

**gputils 0.11.0**

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# Contents

<b>1</b>	<b>gpasm</b>	<b>3</b>
1.1	Running gpasm . . . . .	3
1.1.1	Using gpasm with “make” . . . . .	4
1.1.2	Dealing with errors . . . . .	4
1.2	Syntax . . . . .	4
1.2.1	File structure . . . . .	4
1.2.2	Expressions . . . . .	4
1.2.3	Numbers . . . . .	5
1.2.4	Preprocessor . . . . .	6
1.3	Directives . . . . .	7
1.3.1	Code generation . . . . .	7
1.3.2	Configuration . . . . .	7
1.3.3	Conditional assembly . . . . .	7
1.3.4	Macros . . . . .	7
1.3.5	\$ . . . . .	8
1.3.6	Suggestions for structuring your code . . . . .	8
1.3.7	Directive summary . . . . .	8
1.4	Instructions . . . . .	15
1.4.1	Supported processors . . . . .	15
1.4.2	Instruction set summary . . . . .	16
1.5	Errors/Warnings/Messages . . . . .	18
1.5.1	Errors . . . . .	18
1.5.2	Warnings . . . . .	20
1.5.3	Messages . . . . .	20
<b>2</b>	<b>gplib</b>	<b>22</b>
<b>3</b>	<b>gplink</b>	<b>23</b>
<b>4</b>	<b>Utilities</b>	<b>24</b>
4.1	gpdasm . . . . .	24
4.1.1	Running gpdasm . . . . .	24
4.1.2	Comments on Disassembling . . . . .	24
4.2	gpvc . . . . .	25
4.2.1	Running gpvc . . . . .	25
4.3	gpvo . . . . .	25
4.3.1	Running gpvo . . . . .	25

# Introduction

gputils is a collection of tools for Microchip (TM) PIC microcontrollers. It includes gpasm, gplink, and gplib. Each tool is intended to be an open source replacement for a corresponding Microchip (TM) tool. This manual covers the basics of running the tools. For more details on a microcontroller, consult the manual for the specific PICmicro product that you are using.

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# Chapter 1

## gpasm

### 1.1 Running gpasm

The general syntax for running gpasm is

```
gpasm <options> <asm-file>
```

Where options can be one of:

Option	Meaning
a <format>	Produce hex file in one of four formats: inhx8m, inhx8s, inhx16, inhx32 (the default).
c	Output a relocatable object
d symbol[=value]	Equivalent to “#define <symbol> <value>”.
e [ON OFF]	Expand macros in listing file.
h	Display the help message.
i	Ignore case in source code. By default gpasms to treats “fooYa” and “FOOYA” as being different.
I <directory>	Specify an include directory.
l	List the supported processors.
L	Ignore nolist directives.
m	Memory dump.
n	Use DOS style newlines (CRLF) in hex file. This option is disabled on win32 systems.
o <file>	Alternate name of hex output file.
p<processor>	Select target processor.
q	Quiet
r <radix>	Set the radix, i.e. the number base that gpasm uses when interpreting numbers. <radix> can be one of “oct”, “dec” and “hex” for bases eight, ten, and sixteen respectively. Default is “hex”.
w [ 0   1   2]	Set the message level.
v	Print gpasm version information and exit.

Unless otherwise specified, gpasm removes the “.asm” suffix from its input file, replacing it with “.lst” and “.hex” for the list and hex output files respectively. On most modern operating systems case is significant in filenames. For this reason you should ensure that filenames are named consistently, and that the “.asm” suffix on any source file is in lower case.

gpasm always produces a “.lst” file. If it runs without errors, it also produces a “.hex” file.

### 1.1.1 Using gpasm with “make”

On most operating systems, you can build a project using the make utility. To use gpasm with make, you might have a “makefile” like this:

```
tree.hex: tree.asm treedef.inc
        gpasm tree.asm
```

This will rebuild “tree.hex” whenever either of the “tree.asm” or “treedef.inc” files change. A more comprehensive example of using gpasm with makefiles is included as example1 in the gpasm source distribution.

### 1.1.2 Dealing with errors

gpasm doesn’t specifically create an error file. This can be a problem if you want to keep a record of errors, or if your assembly produces so many errors that they scroll off the screen. To deal with this if your shell is “sh”, “bash” or “ksh”, you can do something like:

```
gpasm tree.asm 2>&1 | tee tree.err
```

This redirects standard error to standard output (“2>&1”), then pipes this output into “tee”, which copies it input to “tree.err”, and then displays it.

## 1.2 Syntax

### 1.2.1 File structure

gpasm source files consist of a series of lines. Lines can contain a label (starting in column 1) or an operation (starting in any column after 1), both, or neither. Comments follow a “;” character, and are treated as a newline. Labels may be any series of the letters A-z, digits 0-9, and the underscore (“\_”); they may not begin with a digit. Labels may be followed by a colon (“:”).

