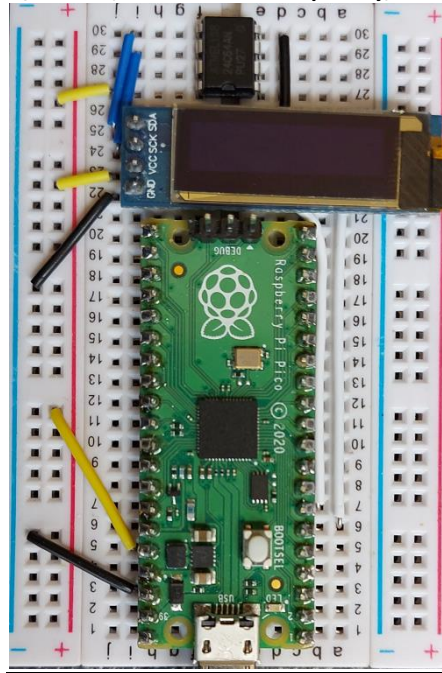


## #JustPicoBasic manual

The project repository (i.e. binaries, manual, and examples) are available at: <https://github.com/bqolab/JustPicoBasic>

### Wiring

Hardware wiring: **RPI PICO I2C0 pins GPIO4/GPIO5, OLED 0.91" I2C(0x3C), EEPROM 24c64 I2C(0x50)**



### Getting started

Connect the USB cable to the PICO board. Start a terminal emulator e.g. **TeraTerm** (settings: **9600,8,N,1**). Copy & Paste is supported. Copy the current UF2 binary (e.g. JustBasic-1.0bxx.uf2) to the PICO disk. The PICO will boot.

Enter '?' and press ENTER to see available commands.

```
COM10 - Tera Term VT
File Edit Setup Control Window Help
JustPicoBasic v1.0B46
(C) 2021 bg
HW: RP2040

TICKS: 395644

LIMITS: SRC/LINE:8000/160, HEAP/STACK:1000/50, NAMES/LENGTH:100/10, IF/LOOP:50/50

SYSTEM: ?, l[load], s[save], c[code], r[run], n[new], b[bye], @n[], t0-t2

BASIC: integer, float, string, print, input, inkey, cls, data, read, restore, if, then, else, endif, f
or, to, step, break, next, while, endwhile, goto, gosub, return, rem, abs, sin, cos, exp, log, sqr, sg
n, hex$, str$, chr$, asc, left$, mid$, right$, len, val, int, fix, dim, end, ,, ;, +, -, and, or, not,
*, /, %, (, ), <, <=, >, >=, =, <>, ==, !=, rnd,

HW: peek, poke, pause, gettick, pmode, dwrite, awrite, dread, aread, lplot, ldraw, lcircle, lprint, at
, lref, lcls, iinit, ideinit, ireadable, iwriteable, iread, iwrite, uinit, udeinit, ureadable, uwritea
ble, uread, uwrite, sinit, sdeinit, sreadable, swriteable, sread, swrite, ts, sm,

CONST: IN, OUT, PULLUP, PULLDOWN, ADC, PWM, TSENSOR, I2C0, I2C1, UART0, UART1, SPI0, SPI1, ESC, OLED,
TECH, HIGH, LOW, ENABLE, DISABLE,

#
```

Enter an example BASIC program:

*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. You can freely format the code – can put many commands in single line, etc. Capital and small letters accepted for keyword (i.e. 'CLS' and 'cls' are the same). Names recognizes small and capital letters (i.e. 'as' is different than 'AS')

### Program structure

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

### System commands

Command	Description/Comments	Example
ESC key	Break the program while Running or prevent from Loading.	
?	Shows info about the VM (ver, 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, ", ", i*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	I2C scan – show I2C devices on both I2C buses	
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 – inserts 'CLS' before line 4

### The BASIC language

Command	Description/Comments	Example
SM <entity> enable/disable	System Mode Configuration. Entity: ESC (default=enabled) - ESC key check (disable to boost performance) OLED (default=enabled) (NOTE: OLED auto-detection is supported now)	SM ESC disable SM OLED 1
REM	Comment	REM MyFunc
CLS	Clear Screen	CLS

### VARIABLES & EXPRESSIONS

#### Suffix-based (suffix #, \$, OR no suffix 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)
- 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-dimensions 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

Command	Description/Comments	Example
var=expr	INT var, name=expr, 1 <sup>st</sup> -reference creates var(value=0);	sy=2*abs(-15) + a*20

