings with multiple dimensions, extensive string handling and full file I/O features.

MMBasic runs on the UBW32 and using the USB interface (or Colour VGA monitor and keyboard) you edit and test your program on the UBW32. When you are ready you can save the program to the internal flash and it will be automatically run whenever power is applied. This makes a complete embedded computer running a high level language.

Features of Colour MMBasic on the UBW32 include:

- Colour VGA output. 480x432 pixels with eight colours (**black**, **red**, **green**, **blue**, **cyan**, **yellow**, **purple** and white). 240x216 pixels with eight colours high performance mode)
- Standard PS2 style keyboard input.
- Stereo audio with support for playing MOD music files and sound effects. Can also be used as a 2 channel PWM analog output.
- Battery backed real time clock (optional).
- 40 external I/O lines which can be configured as analog inputs, digital inputs/outputs, frequency measurement, etc.
- SD card support with capacities of up to 32GB for storing programs and files.
- USB for connecting to a personal computer (Windows, Mac or Linux) as a terminal or for file transfer.
- Extensive communications protocols including Serial, I^2C, SPI and 1-wire.
- Graphic capability includes selectable fonts, user designed fonts, drawing lines, circles, squares and control over any pixel with any colour.
- Firmware upgrades via USB using a standard bootloader.
- Full featured BASIC interpreter and operating system. Instant on, ready for you to type in and test your programs.
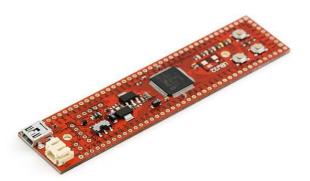
For details of the UBW32 go to: www.schmalzhaus.com/UBW32

Further resources can be found at: sparkfun.com/products/9713

License

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The compiled object code (the .hex file) is free software: you can use or redistribute it as you please.
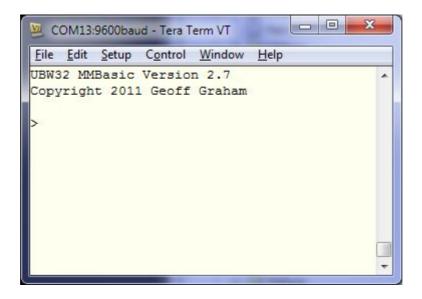
This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
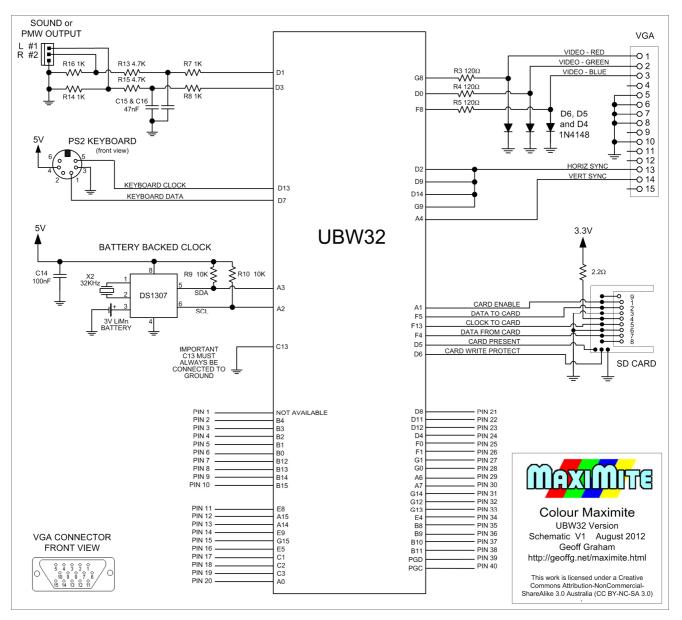
Quick Start

These instructions will get the UBW32 running Colour MMBasic and connected to your PC via a virtual serial port over USB. Using USB you can enter and run BASIC programs and get a good feel for MMBasic. Later, if you want to, you experiment with a more complicated setup by connecting a keyboard and Colour VGA monitor.

- Download the current version of Colour MMBasic and the MMBasic Language Manual from:
  geoffg.net/maximite.html

- Load the MMBasic hex file onto the PIC32 using the universal bootload application (BootLoade.exe) supplied with the upgrade. See the file "Loading New Firmware.pdf" for details. You can also use the standard UBW32 boot load application if you wish.

- Download the Windows USB Serial Port Driver from http://geoffg.net/maximite.html and install it. This driver has been tested on XP, Vista and Win7 both 32 bit and 64 bit. Full instructions are included in the download.

- Cycle the power on the UBW32 and connect it to your computer via USB.