An operation is a single identifier (the same rules as for a label above) followed by a space, and a comma-separated list of parameters. For example, the following are all legal source lines:

			; Blank line
loop	sleep		; Label and operation
	incf	6,1	; Operation with 2 parameters
	goto	loop	; Operation with 1 parameter

### 1.2.2 Expressions

gpasm supports a full set of operators, based on the C operator set. The operators in the following table are arranged in groups of equal precedence, but the groups are arranged in order of increasing precedence. When gpasm encounters operators of equal precedence, it always evaluates from left to right.

Operator	Description
=	assignment
	logical or
&&	logical and
&	bitwise and
	bitwise or
^	bitwise exclusive-or
<	less than
>	greater than
==	equals
!=	not equals
>=	greater than or equal
<=	less than or equal
<<	left shift
>>	right shift
+	addition
-	subtraction
*	multiplication
/	division
%	modulo
HIGH	high byte
LOW	low byte
-	negation
!	logical not
~	bitwise no

Any symbol appearing in column 1 may be assigned a value using the assignment operator (=) in the previous table. Additionally, any value previously assigned may be modified using one of the operators in the table below. Each of these operators evaluates the current value of the symbol and then assigns a new value based on the operator.

Operator	Description
=	assignment
++	increment by 1
--	decrement by 1
+=	increment
-=	decrement
*=	multiply
/=	divide
%=	modulo
<<=	left shift
>>=	right shift
&=	bitwise and
=	bitwise or
^=	bitwise exclusive-or

### 1.2.3 Numbers

gpasm gives you several ways of specifying numbers. You can use a syntax that uses an initial character to indicate the number's base. The following table summarizes the alternatives. Note the C-style option for specifying hexadecimal numbers.

base	general syntax	21 decimal written as
binary	B'[01]*'	B'10101'
octal	O'[0-7]*'	O'25'
decimal	D'[0-9]*'	D'21'
hex	H'[0-F]*'	H'15'
hex	0x[0-F]*	0x15

When you write a number without a specifying prefix such as “45”, gpasm uses the current radix (base) to interpret the number. You can change this radix with the RADIX directive, or with the “-r” option on gpasm’s command-line. If you do not start hexadecimal numbers with a digit, gpasm will attempt to interpret what you’ve written as an identifier. For example, instead of writing C2, write either 0C2, 0xC2 or H’C2’.

Case is not significant when interpreting numbers: 0ca, 0CA, h’CA’ and H’ca’ are all equivalent.

Several legacy mpasm number formats are also supported. These formats have various shortcomings, but are still supported. The table below summarizes them.

base	general syntax	21 decimal written as
binary	[01]*b	10101b
octal	q'[0-7]*'	q'25'
octal	[0-7]*o	25o
octal	[0-7]*q	25q
decimal	0-9]*d	21d
decimal	.[0-9]*	.21
hex	[0-F]*h	15h

You can write the ASCII code for a character X using 'X', or A'X'.

## 1.2.4 Preprocessor

A line such as:

```
include foo.inc
```

will make gpasm fetch source lines from the file “foo.inc” until the end of the file, and then return to the original source file at the line following the include.

Lines beginning with a “#” are preprocessor directives, and are treated differently by gpasm. They may contain a “#define”, or a “#undef” directive.

Once gpasm has processed a line such as:

```
#define X Y
```

every subsequent occurrence of X is replaced with Y, until the end of file or a line

```
#undef X
```

appears.

The preprocessor will replace an occurrence of #v(expression) in a symbol with the value of “expression” in decimal. In the following expression:

```
number equ 5
label_#v( (number +1) * 5 )_suffix equ 0x10
```

gpasm will place the symbol “label\_30\_suffix” with a value of 0x10 in the symbol table.

The preprocessor in gpasm is only *like* the C preprocessor; its syntax is rather different from that of the C preprocessor. gpasm uses a simple internal preprocessor to implement “include”, “#define” and “#undef”.

## 1.3 Directives

### 1.3.1 Code generation

To set the PIC memory location where gpasm will start assembling code, use the ORG directive. If you don't specify an address with ORG, gpasm assumes 0x0000.

### 1.3.2 Configuration

You can choose the fuse settings for your PIC implementation using the \_\_CONFIG directive, so that the hex file set the fuses explicitly. Naturally you should make sure that these settings match your PIC hardware design.

The \_\_MAXRAM and \_\_BADRAM directives specify which RAM locations are legal. These directives are mostly used in processor-specific configuration files.