<code>var#=expr</code>	FLOAT var (# suffix), name#=expr, 1 <sup>st</sup> -reference creates var w/ value=0	<code>w#=2*a#+abs(-1.0)</code>
<code>var\$=sexpr</code>	STR var (\$ suffix), name\$=sexpr	<code>v\$=a\$+left\$(str\$(13),1)</code>
<code>DIM var(s1[,s2]),</code> <code>var#(s1[,s2]), var\$(s1,s2)</code>	INT/FLOAT/STRING array, 1/2-dimensions; multi-array declaration (array names separated by comma)	<code>DIM a(3), b#(4,4),</code> <code>c\$(4,5)</code>
<code>var(expr[,expr])=expr</code>	INT: name(item)=expr	<code>a(0)=3</code>
<code>var#(expr[,exp])=expr</code>	FLOAT: name#(item)=expr	<code>b#(0)=2.5</code>
<code>var\$(expr)=sexpr</code>	STRING: name\$(item)=sexpr	<code>c\$(2)="abc"</code>

### **CONSTANTS (build-in)**

Command	Description/Comments	Example
<code>ENABLE (1), DISABLE (0), HIGH (1), LOW (0)</code>	Generic constants	<code>sm esc disable</code>
<code>IN, OUT, PULLUP, PULLDOWN, ADC, PWM, TSENSOR,</code> <code>I2C0, I2C1, UART0, UART1, SPI0, SPI1</code>	HW constants	<code>pmode 25,out</code> <code>dwrite 25,low</code>

### **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 must have 2-dimensions e.g. string 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 string a(2,5) array

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

### **PROGRAM FLOW CONTROL**

-cond: logical expression e.g. `a>5` and `b<10`

-lexpr(logical expression): combination of conditional(<,>,>=,<=,'=', '==', '<>', '!=') and logical operators(AND,OR,NOT)

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

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

## INPUT, OUTPUT, DATA

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

## BUILT-IN FUNCTIONS

Command	Description/Comments	Example
<code>LEFT\$(sexpr, expr)</code>	Left part of the string	<code>k\$=LEFT\$("abc", 2) + "123" i=12</code>
<code>RIGHT\$(sexpr, expr)</code>	Right part of the string	
<code>MID\$(sexpr,expr,expr)</code>	Middle of the string	<code>i\$=MID\$(STR\$(i),2,3) PRINT i\$</code>
<code>HEX\$(expr)</code>	Hex\$(expr to hex string)	<code>PRINT HEX\$(NOT(0x0F))</code>
<code>STR\$(expr)</code>	Str\$(expr to string)	
<code>CHR\$(expr)</code>	Chr\$(expr%256 to ascii e.g. 65 to 'A')	<code>a=65 d\$=chr\$(a)</code>
<code>LEN(sexpr)</code>	LEN(string length)	<code>PRINT LEN("1234")-&gt;4</code>
<code>VAL(sexpr)</code>	Val(string to value)	<code>PRINT VAL("-1234")+1-&gt;-1233</code>
<code>ASC(sexpr)</code>	ASC(ascii code of the 1 <sup>st</sup> char of the string)	<code>PRINT ASC("AB")-&gt;65</code>
<code>SIN(expr)</code>	Sine	<code>PRINT "SIN:", SIN(3.14/6)</code>
<code>COS(expr)</code>	Cosine	<code>PRINT "COS:", COS(3.14/6)</code>
<code>SQR(expr)</code>	Square root	<code>PRINT "SQRT:", SQR(5)</code>
<code>EXP(expr)</code>	Exponential	<code>PRINT "EXP:", EXP(1)</code>
<code>LOG(expr)</code>	Logarithm	<code>PRINT "LOG:", LOG(2.71)</code>
<code>SGN(expr)</code>	Sign	<code>PRINT "SGN:", SGN(-5)</code>
<code>ABS(expr)</code>	Absolute	<code>PRINT "ABS:", ABS(-5)</code>
<code>RND(max)</code>	Hw-based rnd generator + von Neuman whitenizer	<code>PRINT "RND: ", RND(1000)</code>
<code>GETTICK()</code>	Tick number	<code>a=gettick()</code>
<code>PAUSE msec</code>	Delay (blocking) in msec	<code>PAUSE 2*500</code>
<code>INKEY()</code>	Pressed key, OR 0; non-blocking (no-waiting)	
<code>INT(expr)</code>	QBASIC like	<code>a=INT(1.1) b=INT(-1.1) PRINT a, ", ", b (1,-2)</code>
<code>FIX(expr)</code>		<code>c=FIX(1.9) d=FIX(-1.9) PRINT c, ", ", d (1,-1)</code>
<code>AND(expr,expr)</code>		<code>PRINT AND(0x3,0xF)</code>
<code>OR(expr,expr)</code>		<code>PRINT OR(0x3,0xF)</code>
<code>NOT(expr)</code>		<code>PRINT HEX\$(NOT(0x0F))</code>

