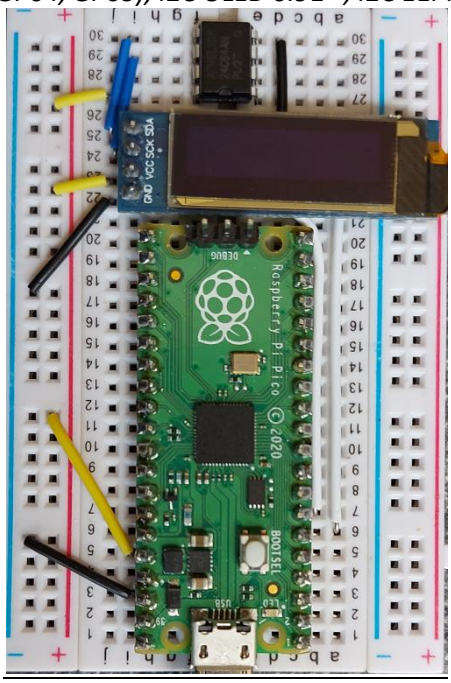
# ***#JustPicoBasic manual***

*The project repository (i.e. binaries, manual, and examples) are available at: [https://github.com/bgolab/JustPicoBasic](https://github.com/bgolab/JustPicoBasic)*

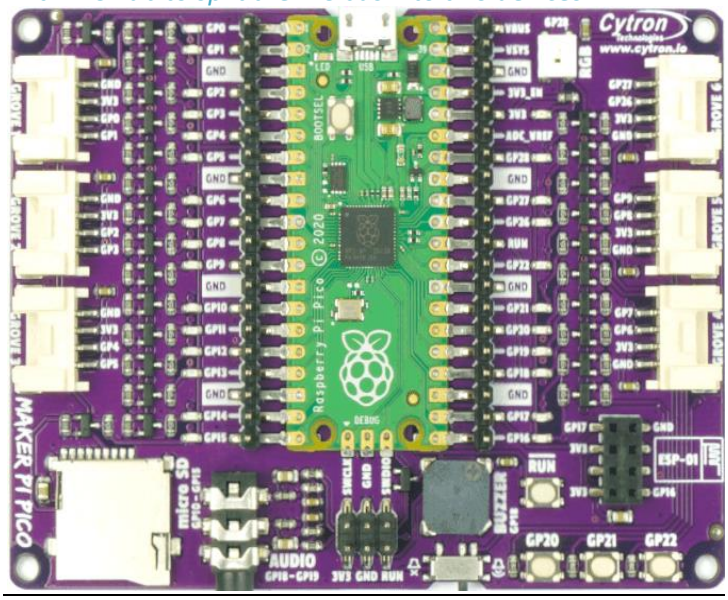
***Wiring***

*NOTE: Current PICO running JustPicoBasic can boot without EEPROM and without OLED. Older JustPicoBasic versions need to press ESC when EEPROM is NOT available (otherwise the PICO gets stuck).*
*NOTE: I2C addresses reserved for hardware auto-detection: OLED 0.91" - 0x3C, EEPROM 24c64 - 0x50*

*1. Original breadboard wiring: PICO I2C0(GP04, GP05), I2C OLED 0.91" , I2C EEPROM 24c64*