### 1.3.3 Conditional assembly

The IF, IFNDEF, IFDEF, ELSE and ENDIF directives enable you to assemble certain sections of code only if a condition is met. In themselves, they do not cause gpasm to emit any PIC code. The example in section 1.3.4 for demonstrates conditional assembly.

### 1.3.4 Macros

gpasm supports a simple macro scheme; you can define and use macros like this:

```
any    macro parm
        movlw parm
        endm

...
any    33
```

A more useful example of some macros in use is:

```
; Shift reg left, result (w or f) in 'dst'
slf    macro    reg,dst
        clrc
        rlf     reg,f
    endm

; Scale W by "factor".  Result in "reg", W unchanged.
scale  macro    reg, factor
    if (factor == 1)
        movwf reg                ; 1 X is easy
    else
        scale    reg, (factor / 2) ; W * (factor / 2)
        slf      reg,f             ; double reg
        if ((factor & 1) == 1)     ; if lo-bit set ..
            addwf  reg,f           ; .. add W to reg
        endif
    endif
endm
```

This recursive macro generates code to multiply W by a constant "factor", and stores the result in "reg". So writing:

```
scale    tmp,D'10'
```



is the same as writing:

```
movwf    tmp        ; tmp = W
clrc
rlf      tmp,f      ; tmp = 2 * W
clrc
rlf      tmp,f      ; tmp = 4 * W
addwf    tmp,f      ; tmp = (4 * W) + W = 5 * W
clrc
rlf      tmp,f      ; tmp = 10 * W
```

### 1.3.5 \$

\$ expands to the address of the instruction currently being assembled. If it's used in a context other than an instruction, such as a conditional, it expands to the address the next instruction would occupy, since the assembler's idea of current address is incremented after an instruction is assembled. \$ may be manipulated just like any other number:

```
$
$ + 1
$ - 2
```

and can be used as a shortcut for writing loops without labels.

```
LOOP:    BTFSS flag,0x00
          GOTO LOOP
          BTFSS flag,0x00
          GOTO $ - 1
```

### 1.3.6 Suggestions for structuring your code

Nested IF operations can quickly become confusing. Indentation is one way of making code clearer. Another way is to add braces on IF, ELSE and ENDIF, like this:

```
IF (this) ; {
    ...
ELSE      ; }{
    ...
ENDIF     ; }
```

After you've done this, you can use your text editor's show-matching-brace to check matching parts of the IF structure. In vi this command is "%", in emacs it's M-C-f and M-C-b.

### 1.3.7 Directive summary

#### **\_\_BADRAM**

```
__BADRAM <expression> [, <expression>]*
```

Instructs gpasm that it should generate an error if there is any use of the given RAM locations. Specify a range of addresses with <lo>-<hi>. See any processor-specific header file for an example.

See also: \_\_MAXRAM

#### **\_\_CONFIG**

```
__CONFIG <expression>
```

Sets the PIC processor's configuration fuses.

**\_\_IDLOCS**

```
__IDLOCS <expression> or __IDLOCS <expression1>,<expression2>
```

Sets the PIC processor's identification locations. For 12 and 14 bit processors, the four id locations are set to the hexadecimal value of expression. For 18cxx devices idlocation expression1 is set to the hexadecimal value of expression2.

**\_\_MAXRAM**

```
__MAXRAM <expression>
```

Instructs gpasm that an attempt to use any RAM location above the one specified should be treated as an error. See any processor specific header file for an example.

See also: `__BADRAM`

**BANKISEL**

```
BANKISEL <label>
```

This directive generates bank selecting code for indirect access of the address specified by <label>. The directive is not available for all devices. It is only available for 14 bit and 16 bit devices. For 14 bit devices, the bank selecting code will set/clear the IRP bit of the STATUS register. It will use MOVLB or MOVLRL in 16 bit devices.

See also: `BANKSEL`, `PAGESEL`

**BANKSEL**

```
BANKSEL <label>
```

This directive generates bank selecting code to set the bank to the bank containing <label>. The bank selecting code will set/clear bits in the FSR for 12 bit devices. It will set/clear bits in the STATUS register for 14 bit devices. It will use MOVLB or MOVLRL in 16 bit devices. MOVLB will be used for enhanced 16 bit devices.

See also: `BANKISEL`, `PAGESEL`

**CBLOCK**

```
CBLOCK [<expression>]
      <label>[:<increment>][,<label>[:<increment>]]
ENDC
```

Marks the beginning of a block of constants <label>. gpasm allocates values for symbols in the block starting at the value <expression> given to CBLOCK. An optional <increment> value leaves space after the <label> before the next <label>.

