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TMS9900/99105 Cross-assembler

☺

Rev. 1.0

☺

Derived from the original William C. Colley, III.
☺ M6800 Cross Assembler

☺

by

☺

Alexander Cameron

☺

Written and modified during June 1984.

☺

The Manual Such As It Is.

©

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1.1 Format of Cross-assembler Commands
© 1.1.1 Command Strings

©

Tná ruε tho 990: cross-assemblerá typsá tho i

©

A>a99 filename options

©

filename||

Θááááááááááááááááááá Thsáá namcsá ouá thoá sourcsá inpuʃáá filcsáá i≤ i

©

options: See next section.

©

1.1.2 Options

©

Thsá sourcsá filcsá come≤á froφá thoá currentl. i

©

a, b, c, d Disk drives.

©

- The currently logged in disk drive.

©

Line≤á ou inpuʃ containint error≤ wil∞á alway≤ i

©

i

Θááááááááááááááááááá

Consolo dev

©

y List device.

©

Thoá he° filo wil∞ noʃ bo outpuʃ unles≤ calleΣ i

©

Option≤á musʃá bo ruε togetheΣ intná βá singlo i

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1.1.3 Examples

©

A>a99 barf

source -- a:barf.a99

©

list -- none.

©

hex -- none.

A>a99 barf sblxha source -- b:barf.a99
 list -- con:
 hex -- a:barf.h99

 A>a99 barf ly source -- a:barf.a99
 list -- lst:
 hex -- none.

 A>b:a99 barf sbh- source -- b:barf.a99
 list -- none.

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 hex -- a:barf.h99

 1.2 Format of TMS9900 Cross-assembler Source Files

 Line≤ ou sourco inpuſ aro terminateΣ witΦ CR/L¶ ì

 Lowe≥á casoá letter≤ aro converteΣá tñá uppe≥ ì

 1) In opcodes,

 2) In checking for keywords such as NOT, and

 3) In command strings.

 This mean≤ thaſ "not"¶á "NOT"¶á "Not"¶ etc< ì

 1.2.1 Statements

 Sourco file≤ inpuſ tñ the 990:á Cross-assemble≥ ì

 [label] [opcode] [arguments] [;comments.]

☺

Label≤á aróá recognizeΣ b· thei≥ beginnintá iε i

☺

Opcode≤áá ma·á boá eithe≥á 990;áá instructioε i

☺

Thoá argument≤ followint tho opcodö wil∞á var. i

☺

Line≤á terminatö witΦ eithe≥ß CR/LF paiz o≥á ß i

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1.2.2 Symbols

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☺

Symbol≤ ma· bo ou an· length≤á buʃ onl·á tho i

☺

☺

A-Z a-z ! & . : ? [\] ^ _ `

☺

Notoá thaʃá symbol≤ ma· noʃ begie witΦ 0-#á a≤ i

☺

lá specia∞á symboo∞ n i≤ alway≤ equa∞á tná tho i

☺

1.2.3 Numeric Constants

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Number≤á begieá witΦá 0-9,%<á Ñá leadintá basö i

☺ 0ff80h evaluate to ff80 hex.
☺ 128 and 128d evaluate to 80 hex.
☺ 35o, and 35q evaluate to 1d hex.
☺ %0111000 and 0111000b evaluate to 39 hex.

☺ Lá charactežá constanſ i≤ ñ strint composeΣá oμ i

☺ "ab" evaluates to 6162 hex.
☺ " " evaluates to 0000 hex.
☺ " " evaluates to 0027 hex.
☺ 'A' evaluates to 0041 hex.

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☺ Notσáá thaſá iεá thσá two-charactežáá charactež i

☺ 1.2.4 Strings

☺ Stringſá arσá formeΣ iε thσ samσ wa·á a≤ i

☺ 1.3 Expression Evaluation

☺ Thosá followintá operator≤á arsá alloweΣáá iε i

☺ Unary Plus, Unary Minus

☺ *, /, MOD, SHL, SHR

☺ +, -

☺ >, >=, <, <=, <>, =

☺ (These can also be written as
☺ GT, GE, LT, LE, NE, EQ.)

☺ NOT (1's complement)

☺ AND (Bitwise logical AND)

☺ OR, XOR (Bitwise logical OR and Exclusive
☺ OR)

☺ HIGH, LOW

☺ Parenthesesá arsá useΣ tñ changσ thosá ordeΣá op i

☺ All operators except +^{1/4} -^{1/4} *^{1/4} /^{1/4} =^{1/4} <^{1/4}>^{1/4} >=^{1/4} i

☺ The "HIGH" mumbleó i≤ equivalent to "mumbleσ SH" i

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☺ AN- 0ffH".