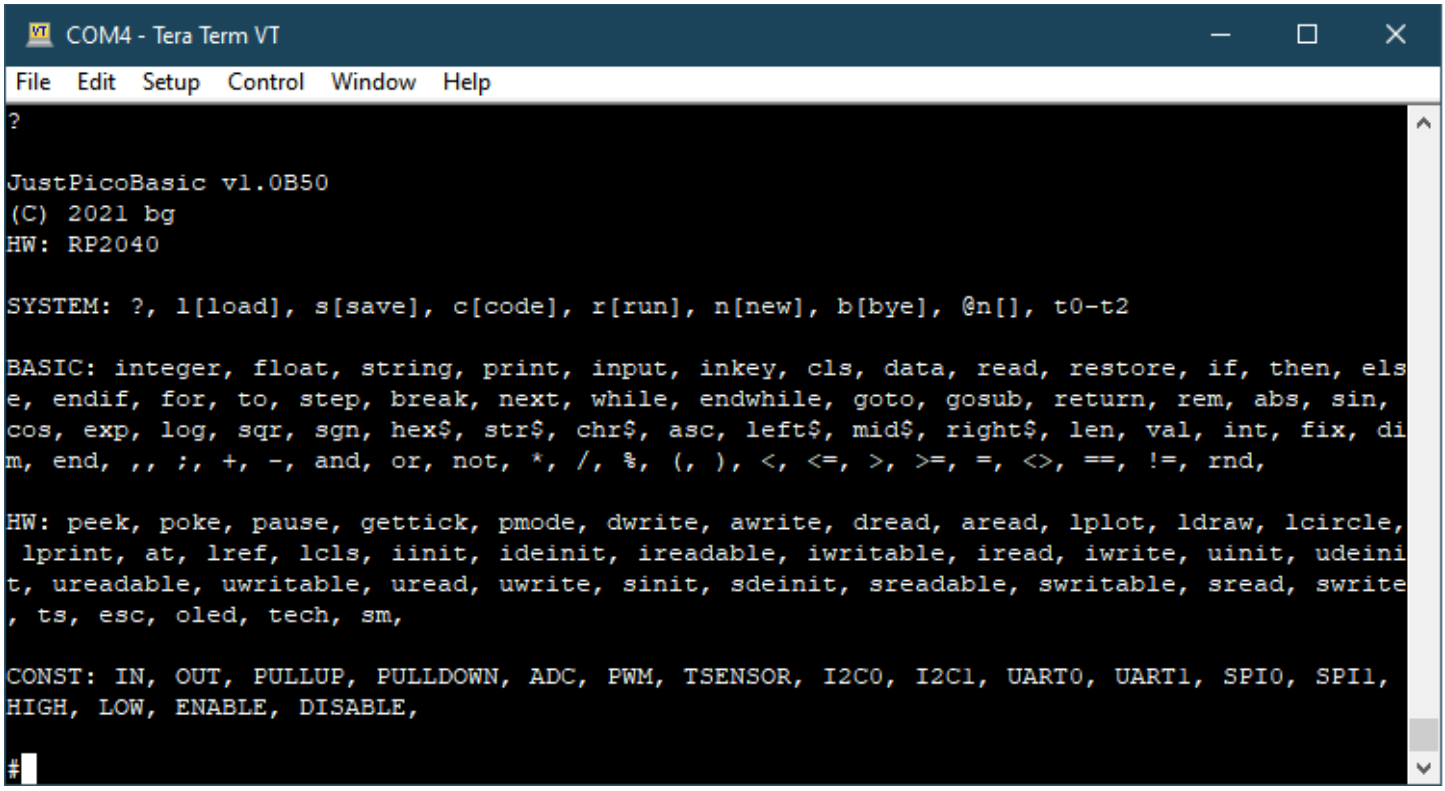


*2. Cytron Maker Pi Pico board wiring: PICO I2C0(GP04, GP05), I2C OLED 0.91" , I2C EEPROM 24c64*
*NOTE: Use Grove 3 connecttor with I2C hub to split the I2C bus into two devices*




***Getting started***

*Press the **BOOTSEL** button and hold it while you connect the other end of the micro USB cable to your PC. Copy the latest BASIC UF2 file (e.g. JustBasic-xx.uf2) to the PICO disk. Start a terminal emulator e.g. **TeraTerm** (use settings: **9600,8,N,1**). The PICO will boot. Enter '**?**' and press ENTER to see available commands.*




*Enter an example BASIC program (you can use Copy & Paste)*

```
pmode 25,OUT
for k=1 to 5
        dwrite 25,HIGH pause 500
        dwrite 25,LOW pause 500
next k
end
```

*Use '**c**' or '**cc**' to see the code, '**r**' to run the code. The built-in LED will blink. The '**n**' clears the program memory.*
*You can use **@N** (e.g. @0) to delete Nth line or **@N <code>** (@0 print 1) to insert the line of code.*
*Capital and small letters accepted for keywords (i.e. 'CLS' equals 'cls'). For the names small and capital letters are recognized (i.e. 'as' is different than 'AS')*