See also: `EQU`

**CONSTANT**

```
CONSTANT <label>=<expression> [, <label>=<expression>]*
```

Permanently assigns the value obtained by evaluating <expression> to the symbol <label>. Similar to SET and VARIABLE, except it can not be changed once assigned.

See also: `EQU`, `SET`, `VARIABLE`

**DA**

```
<label> DA <expression> [, <expression>]*
```

Stores Strings in program memory. The data is stored as one 14 bit word representing two 7 bit ASCII characters.

See also: DT

**DATA**

```
DATA <expression> [, <expression>]*
```

Generates the specified data.

See also: DA, DB, DE, DW

**DB**

```
<label> DB <expression> [, <expression>]*
```

Declare data of one byte. The values are packed two per word.

See also: DA, DATA, DE, DW

**DE**

```
<label> DE <expression> [, <expression>]*
```

Define EEPROM data. Each character in a string is stored in a separate word.

See also: DA, DATA, DB, DW

**DT**

```
DT <expression> [, <expression>]*
```

Generates the specified data as bytes in a sequence of RETLW instructions.

See also: DATA

**DW**

```
<label> DW <expression> [, <expression>]*
```

Declare data of one word.

See also: DA, DATA, DB, DW

**ELSE**

```
ELSE
```

Marks the alternate section of a conditional assembly block.

See also: IF, IFDEF, IFNDEF, ELSE, ENDIF

**END**

```
END
```

Marks the end of the source file.

**ENDC**

```
ENDC
```

Marks the end of a CBLOCK.

See also: CBLOCK

**ENDIF**

```
ENDIF
```

Ends a conditional assembly block.

See also: IFDEF, IFNDEF, ELSE, ENDIF

**ENDM**

```
ENDM
```

Ends a macro definition.

See also: MACRO

**ENDW**

```
ENDW
```

Ends a while loop.

See also: WHILE

**EQU**

```
<label> EQU <expression>
```

Permanently assigns the value obtained by evaluating <expression> to the symbol <label>. Similar to SET and VARIABLE, except it can not be changed once assigned.

See also: CONSTANT, SET

**ERROR**

```
ERROR <string>
```

Issues an error message.

See also: MESSG

**ERRORLEVEL**

```
ERRORLEVEL {0 | 1 | 2 | +<msgnum> | -<msgnum>}[, ...]
```

Sets the types of messages that are printed.

Setting	Affect
0	Messages, warnings and errors printed.
1	Warnings and error printed.
2	Errors printed.
+<msgnum>	Inhibits the printing of message <msgnum>.
-<msgnum>	Enables the printing of message <msgnum>.

See also: LIST

**EXITM**

EXITM

Immediately return from macro expansion during assembly.

See also: ENDM

**EXPAND**

EXPAND

Expand the macro in the listing file.

See also: ENDM

**FILL**

<label> FILL <expression>,<count>

Generates <count> occurrences of the program word or byte <expression>. If expression is enclosed by parentheses, expression is a line of assembly.

See also: DATA DW ORG

**IF**

IF <expression>

Begin a conditional assembly block. If the value obtained by evaluating <expression> is true (i.e. non-zero), code up to the following ELSE or ENDIF is assembled. If the value is false (i.e. zero), code is not assembled until the corresponding ELSE or ENDIF.

See also: IFDEF, IFNDEF, ELSE, ENDIF

**IFDEF**

IFDEF <symbol>

Begin a conditional assembly block. If <symbol> appears in the symbol table, gpasm assembles the following code.

See also: IF, IFNDEF, ELSE, ENDIF

**IFNDEF**

IFNDEF <symbol>

Begin a conditional assembly block. If <symbol> does not appear in the symbol table, gpasm assembles the following code.

See also: IF, IFNDEF, ELSE, ENDIF

**LIST**

LIST <expression> [ , <expression> ] \*

Enables output to the list (“.lst”) file. All arguments are interpreted as decimal regardless of the current radix setting. “list n=0” may be used to prevent page breaks in the code section of the list file. Other options are listed in the table below:

option	description
b=nnn	Sets the tab spaces
f=<format>	Set the hex file format. Can be inhx8m, inhx8s, inhx16, or inhx32.
mm=[ON OFF]	Memory Map on or off
n=nnn	Sets the number of lines per page
p = <symbol>	Sets the current processor
r= [ oct   dec   hex ]	Sets the radix
st = [ ON   OFF ]	Symbol table dump on or off
w=[0   1   2]	Sets the message level.
x=[ON OFF]	Macro expansion on or off

See also: NOLIST, RADIX, PROCESSOR

## LOCAL

```
LOCAL <symbol>[ [=<expression>], [<symbol> [=<expression>]]* ]
```

Declares <symbol> as local to the macro that's currently being defined. This means that further occurrences of <symbol> in the macro definition refer to a local variable, with scope and lifetime limited to the execution of the macro.