- Start your terminal emulator (Terra Term is a good choice), connect it to the virtual USB serial port that MMBasic created on your system (use any baud rate) and you should be greeted by the initial prompt:

- You can now start experimenting with MMBasic commands.
  Try typing in something like: PRINT "Hello World"

- When you enter your program you can save it to the internal flash drive (A:) as AUTORUN.BAS and it will be automatically run every time the UBW32 is powered up – even if it is not connected to the USB.

- To enjoy colour output you will need to install the VGA output circuit (see the next section).

UBW32 Connections

SOUND or
PMW OUTPUT

L #1
R #2

VGA

R16 1K   R13 4.7K   R7 1K

R15 4.7K

R14 1K   C15 & C16   R8 1K
47nF

D1
D3

VIDEO - RED
VIDEO - GREEN
VIDEO - BLUE

G8   R3 120Ω
D0   R4 120Ω
F8   R5 120Ω

D6, D5
and D4
1N4148

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

5V   PS2 KEYBOARD
(front view)

6   5
4   3
2   1

KEYBOARD CLOCK
KEYBOARD DATA

D13
D7

D2
D9
D14
G9
A4

HORIZ SYNC
VERT SYNC

UBW32

5V

BATTERY BACKED CLOCK

3.3V

C14
100nF

X2
32KHz

DS1307

8
1   5   R9 10K   R10 10K
2   SDA   A3
3   SCL   A2
4

2.2Ω

3V LiMn
BATTERY

IMPORTANT
C13 MUST
ALWAYS BE
CONNECTED TO
GROUND

C13

A1   CARD ENABLE
F5   DATA TO CARD
F13   CLOCK TO CARD
F4   DATA FROM CARD
D5   CARD PRESENT
D6   CARD WRITE PROTECT

9
1
2
3
4
5
6
7
8

SD CARD

PIN 1	NOT AVAILABLE
PIN 2	B4
PIN 3	B3
PIN 4	B2
PIN 5	B1
PIN 6	B0
PIN 7	B12
PIN 8	B13
PIN 9	B14
PIN 10	B15
PIN 11	E8
PIN 12	A15
PIN 13	A14
PIN 14	E9
PIN 15	G15
PIN 16	E5
PIN 17	C1
PIN 18	C2
PIN 19	C3
PIN 20	A0

D8	PIN 21
D11	PIN 22
D12	PIN 23
D4	PIN 24
F0	PIN 25
F1	PIN 26
G1	PIN 27
G0	PIN 28
A6	PIN 29
A7	PIN 30
G14	PIN 31
G12	PIN 32
G13	PIN 33
E4	PIN 34
B8	PIN 35
B9	PIN 36
B10	PIN 37
B11	PIN 38
PGD	PIN 39
PGC	PIN 40

VGA CONNECTOR
FRONT VIEW

5 4 3 2 1
10 9 8 7 6
15 14 13 12 11

MaxiMite

Colour Maximite
UBW32 Version
Schematic V1   August 2012
Geoff Graham
http://geoffg.net/maximite.html

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Except for C13 all connections to the UBW32 are optional; when a peripheral is omitted Colour MMBasic will ignore it. You can leave all of them out and still use the UBW32 as a BASIC computer via the USB port.

Construction

Mick Gulovsen has designed a low cost printed circuit board (PCB) that holds the extra components (connectors, clock, etc) and has a socket for the UBW32 to plug into. He has even prepared an assembly manual. Using this makes the task of building a Colour UBW32 Maximite much easier.

You can purchase the PCB from http://www.dontronics-shop.com/ubw32-mcc-pcb.html.

If you are building the circuit without Mick's PCB you will need at least the following parts:

VGA Connector	DE-15 (or HD-15) High Density 15 Pin Female D Connector (AMP 1-1734530-1, MULTICOMP SPC15430, Element14 1557991 or 1564252)
PS2 Connector	6 Pin Mini DIN Female Socket (example: sparkfun.com/products/8509)
SD Card Connector	SD Card holder preferably mounted on a PCB (example: sparkfun.com/products/11403).
Battery Backed Clock	SparkFun BOB-00099 Real Time Clock Module (sparkfun.com/products/99) Or the parts can be purchased individually from futurlec.com.

Using Colour MMBasic on the UBW32

The MMBasic Language Manual covers most of the details of running Colour MMBasic. These notes cover specific UBW32 subjects.

Compatibility

The UBW32 runs exactly the same hex file (loadable firmware image) as the Colour Maximite. So, when you are looking for upgraded versions of the firmware look for a version that runs on the Colour Maximite.

If you install all the external connectors and components listed in the previous section the UBW32 will run exactly the same as the Colour Maximite.

Battery Backed Clock

If you have installed the battery backed clock the firmware will recognise that the clock is present and will display a message under the Maximite logo saying that the clock is not set. To set it you use the standard commands in MMBasic for setting the time (TIME$ and DATE$).