*NOTE: If you use TeraTerm and some characters are lost during Copy & Paste operation consider increasing the 'Paste delay per line' in Setup->Additional Settings->Copy and Paste*

***Program structure***

| ***Program Structure*** | ***Description/Comments*** | ***Example*** |
|---|---|---|
| *gosub subr1*<br>***end***<br>*subr1:*<br>*[subr1 code]*<br>*return* | *Command 'end' has to be the last line of the main code. Subroutines have to follow the 'end'.* | *gosub callme*<br>***end***<br>*callme:*<br>*print "Hi!"*<br>*return* |

***System commands***

| ***Command*** | ***Description/Comments*** | ***Example*** |
|---|---|---|
| *ESC key* | *Stop the running program or stop initial loading program while booting* | |
| *?* | *Shows info about the VM (version, available commands)* | |
| *c, cc* | *c-show the code w/ line numbers, cc-show the code w/o line numbers* | |
| *r* | *Run – run code from SRAM memory* | |
| *r <code>* | *Run - run single line of code NOT stored in memory (ad-hoc)* | *r for i=1 to 5 print i next i end* |
| *n* | *New – clear VM memory and code* | |

| | | |
|---|---|---|
| b | Bye: PICO – reboot VM in disk mode, Windows - exist | |
| l | l - Load program from EEPROM (auto.bas) | |
| s | s - Save program to EEPROM (auto.bas) | |
| ee | ee - EEPROM erase – now command disabled | |
| ed | ed - EEPROM dump – show EEPROM content | |
| is 0\|1 | I2C scan devices (bus: 0 or 1); NOTE: 'is' stuck when a bus not terminated | is 0 is 1 |
| t0\|t1\|t2 | **Program Flow Tracing**: t0 – OFF; t1 - Step Mode; t2 – Cont Mode | t1\|t2 - enable tracing mode |
| @N | **Pico Editor:** @N - delete N-th line | @3 – removes 3rd line of code |
| @N <code> | **Pico Editor:** @N <code> - insert <code> before N-th line | @4 cls – insert 'cls' before line 4 |

## The BASIC language

### VARIABLES & EXPRESSIONS

**Suffix-based (suffix #, $, OR no suffic to declare variable type) varname and array syntax**

-variable name: up to 8chars letter&digits starting w/ a letter (digits, '#", '$', '_', ':' accepted)
-expr(arithmetic expression): combination of INT/FLOAT and ops/brackets( +, -, *, /, %,(, )) and INT/FLOAT vars;
-sexpr(string expression): combination of string, string functions (with suffix $) and string vars (with suffix $) and '+' op
-variable type differentiation through the suffix (no suffix – integer, '#' suffix – float, '$' suffix – string
-hex integer format supported, e.g. 0xAA
-array index counts from 0 (for: DIM a(3) available array elements are referred by a(0), a(1), a(2)
-string arrays must have 2-dimentions e.g. DIM a$(2,5) – 2 strings, maximum length of a string is 5 characters; string arrays are always referred through single index a$(0), a$(1) for DIM a$(2,5) array
-array size can be an expression

| Command | Description/Comments | Example |
|---|---|---|
| var=expr | INT var, name=expr, 1st-reference creates var(value=0); | sy=2*abs(-15) + a*20 |
| var#=expr | FLOAT var (# suffix), name#=expr, 1st-reference creates var w/ value=0 | w#=2*a#+abs(-1.0) |
| var$=sexpr | STR var ($ suffix), name$=sexpr | v$=a$+left$(str$(13),1) |
| DIM var(s1[,s2]), var#(s1[,s2]), var$(s1,s2) | 1 or 2-dimensions integer/float array; 2-dimensions string array; multi-array declaration (array names separated by comma) | DIM a(3), b#(4,4), c$(4,5) |
| var(expr[,expr])=expr | INT: name(item)=expr | a(0)=3 |
| var#(expr[,exp])=expr | FLOAT: name#(item)=expr | b#(0)=2.5 |
| var$(expr)=sexpr | STRING: name$(item)=sexpr | c$(2)="abc" |