See also: MACRO, ENDM

## MACRO

```
<label> MACRO [ <symbol> [ , <symbol> ]* ]
```

Declares a macro with name <label>. gpasm replaces any occurrences of <symbol> in the macro definition with the parameters given at macro invocation.

See also: LOCAL, ENDM

## MESSG

```
MESSG <string>
```

Writes <string> to the list file, and to the standard error output.

See also: ERROR

## NOEXPAND

```
NOEXPAND
```

Turn off macro expansion in the list file.

See also: EXPAND

## NOLIST

```
NOLIST
```

Disables list file output.

See also: LIST

## ORG

```
ORG <expression>
```

Sets the location at which instructions will be placed. If the source file does not specify an address with ORG, gpasm assumes an ORG of zero.

## PAGE

PAGE

Causes the list file to advance to the next page.

See also: LIST

## PAGESEL

PAGESEL <label>  
GOTO <label>

This directive will generate page selecting code to set the page bits to the page containing the designated <label>. The page selecting code will set/clear bits in the STATUS for 12 bit devices. For 14 bit and 16 bit devices, it will generate MOVLW and MOVWF to modify PCLATH. The directive is ignored for enhanced 16 bit devices.

See also: BANKISEL, BANKSEL

## PROCESSOR

PROCESSOR <symbol>

Selects the target processor. See section ?? for more details.

See also: LIST

## RADIX

RADIX <symbol>

Selects the default radix from “oct” for octal, “dec” for decimal or “hex” for hexadecimal. gpasm uses this radix to interpret numbers that don’t have an explicit radix.

See also: LIST

## RES

RES <mem\_units>

Causes the memory location pointer to be advanced <mem\_units>. Can be used to reserve data storage.

See also: FILL, ORG

## SET

<label> SET <expression>

Temporarily assigns the value obtained by evaluating <expression> to the symbol <label>.

See also: SET

## SPACE

SPACE <expression>

Inserts <expression> number of blank lines into the listing file.

See also: LIST

**SUBTITLE**

```
SUBTITLE <string>
```

This directive establishes a second program header line for use as a subtitle in the listing output. <string> is an ASCII string enclosed by double quotes, no longer than 60 characters.

See also: TITLE

**TITLE**

```
TITLE <string>
```

This directive establishes a program header line for use as a title in the listing output. <string> is an ASCII string enclosed by double quotes, no longer than 60 characters.

See also: SUBTITLE

**VARIABLE**

```
VARIABLE <label>[=<expression>, <label>[=<expression>]]*
```

Declares variable with the name <label>. The value of <label> may later be reassigned. The value of <label> does not have to be assigned at declaration.

See also: CONSTANT

**WHILE**

```
WHILE <expression>
```

Performs loop while <expression> is true.

See also: ENDW

**1.4 Instructions****1.4.1 Supported processors**

gpasm currently supports the following processors:

eeprom8	gen	p12c508	p12c508a	p12c509	p12c509a
p12c671	p12c672	p12ce518	p12ce519	p12ce673	p12ce674
p12cr509a	p12f629	p12f675	p14000	p16c5x	p16cxx
p16c432	p16c433	p16c505	p16c52	p16c54	p16c54a
p16c54b	p16c54c	p16c55	p16c55a	p16c554	p16c557
p16c558	p16c56	p16c56a	p16c57	p16c57c	p16c58a
p16c58b	p16c61	p16c62	p16c62a	p16c62b	p16c620
p16c620a	p16c621	p16c621a	p16c622	p16c622a	p16c63
p16c63a	p16c64	p16c64a	p16c642	p16c65	p16c65a
p16c65b	p16c66	p16c662	p16c67	p16c71	p16c710
p16c711	p16c712	p16c715	p16c716	p16c717	p16c72
p16c72a	p16c73	p16c73a	p16c73b	p16c74	p16c745
p16c74a	p16c74b	p16c76	p16c765	p16c77	p16c770
p16c771	p16c773	p16c774	p16c781	p16c782	p16c84
p16c923	p16c924	p16c925	p16c926	p16ce623	p16ce624
p16ce625	p16cr54	p16cr54a	p16cr54b	p16cr54c	p16cr56a
p16cr57a	p16cr57b	p16cr57c	p16cr58a	p16cr58b	p16cr62
p16cr620a	p16cr63	p16cr64	p16cr65	p16cr72	p16cr83
p16cr84	p16f627	p16f627a	p16f628	p16f628a	p16f630
p16f676	p16f72	p16f73	p16f74	p16f76	p16f77