## PICO HARDWARE SUPPORT

Command	Description/Comments	Example
<code>POKE addr,value</code>	Memory write; hex supported	<code>REM SYSTICK (ST)</code>
<code>PEEK(addr)</code>	Memory read; hex supported	<code>STCSR=0xe000e010 STRVR=0xe000e014 STCVR=0xe000e018</code> <code>poke STCSR,0 poke STRVR,0x1e847 poke STCSR,5</code> <code>for k=0 to 9 print and(peek(STCVR),0xFFFFF) pause 100 next k</code>
<code>PMODE pin,mode</code>	m: const: IN,OUT,PULLUP,PULLDOWN, ADC, PWM, TSENSOR	<code>pmode 100, tsensor temp= aread(100)</code>
<code>AREAD(pin)</code>	Read analog pin; pins=26-29; pin=100 – temperature virtual pin	<code>pmode 26, adc voltage=aread(26)</code> <code>pmode 100,tsensor temp= aread(100)</code>
<code>AWRITE pin,cycle</code>	PWM duty=cycle/65535,cycle<65535	<code>pmode 22, pwm awrite 22, 16000</code>
<code>DREAD(pin)</code>	Read digital pin	<code>y=15 pmode y,in pmode y,pullup</code> <code>for k=1 to 2 step 0 pause 50 print dread(y) next k</code>
<code>DWRITE pin,value</code>	Write digital pin	<code>pmode 25,out dwrite 25,high pause 3000 dwrite 25,low</code>

**GRAPHIC LCD/OLED SUPPORT** (currently: OLED0.91 support)

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

**I2C/UART/SPI SUPPORT** (*experimental*)

- 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
- *limited internal comBuf buffer size to 256 – no more data will be read/write at once*
- framework: xinit, xwrite, xread, xdeinit (where: x=i for i2c, u for uart, s for spi)
- SPI csn is controlled through gpio dwrite*

Command	Description/Comments	Example
<i>IINIT in, sda, scl[,baud]</i> <i>UINIT in, tx, rx[,baud[,data,stop,parity]]</i> <i>SINIT in, tx, rx, sck[,baud[,format]]</i>	<i>initialize hw; sda/scl/tx/rc/sck: GPIO</i> <i>in: i2c0, i2c1, uart0, uart1, spi0, spi1</i> <i>defaults: i2c:400k; uart:115.2k,8,N,1; spi:10M</i>	<i>REM UART loop-test</i> <i>l=8</i> <i>integer bi(l), bo(l)</i> <i>for k=0 to l-1 bi(k)=k next k</i> <i>uinit uart0, 0, 1, 9600</i> <i>uwrite uart0, bi, l</i> <i>pause 100</i> <i>uread uart0, bo, l</i> <i>udeinit uart0</i> <i>end</i>
<i>IREAD in, ad, arrr, len, nstop</i> <i>UREAD in, arr, len</i> <i>SREAD in, arr, len</i>	<i>read / write operations</i> <i>ad: i2c device address;</i> <i>arr: array name for read;</i>	
<i>IWRITE in, ad, arr/str, len, nstop</i> <i>UWRITE in, arr/str, len</i> <i>SWRITE in, arr/str, len</i>	<i>arr/str: array OR string name for write;</i> <i>len: number of bytes to read/write;</i> <i>nstop: 1-no Stop issued, 0-Stop issued</i>	
<i>IDEINIT in; UDEINIT in; SDEINIT in</i>	<i>de-initialize hw</i>	<i>end</i>
<i>IREADABLE(in); IWRITABLE(in)</i> <i>UREADABLE(in); UWRITABLE(in)</i> <i>SREADABLE(in); SWRITABLE(in)</i>	<i>for non-blocking write / write</i> <i>returns: 0,1;</i>	<i>-----</i> <i>REM SPI MAX7219 test</i> <i>TST=0x0F</i> <i>cs=13</i> <i>ll=2</i> <i>integer buf(ll)</i> <i>pmode cs,OUT</i> <i>sinit spi1, 11, 12, 10, 1000000</i> <i>buf(0)=TST buf(1)=0x1 gosub mW</i> <i>pause 1000</i> <i>buf(0)=TST buf(1)=0x0 gosub mW</i> <i>sdeinit spi1</i> <i>end</i> <i>mW:</i> <i>    dwrite cs, LOW</i> <i>    swrite spi1, buf, ll</i> <i>    dwrite cs, HIGH</i> <i>return</i>