### BUILT-IN CONSTANTS

| Command | Description | Example |
|---|---|---|
| HIGH (1), LOW (0) | Generic const | dwrite 1,low |
| IN, OUT, PULLUP, PULLDOWN, ADC, PWM, TSENSOR, I2C0, I2C1, UART0, UART1, SPI0, SPI1 | HW const | pmode 2,out |

**Suffixless varname and array syntax**

-variable needs to be declared (if not declared integer type is assumed), multi-declaration in single command supported
-initialization during the declaration phase is not supported yet
-array index counts from 0 (for: DIM a(3) available array elements are referred by a(0), a(1), a(2)
-string arrays have always 2-dimentions e.g. string a(2,5) – two 5-chars strings; string arrays are referred via single index a(0) then
-array size can be an expression

| Command | Description/Comments | Example |
|---|---|---|
| integer vname, vname2(s1[,s2])),.. | Declare integer var or 1/2-dimensional array; value=0 set | integer a, b(8,2) b(0,0)=1 |
| float vname, vname2(s1[,s2]),.. | Declare float var or 1/2-dimensional array; value=0 set | float c, b(0,0)=1.0 |
| string vname, vname2(s1,s2),.. | Declare string var or 2-dims string array; value=null set | string b(2,4) a(1)="no" |

### PROGRAM FLOW CONTROL

*-lexpr: combination of expressions, conditionals('>','<','>=','<=','=','==','<>','!=') and logical operators (AND,OR,NOT); e.g. a>5 AND gettick()<1000;*

*NOTE: the '<>' is equivalent to '!=', the '=' is equivalent to '=='*

*NOTE: The for-loop STEP/TO values are evaluated only once and their values are kept in static structures like tables. This is likely to change in the future (either STEP/TO will be evaluated in each for-cycle or STEP/TO values will be kept on the return stack) allowing for-loop usage in recurrent calls.*

| **Command** | **Description/Comments** | **Example** |
|---|---|---|
| FOR v=expr TO expr [STEP expr] [code] NEXT var | If STEP[default=1] is negative var decreases; INT/FLOAT supported; loop nesting supported | FOR k = 5 TO 1 STEP -1 NEXT k END |
| WHILE lexpr [code] ENDWHILE | INT/FLOAT supported; loop nesting supported;<br>cond: AND/OR/NOT supported; | REM Simple while-loop<br>a=0 while a<5 print a a=a+1 endwhile<br>REM Wait for 500msec (non-blocking)<br>waitTime=500 t_start=gettick()<br>while gettick()<t_start+waitTime endwhile |
| BREAK | Can be used in FOR and WHILE loops. | while 1>0<br>k=inkey()<br>if(k!=0) then print k endif<br>if(k==113) then break endif<br>endwhile |
| IF lexpr THEN [code] [ELSE] [code] ENDIF | INT/FLOAT supported; nesting supported AND/OR/NOT) supported; | if a>1 and b#>3.4 then print "ok" else print "bad" endif |
| label:<br>GOTO label | Label name starts with a letter, terminated by colon; up to 8 letter & digits( plus '_'); | k=1 again: print k k=k+1<br>if k<5 then goto again: endif |
| GOSUB label | Label must be located after END | gosub task0 end |
| label: RETURN | label: [code] RETURN | task0: print "done" return |
| END | Last instruction. GOSUB labels follows END | |

***INPUT, OUTPUT, DATA***

| **Command** | **Description/Comments** | **Example** |
|---|---|---|
| PRINT expr[, sexpr], [;] | Prints expr, sexpr separated by ','<br>';' to skip NEW LINE | PRINT "6/3=", 6/3 (with NEW LINE)<br>PRINT 1; (w/o NEW LINE because of ';') |
| INPUT var,… | Assign int/float/str values to (array) var | INPUT a(2), d#, n$ print a(2), d#, n$ |
| DATA expr, sexpr; | INT/FLOAT/STR supported | DATA 1.5, 2*a |
| READ a, b#, d$ | Assign DATA specified input to vars | READ v, v#, v(), v#(); |
| RESTORE | Reset data pointer | |
| CLS | Clear Screen | cls |
| REM | Comment | rem MyFunc |