p16f818	p16f819	p16f83	p16f84	p16f84a	p16f87
p16f870	p16f871	p16f872	p16f873	p16f873a	p16f874
p16f874a	p16f876	p16f876a	p16f877	p16f877a	p16f88
p16hv540	p17cxx	p17c42	p17c42a	p17c43	p17c44
p17c752	p17c756	p17c756a	p17c762	p17c766	p17cr42
p17cr43	p18cxx	p18c242	p18c252	p18c442	p18c452
p18c601	p18c658	p18c801	p18c858	p18f1220	p18f1320
p18f2220	p18f2320	p18f242	p18f248	p18f252	p18f258
p18f4220	p18f4320	p18f442	p18f448	p18f452	p18f458
p18f6620	p18f6720	p18f8620	p18f8720	rf509af	rf509ag
sx18	sx20	sx28			

## 1.4.2 Instruction set summary

### 12 bit Devices (PIC12C5XX)

Syntax	Description
ADDWF <f>,<dst>	Add W to <f>, result in <dst>
ANDLW <f>,<dst>	And W and literal, result in W
ANDWF <f>,<dst>	And W and <f>, result in <dst>
BCF <f>,<bit>	Clear <bit> of <f>
BSF <f>,<bit>	Set <bit> of <f>
BTFSC <f>,<bit>	Skip next instruction if <bit> of <f> is clear
BTFSS <f>,<bit>	Skip next instruction if <bit> of <f> is set
CALL <addr>	Call subroutine
CLRF <f>,<dst>	Write zero to <dst>
CLRW	Write zero to W
CLRWDW	Reset watchdog timer
COMF <f>,<dst>	Complement <f>, result in <dst>
DECF <f>,<dst>	Decrement <f>, result in <dst>
DECFSZ <f>,<dst>	Decrement <f>, result in <dst>, skip if zero
GOTO <addr>	Go to <addr>
INCF <f>,<dst>	Increment <f>, result in <dst>
INCFSZ <f>,<dst>	Increment <f>, result in <dst>, skip if zero
IORLW <f>,<dst>	Or W and <f>, result in <dst>
MOVF <f>,<dst>	Move <f> to <dst>
MOVLW <imm8>	Move literal to W
MOVWF <f>	Move W to <f>
NOP	No operation
OPTION	
RETLW <imm8>	Load W with immediate and return
RLF <f>,<dst>	Rotate <f> left, result in <dst>
RRF <f>,<dst>	Rotate <f> right, result in <dst>
SLEEP	Enter sleep mode
SUBWF <f>,<dst>	Subtract W from <f>, result in <dst>
SWAPF <f>,<dst>	Swap nibbles of <f>, result in <dst>
TRIS	
XORLW	Xor W and <f>, result in <dst>
XORWF	Xor W and immediate

**14 Bit Devices (PIC16CXX)**

Syntax	Description
ADDLW <imm8>	Add immediate to W
ADDWF <f>,<dst>	Add W to <f>, result in <dst>
ANDLW <f>,<dst>	And W and <f>, result in <dst>
BCF <f>,<bit>	Clear <bit> of <f>
BSF <f>,<bit>	Set <bit> of <f>
BTFSC <f>,<bit>	Skip next instruction if <bit> of <f> is clear
BTFSS <f>,<bit>	Skip next instruction if <bit> of <f> is set
CALL <addr>	Call subroutine
CLRF <f>,<dst>	Write zero to <dst>
CLRW	Write zero to W
CLRWDI	Reset watchdog timer
COMF <f>,<dst>	Complement <f>, result in <dst>
DECF <f>,<dst>	Decrement <f>, result in <dst>
DECFSZ <f>,<dst>	Decrement <f>, result in <dst>, skip if zero
GOTO <addr>	Go to <addr>
INCF <f>,<dst>	Increment <f>, result in <dst>
INCFSZ <f>,<dst>	Increment <f>, result in <dst>, skip if zero
IORLW <f>,<dst>	Or W and <f>, result in <dst>
MOVF <f>,<dst>	Move <f> to <dst>
MOVLW <imm8>	Move literal to W
MOVWF <f>	Move W to <f>
NOP	No operation
OPTION	
RETFIE	Return from interrupt
RETLW <imm8>	Load W with immediate and return
RETURN	Return from subroutine
RLF <f>,<dst>	Rotate <f> left, result in <dst>
RRF <f>,<dst>	Rotate <f> right, result in <dst>
SLEEP	Enter sleep mode
SUBLW	Subtract W from literal
SUBWF <f>,<dst>	Subtract W from <f>, result in <dst>
SWAPF <f>,<dst>	Swap nibbles of <f>, result in <dst>
TRIS	
XORLW	Xor W and <f>, result in <dst>
XORWF	Xor W and immediate

**Ubcicom Processors**

For Ubcicom (Scenix) processors, the assembler supports the following instructions, in addition to those listed under “12 Bit Devices” above.