☺ The relational operators (=^{1/4} >^{1/4} etc.) evaluate i

☺ Expression≤ááá arsáá terminateΣáá b·áá commas^{1/4} i

☺

Thosááá instruction≤ááá opááá thosááá 9900/9910- i

☺

The basic syntax is as follows:

☺

[label] LI R1,expression ;The expression
;is evaluated
;from left to
;right.

☺

Thosá typosá opá addressint eacΦá instructioεá i≤ i

1.4.1 Addressing Modes

Thosá instructioε seſ allows for addressing modes in the instruction set.

Addressing Mode

Workspace register

Workspace register indirect

Symbolic

Index register

Workspace register indirect

(auto increment)

Example

MOV R1,R3

A *R1,R2

CLR @expr

A @expr(R1),R2

DEC *R7+

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These modes will generate writes to memory locations.

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Registers

R, *R, *R+, @X, @X(R)

This group contains the following opcodes:

COC CZC XOR MPY DIV XOP LDCR STCR

Instruction format: [opcode | format3 | format1]

Example: XOP @LABEL, 3

1.4.6 Group 4 Instructions

This group contains the following instructions:

This instruction belongs to the Group 4 instructions.

BLW CLT SETL INR NEB SWPB
INC INCT DEC DECT X
BIND(a TMS99105 instruction)

Instruction format: [opcode | format1]

Example: INC @LABEL(R3)

1.4.7 Group 5 Instructions

This group contains the following instructions:

This instruction belongs to the Group 5 instructions.

SBO SBZ TB

Instruction format: [opcode | format4]

Example: SBO 25

1.4.8 Group 6 Instructions

This group contains the following instructions:

This instruction belongs to the Group 6 instructions.

JEQ JGT JH JHE JL JLE JLT JMP JNC JNE
JNO JOC JOP

Instruction format: [opcode | format2]

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Example:

JEQ LABEL

Group 7 Instructions

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This group covers immediate Source Operation instructions.

The following instruction belongs to this group:

AI ANDI CI LI ORI
BLSK (a TMS99105 instruction)

Instruction format: [opcode | format5]
[format6]

Example: AI R3,128

Group 8 Instructions

This group covers internal Register Load instructions.

The following instruction belongs to this group:

LWPI LIMI

Instruction format: [opcode]
[format6]

Example: LIMI 3

Group 9 Instructions

This group covers internal Register Store instructions.

The following instruction belongs to this group:

STST STWP
LSLW (TMS99105 instructions)

Instruction format: [opcode | format5]

[format3 | format1]

Example:

STST R3

1.4.12 Group 10 (TMS99105 only)

(*)

This group covers the Bit-Manipulation instructions

TMB TCMB TSMC

etc

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Instruction format: [opcode]

[format3 | format1]

[format3 | format1]

Example:

TMB @BITMAP(R3),8

1.5 Pseudo-operations

1.5.1 END

When this statement is encountered by the assembler, it

[label] END

If an IF statement is not closed with an END, it

This statement permits no arguments.

1.5.2 EQU

This statement is used to assign a permanent value to a

label EQU expression

⌚ Á phasint (Pr̄ erro≥ wil∞ resul[iμá an. i

⌚ 1.5.3 BYTE

⌚ Thi≤á statemen[á i≤á useΣá tñá placσá byte≤á ie i

⌚ [label] BYTE [expr1[,expr2]].....

⌚ 1.5.4 TEXT

⌚ Thi≤á statemen[á i≤ useΣ tñá placσá string≤á ie i

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⌚ [label] TEXT [string][,string].....

⌚ 1.5.5 WORD

⌚ Thi≤á statemen[á i≤á useΣá tñá placσá word≤á ie i

⌚ [label] WORD [expr1[,expr2]].....