***BUILT-IN FUNCTIONS***

| **Command** | **Description/Comments** | **Example** |
|---|---|---|
| LEFT$(sexpr, expr) | Left part of the string | k$=LEFT$("abc", 2) + "123" i=12 |
| RIGHT$(sexpr, expr) | Right part of the string | |
| MID$(sexpr,expr,expr) | Middle of the string | i$=MID$(STR$(i),2,3) PRINT i$ |
| HEX$(expr) | Hex$(expr to hex string) | PRINT HEX$(NOT(0x0F)) |
| STR$(expr) | Str$(expr to string) | |
| CHR$(expr) | Chr$(expr%256 to ascii e.g. 65 to 'A') | a=65 d$=chr$(a) |
| LEN(sexpr) | LEN(string length) | PRINT LEN("1234")->4 |
| VAL(sexpr) | Val(string to value) | PRINT VAL("-1234")+1->-1233 |
| ASC(sexpr) | ASC(ascii code of the 1st char of the string) | PRINT ASC("AB")->65 |
| SIN(expr) | Sine | PRINT "SIN:",SIN(3.14/6) |
| COS(expr) | Cosine | PRINT "COS:",COS(3.14/6) |

| | | |
|---|---|---|
| SQR(expr) | Square root | PRINT "SQRT:", SQR(5) |
| EXP(expr) | Expotential | PRINT "EXP:", EXP(1) |
| LOG(expr) | Logarithm | PRINT "LOG:", LOG(2.71) |
| SGN(expr) | Sign | PRINT "SGN:", SGN(-5) |
| ABS(expr) | Absolute | PRINT "ABS:", ABS(-5) |
| RND(max) | Hw-based rnd generator + von Neuman whitenizer | PRINT "RND: ", RND(1000) |
| GETTICK() | Tick number | a=gettick() |
| PAUSE msec | Delay (blocking) in msec | PAUSE 2*500 |
| INKEY() | Pressed key, OR 0; non-blocking (no-wating) | |
| INT(expr) | QBASIC like | a=INT(1.1) b=INT(-1.1) PRINT a, ", ", b (1,-2) |
| FIX(expr) | | c=FIX(1.9) d=FIX(-1.9) PRINT c, ", ", d (1,-1) |
| AND(expr,expr) | | PRINT AND(0x3,0xF) |
| OR(expr,expr) | | PRINT OR(0x3,0xF) |
| NOT(expr) | | PRINT HEX$(NOT(0x0F)) |

***POKE & PEEK SUPPORT***

| Command | Description/Comments | Example |
|---|---|---|
| POKE addr,value | Memory write; hex format supported | REM SYSTICK (ST)<br>STCSR=0xe000e010 STRVR=0xe000e014 STCVR=0xe000e018<br>poke STCSR,0 poke STRVR,0x1e847 poke STCSR,5<br>for k=0 to 9 print and(peek(STCVR),0xFFFFFF) pause 100 next k |
| PEEK(addr) | Memory read; hex format supported | |

***GPIO SUPPORT***

| Command | Description/Comments | Example |
|---|---|---|
| PMODE pin,mode | m: const: IN,OUT,PULLUP,PULLDOWN, ADC, PWM, TSENSOR | pmode 100, tsensor temp= aread(100) |
| AREAD(pin) | Read analog pin; pins=26-29;<br>pin=100 – temperature virtual pin | pmode 26, adc voltage=aread(26)<br>pmode 100,tsensor temp= aread(100) |
| AWRITE pin,cycle | PWM duty=cycle/65535,cycle<65535 | pmode 22, pwm awrite 22, 16000 |
| DREAD(pin) | Read digital pin | y=15 pmode y,in pmode y,pullup<br>for k=1 to 2 step 0 pause 50 print dread(y) next k |
| DWRITE pin,value | Write digital pin | pmode 25,out dwrite 25,high pause 3000 dwrite 25,low |