Syntax	Description
BANK <imm3>	
IREAD	
MODE <imm4>	
MOVW	
MOVWM	
PAGE <imm3>	
RETI	
RETIW	
RETP	
RETURN	

## Special macros

There are also a number of standard additional macros. These macros are:

Syntax	Description
ADDCF <f>,<dst>	Add carry to <f>, result in <dst>
B <addr>	Branch
BC <addr>	Branch on carry
BZ <addr>	Branch on zero
BNC <addr>	Branch on no carry
BNZ <addr>	Branch on not zero
CLRC	Clear carry
CLRZ	Clear zero
SETC	Set carry
SETZ	Set zero
MOVFW <f>	Move file to W
NEGF <f>	Negate <f>
SKPC	Skip on carry
SKPZ	Skip on zero
SKPNC	Skip on no carry
SKPNZ	Skip on not zero
SUBCF <f>,<dst>	Subtract carry from <f>, result in <dst>
TSTF <f>	Test <f>

## 1.5 Errors/Warnings/Messages

gpasm writes every error message to two locations:

- the standard error output
- the list file (“`.lst`”)

The format of error messages is:

```
Error <src-file> <line> : <code> <description>
```

where:

**<src-file>** is the source file where gpasm encountered the error

**<line>** is the line number

**<code>** is the 3-digit code for the error, given in the list below

**<description>** is a short description of the error. In some cases this contains further information about the error.

Error messages are suitable for parsing by emacs’ “compilation mode”. This chapter lists the error messages that gpasm produces.

### 1.5.1 Errors

#### 101 ERROR directive

A user-generated error. See the ERROR directive for more details.

#### 114 Divide by zero

gpasm encountered a divide by zero.

**115 Duplicate Label**

Duplicate label or redefining a symbol that can not be redefined.

**124 Illegal Argument**

gpasm encountered an illegal argument in an expression.

**125 Illegal Condition**

An illegal condition like a missing ENDIF or ENDW has been encountered.

**126 Argument out of Range**

The expression has an argument that was out of range.

**127 Too many arguments**

gpasm encountered an expression with too many arguments.

**128 Missing argument(s)**

gpasm encountered an expression with at least one missing argument.

**129 Expected**

Expected a certain type of argument.

**130 Processor type previously defined**

The processor is being redefined.

**131 Undefined processor**

The processor type has not been defined.

**132 Unknown processor**

The selected processor is not valid. Check the processors listed in section ??.

**133 Hex file format INHX32 required**

An address above 32K was specified.

**135 Macro name missing**

A macro was defined without a name.

**136 Duplicate macro name**

A macro name was duplicated.

**145 Unmatched ENDM**

ENDM found without a macro definition.

**159 Odd number of FILL bytes**

In PIC18CXX devices the number of bytes must be even.

### 1.5.2 Warnings

#### 201 Symbol not previously defined.

The symbol being #undefined was not previously defined.

#### 202 Argument out of range

The argument does not fit in the allocated space.

#### 211 Extraneous arguments

Extra arguments were found on the line.

#### 215 Processor superseded by command line

The processor was specified on the command line and in the source file. The command line has precedence.

#### 216 Radix superseded by command line

The radix was specified on the command line and in the source file. The command line has precedence.

#### 217 Hex format superseded by command line

The hex file format was specified on the command line and in the source file. The command line has precedence.

#### 218 Expected DEC, OCT, HEX. Will use HEX.

gpasm encountered an invalid radix.

#### 219 Invalid RAM location specified.

gpasm encountered an invalid RAM location as specified by the \_\_MAXRAM and \_\_BADRAM directives.

#### 222 Error messages can not be disabled

Error messages can not be disabled using the ERRORLEVEL directive.

#### 223 Redefining processor

The processor is being reselected by the LIST or PROCESSOR directive.

#### 224 Use of this instruction is not recommended

Use of the TRIS and OPTION instructions is not recommended for a PIC16CXX device.

### 1.5.3 Messages

#### 301 User Message

User message, invoked with the MESSG directive.

#### 303 Program word too large. Truncated to core size.

gpasm has encounter a program word larger than the core size of the selected device.

#### 304 ID Locations value too large. Last four hex digits used.

The ID locations value specified is too large.

**305** Using default destination of 1 (file).

No destination was specified so the default location was used.

**308** Warning level superseded by command line

The warning level was specified on the command line and in the source file. The command line has precedence.

**309** Macro expansion superseded by command line

Macro expansion was specified on the command line and in the source file. The command line has precedence.

## Chapter 2

# gplib

gplib is a new and incomplete tool. When complete, it will provide the ability to archive relocatable objects. These archives, or libraries, can be used to simplify linking.