From then on MMBasic will automatically retrieve the current time and date on power up and display it under the Maximite logo– just to let you know that your battery backed clock is working correctly.

If you do not install the components MMBasic will use its internal clock (which is set to zero on power up).

UBW32 Indicator LEDs

BLUE   Not controlled by MMBasic – illuminated when power is applied

YELLOW   Indicates that MMBasic is running. Can be user controlled using Pin 0.

RED   SD card activity (reading/writing).

Input/Output Pins

Colour MMBasic on the UBW32 provides for 40 I/O pins.

Pins 2 to 20 operate the same as the standard I/O connector on the Maximite (due to the design of the UBW32 pin 1 is not available – see below to enable it).

Pins 21 to 34 operate the same as the Arduino I/O pins D0 to D13 on the Colour Maximite.

Pins 35 to 40 operate the same as the Arduino I/O pins A0 to A5 on the Colour Maximite.

The serial port COM2 uses pin 21 for receive data and 22 for transmit data. COM1 uses the same pins as the Maximite.

See "Input/Output" in the MMBasic Language Manual for more details.

USB Communications

Implements the CDC (Communication Device Class) protocol over USB 2.0. This is a serial interface to the BASIC interpreter so, by using a terminal emulator on the host, programs can be entered, edited and run. Using this interface you can upload programs by streaming the text with a suitable terminal editor.

The Windows driver is available from http://geoffg.net/maximite.html. There is native support for the CDC protocol in Linux (the cdc-acm driver) and Apple OS/X.

Sound Output

The audio generated by MMBasic is output as a pulse width modulated (PWM) signal. The pulse repetition rate is approx 100KHz and MMBasic can modulate the output by varying the duty cycle.

The sound output circuit is a low pass filter intended for driving an audio amplifier but you can easily drive headphones or even a small speaker. In that case remove all components and connect the speaker or headphones direct to the outputs of the PIC32. You do not need a low pass filter as the speaker/headphone coil will do that for you.

See "Audio and PWM Output" in the MMBasic Language Manual for more details.

Pin 1

MMBasic pin 1 is not available because the standard UBW32 bootloader programmed into the PIC32 disables B5 which is used for pin 1.

You can enable B5 by re-programming the UBW32 with the standard UBW32 bootloader with changed configuration settings. In MPLAB this is accessed via Configure -> Configuration Bits then untick "Configuration bits set in code". Change the settings of both FUSBIDIO and FVBUSONIO to *Controlled by Port Function*.

An alternative is to program the UBW32 with the ColourMM_plus_bootloader_V4.0.hex firmware which is found in the Colour Maximite Construction Pack and the bootloader will then be the Colour Maximite bootloader. This will operate the same except that C13 now becomes the bootload switch. When C13 is pulled low the firmware will enter bootload mode, when C13 is disconnected the firmware operates as normal (the PROG button on the UBW32 is ignored).
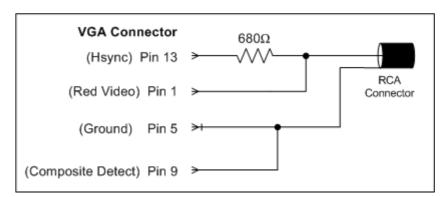
There have been reports of some UBW32s which refuse to start when loaded with this firmware and this may be caused by the config settings used by the new bootloader. This is very rare but you can try changing the following configuration settings before programming.:

- IESO set to *Enabled*
- POSCMD set to *XT*
- OSCIOFNC set to *Disabled*
- FPBDIV set to Pb_*Clk is Sys_Clk/1*
- FCKSM set to *Clock Switch Enable, FSCM Enabled*

Composite Video Output

Composite video (in monochrome not colour) can be accessed via the VGA connector using the connections depicted on the right.

You will also need to connect pin 9 on the VGA connector to C14 on the UBW32. Normally pin 9 is unused on the VGA connector but when wired to C14 this pin will automatically select composite when the circuit on the right is used.

To enable composite video in MMBasic you must also issue one of the following two commands:

CONFIG COMPOSITE PAL

 - or -

CONFIG COMPOSITE NTSC

Either of these two commands will enable the composite detect (pin 9 on the VGA connector, C14 on the UBW32) and select the correct video timing.

Controller Area Network (CAN) Support

A special version of MMBasic which supports CAN is available from http://geoffg.net/maximite.html. Except for the support of CAN this version runs the same as the standard version of MMBasic.

The CAN signals are available on F0 (Rx) and F1 (Tx) - I/O pins 25 and 26. The UBW32 does not have a driver chip so that will need to be added. Mick Gulovsen's mother board for the UBW32 (see Construction above) has support for such a chip.