***GRAPHIC LCD/OLED SUPPORT*** *(currently: OLED 0.91" supported)*

*NOTE: use 'lref' to refresh the screen as ALL the lxxx command update only the memory buffer*

| Command | Description/Comments | Example |
|---|---|---|
| LPLOT X, Y | Draw point at X, Y | for x=0 to 127 lplot x,fix(15+15*sin(6.28*x/128)) next x lref |
| LDRAW X0, Y0, X1, Y1 | Draw line from X0, Y0 to X1, Y1 | ldraw 10, 10, 20,20 lref |
| LCIRCLE x, y, r | Draw circle at x, y, r | lcircle 15, 15, 10 |
| LPRINT expr, sexpr [AT x,y] | Print expr, sexpr separated by ',' [AT x, y] (default 0,0) | lprint "2+2=", 2+2 AT 10,10<br>lref |
| LCLS | Clear Screen | lcls lref |
| LREF | Refresh LCD (copy mem to LCD) | lref |

***TONE SUPPORT*** *(tested on piezo)*

| Command | Description/Comments | Example |
|---|---|---|
| TONE pin, freq | Start PWM square signal at freq, duty 50% on a pin; freq>10Hz; non-blocking; | TONE 18, 440 |
| NOTONE pin | Stop generating the signal on a pin | NOTONE 18 |

***I2C/UART/SPI SUPPORT***

*-the API is based on the PICO SDK API; all xREAD/xWRITE are blocking (can wait for the data forever);*

*-non-blocking approach possible by checking if the fifo is empty using xREADABLE/xWRITEABLE functions*

NOTE: Internal buffer size = 256 (max number of bytes to read/write);
NOTE: SPI csn is controlled through gpio (dwrite)
NOTE: UART data,stop,parity options are NOT supported now
NOTE: SPI format is NOT supported now
NOTE: string is preferred to WRITE commands, for READ command need to allocate fake string to space the read data

| **Command** | **Description/Comments** | **Example** |
|---|---|---|
| IINIT in, sda, scl[,baud]<br>UINIT in, tx, rx[,baud[,data,stop,parity]]<br>SINIT in, tx, rx, sck[,baud[,format]] | initialize hw; sda/scl/tx/rc/sck: GPIO<br>in: i2c0, i2c1, uart0, uart1, spi0, spi1<br>defaults: i2c:400k; uart:115.2k,8,N,1; spi:10M | REM UART loop-test<br>l=8<br>integer bi(l), bo(l)<br>for k=0 to l-1 bi(k)=k next k<br>uinit uart0, 0, 1, 9600<br>uwrite uart0, bi, l<br>pause 100<br>uread uart0, bo, l<br>udeinit uart0<br>end<br>------<br>REM MAX7219 (SPI test)<br>TESTREG=0x0F<br>tx=11 rx=12 sck=10 csn=13<br>baud=10000000 ll=2<br>integer buf(ll)<br>pmode csn,OUT<br>sinit spi1, tx, rx, sck, baud<br>buf(0)=TESTREG buf(1)=0x1<br>gosub MaxWrite<br>pause 1000<br>buf(0)=TESTREG buf(1)=0x0<br>gosub MaxWrite<br>sdeinit spi1<br>end<br>MaxWrite:<br>dwrite csn, LOW<br>swrite spi1, buf, ll<br>dwrite csn, HIGH<br>return |
| IREAD in, ad, arrr, len, nstop<br>UREAD in, arr, len<br>SREAD in, arr, len | read / write operations<br>ad: i2c device address;<br>arr: array name for read; | |
| IWRITE in, ad, arr/str, len, nstop<br>UWRITE in, arr/str, len<br>SWRITE in, arr/str, len | arr/str: array OR string name for write;<br>len: number of bytes to read/write;<br>nstop: 1-no Stop issued, 0-Stop issued | |
| IDEINIT in; UDEINIT in; SDEINIT in | de-initialize hw | |
| IREADABLE(in); IWRITABLE(in)<br>UREADABLE(in); UWRITABLE(in)<br>SREADABLE(in); SWRITABLE(in) | for non-blocking write / write<br>returns: 0,1; | |