## Chapter 3

# gplink

gplink is a new and incomplete tool. When complete, it will provide the ability to link relocatable objects to produce an executable object.



# Chapter 4

## Utilities

### 4.1 gpdasm

gpdasm is open source disassembler for Microchip’s popular PICmicro (TM) line of microcontrollers. gpdasm is part of gputils.

#### 4.1.1 Running gpdasm

The general syntax for running gpdasm is

```
gpdasm <options> <hex-file>
```

Where options can be one of:

Option	Meaning
h	Display the help message.
i	Display hex file information
l	List supported processors.
m	Memory dump hex file.
p<processor>	Select processor.
s	Print short form output
v	Print gpasm version information and exit.

gpdasm doesn’t specifically create an output file. It dumps its output to the screen. This helps to reduce the risk that a good source file will be unintentionally overwritten. If you want to create an output file and your shell is “sh”, “bash” or “ksh”, you can do something like:

```
gpdasm test.hex > test.dis
```

This redirects standard output to the file “test.dis”.

#### 4.1.2 Comments on Disassembling

- The gpdasm only uses a hex file as an input. Because of this it has no way to distinguish between instructions and data in program memory.
- If gpdasm encounters an unknown instruction it uses the DW directive and treats it as raw data.
- There are DON’T CARE bits in the instruction words. Normally, this isn’t a problem. It could be, however, if a file with data in the program memory space is disassembled and then reassembled. Example: gpdasm will treat 0x0060 in a 14 bit device as a NOP. If the output is then reassembled, gpasm will assign a 0x0000 value. The value has changed and both tools are behaving correctly.

## 4.2 gpvc

gpvc is open source cod file viewer for Microchip’s popular PICmicro (TM) line of microcontrollers. gpvc is part of gputils.

### 4.2.1 Running gpvc

The general syntax for running gpvc is

```
gpvc <options> <cod-file>
```

Where options can be one of:

Option	Meaning
a	Display all information
d	Display directory header
s	Display symbols
h	Show the help message.
r	Display ROM
l	Display source listing
m	Display debug message area
v	Print gpvc version information and exit.

gpvc doesn’t specifically create an output file. It dumps its output to the screen. If you want to create an output file and your shell is “sh”, “bash” or “ksh”, you can do something like:

```
gpvc test.cod > test.dump
```

This redirects standard output to the file “test.dump”.

## 4.3 gpvo

gpvo is open source object file viewer for Microchip’s popular PICmicro (TM) line of microcontrollers. gpvo is part of gputils.

### 4.3.1 Running gpvo

The general syntax for running gpvo is

```
gpvo <options> <object-file>
```

Where options can be one of:

Option	Meaning
b	Binary data
f	File header
h	Show the help message
n	Suppress filenames
s	Section data
t	Symbol data
v	Print gpvo version information and exit

gpvo doesn’t specifically create an output file. It dumps its output to the screen. If you want to create an output file and your shell is “sh”, “bash” or “ksh”, you can do something like:

```
gpvo test.obj > test.dump
```

This redirects standard output to the file “test.dump”.

# Index

ASCII, 6

BADRAM, 8  
BANKISEL, 9  
BANKSEL, 9  
bash, 4, 24, 25

case, 3  
CBLOCK, 9  
character, 6  
comments, 4  
CONFIG, 8  
CONSTANT, 9

DA, 10  
DATA, 10  
DB, 10  
DE, 10  
DT, 10  
DW, 10

ELSE, 10  
END, 10  
ENDC, 11  
ENDIF, 11  
ENDM, 11  
ENDW, 11  
EQU, 11  
ERROR, 11  
error file, 4  
ERRORLEVEL, 11  
EXITM, 12

FILL, 12

GNU, 2  
gpdasm, 24  
gpvc, 25  
gpvo, 25

hex file, 3

IDLOCS, 9  
IF, 12  
IFDEF, 12  
IFNDEF, 12  
include, 6

ksh, 4, 24, 25

labels, 4  
License, 2  
LIST, 12  
LOCAL, 13

MACRO, 13  
make, 4  
MAXRAM, 9  
MESSG, 13

NO WARRANTY, 2  
NOEXPAND, 13  
NOLIST, 13

operators, 4  
options, 3  
ORG, 13

PAGE, 14  
PAGESEL, 14  
PROCESSOR, 14

RADIX, 14  
radix, 3, 5  
RES, 14  
Running gpdasm, 24  
Running gpvc, 25  
Running gpvo, 25

SET, 14  
sh, 4, 24, 25  
SPACE, 14  
SUBTITLE, 15

tee, 4  
TITLE, 15

VARIABLE, 15

WHILE, 15