⌚ 1.5.6 BSS (Block Starting with Symbol)

⌚ Thi≤á statemen[i≤ useΣ tñ reservσ ßá blocδá op i

⌚ [label] BSS expression

1.5.7 EVEN

This statement is used to force the assembler to

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↑ [label] EVEN

☺

1.5.8 DXOP

This statement allows the programmer to define

DXOP PUSH,3 ; assign the name PUSH to
; XOP number 3
For example if PUSH is previously defined XOP is

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↑

1.5.9 Conditional Assembly

This statement is used to assemble a block of code into

☺

IF expression

☺

(lines of code)

☺

ENDIF

If the expression evaluates to 0 it is the code is

☺ Ιεάά additionάάά thσá ELS+á directivσá i≤ ī

☺ IF expression

☺ (lines of code)

☺ ELSE

☺ (more lines of code)

☺ ENDI

☺ This is equivalent to:

☺ IF expression

☺ (lines of code)

☺ ENDI

☺ IF NOT expression

☺ (more lines of code)

☺ ENDI

☺ Notσá thaſá label≤ arσá noſá permitteΣá oε ī

☺ ↓ phasint (P- erro≥ wil∞ bσ flaggeΣ ipá therσ ī

☺ 1.5.10 AORG

☺ Thi≤á statemenſá i≤ useΣ tη loaΣ βá valuo īè

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☺ Οάάάάάάάάάάάάάάάintη thσ assembl. prograφ counter« Thσ valuo ī

☺ [label] AORG expression

- ⌚ 1.5.11 SET
 - ⌚ This statement uses the assignment operator (=) to assign a temporary value to a label.

- ⌚ The syntax is:
 - ⌚ label SET expression

- ⌚ 1.6 Error Messages
 - ⌚ Error messages are flagged with the single character 'i'.

 - ⌚ A Presently not implemented.
 - ⌚ B Distance or branch instruction is illegal.

 - ⌚ C Digital tonal largo form is based on width.

 - ⌚ D Expression ill-formed. Loop form not implemented.
 - ⌚ E Input stack imbalance. Loop form ELS+ is illegal.

 - ⌚ F Invalid label. Label must contain letters only.

 - ⌚ G Label already defined. Label is illegal.

- ⑥ O Invalid opcode[¶] Looδáá fo≥ i
- ⑥ P Phasint error[¶] Looδ fo≥ expression≤ i
- ⑥ R Registe≥ valuo too large[¶] Register≤ i
- ⑥ S Synta°á error[¶] Checδá you≥á synta° i
- ⑥ T Tooáá man·á argument≤á oεáá thi≤ i
- ⑥ U UndefineΣá symbo∞á encountereΣ i
- ⑥ V Valuoáá ouʃáá oμáá bounds[¶] Iε i
- ⑥ * Thi≤á statemen†á generateΣá b·á tho i
- ⑥ " Quotσá imbalancσá error[¶] Bea≥á i ε i
- ⑥ (Parenthesi≤á imbalancσ error[¶] Coun| i
- ⑥ 1.7 Assembler Abort Conditions
- ⑥ Unde≥ certaiε circumstances[¶] thi≤á assemble≥ i

☺ Thosá sourco filo does not exist.

☺ 1) Can't open source.

☺ Thosá sourco filo does not exist.

☺ 2) Can't open list.
☺ Can't open hex.

☺ No director. entries left. One of the is

☺ 3) Illegal command line.

☺ Bone up on command lines.

☺ 4) No file info supplied.

☺ Bone up on command lines.

☺ 5) If stack overflow.

☺ If directive¹ makes only one byte needed in

☺ 6) Disk read error.

☺ Source file has bad bytes CR LF or others.

☺ 7) Disk write error.

☺ Out of disk space or director. space or the is

☺ 8) Error closing file.

☺ Problem closing list. overflow happened.

☺ 9) Symbol Table Overflow.

☺ You have defined too many symbols.

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1.8 Compiling the Assembler

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Toá compiló tho assemblez a≤ i|á stands%á yo] i

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1) 40K of RAM.

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2) The BDS C Compiler Version 1.5
(good box, Leor!!).

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3) Digital Research's AS=á o≥á MA| i

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To get a99tbls.crl u≡ from scratch%á yo] i

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A>casm a99tbls ;source a99tbls.csm

è

This should yield a file a99tbls.asm on drive A.

è

A>maná a99tbls \$p. -l ;ma. uss asp fn.aa. i

è

A>cloaΣá a99tbls ;produces CR| filo i

è

You should now have a99tbls.crl on drive A.

è

Now you can read the res[ouá tho i

è

A>cc a99
A>cc a99asmlnc
A>cc a99evalc
A>cc a99getc
A>cc a99putc
A>cc a99symbc

è

Now you can link it all together.

☺ A>clink a99 -s
☺ *a99asmln
☺ *a99eval
☺ *a99get
☺ *a99put
☺ *a99symb
☺ *a99tbls
☺ And, as if by magic, you've got a99.com!
☺ Notóá thaſá thσ linkagσ caε al∞ bσ donσ oεá onσ i

è

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☺ 1.9 Final Comments
☺ Happ·á assemblingía Iμ yo] havσ question≤ o≥ i

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