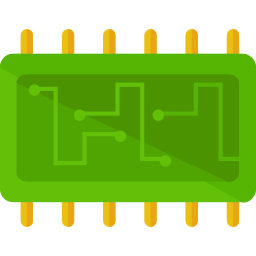
[](https://github.com/ZwerOxotnik/m-microcontroller) [FAL](https://mods.factorio.com/mod/m-microcontroller)

Factorio Assembly Language

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**REFERENCE MANUAL**

**v0.5.7**

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# OVERVIEW

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The Factorio Assembly Language is the future of automated manufacture. Designed ground-up for use in large-scale factories. The Factorio Assembly Language has over op-codes and the FMCU (Factorio MicroController Unit) can store 32 instructions. The FMCU has 4 internal read/write registers as well as 4 read-only registers.

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| Notes like this will appear in black outlined rectangles. These notes indicate more information on a topic |

## Registers

The FMCU has 4 internal read-write registers:

**MEM1 MEM2 MEM3 MEM4**

It also has 4 read-only registers:

**MEM5** or **IPT**: Instruction pointer index.

**MEM6** or **CNR**: Number of Signals on the Red Wire Input.

**MEM7** or **CNG**: Number of Signals on the Green Wire Input

**MEM8** or **CLK**: Monotonic clock.

## Napped Memory

The FMCU can be extended with FRAMM (Factorio Random Access Memory Module). The FMCU has 4 external memory ports:

**North Port 01** is mapped to **MEM11-14**.

**South Port 01** is mapped to **MEM21-42**.

**North Port 02** is mapped to **MEM31-34**.

**South Port 02** is mapped to **MEM41-44**.

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| You can also connect an external FMCU to North and South Port 01. |

# GLOSSARY

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## Signal

A Type and a signed integer value.

## Type

Each signal contains a Type. The type could either refer to an item your factory consumes or produces or could be a ‘virtual’ type.

## Value

The integer part of a Signal.

## Move

Copy a Signal from one register to another.

## Set

Set the Value of a Signal to another Value.

## Register

Register A unit of memory that can store one Signal.

## Clear

Reset a Register to NULL.

## NULL

A Virtual Black Signal with a Value of 0.

## Label

A text identifier used for the jumps.

# BASIC INSTRUCTION SET

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<:I> specifies a parameter that takes a literal integer.

<:R> specifies a parameter that takes a register address.

<:W> specifies a parameter that takes a register address.

<:L> specifies a parameter that takes a register address.

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| The FMCU can only read one instruction per tick. |

## Comments

**Syntax:** #<COMMENT>

All text after the comment

## Labels

**Syntax:** :<LABEL>

Labels are used as identifiers for the jump instructions. A label is a colon followed by text. When using a label in a jump instruction you must also include the colon.

**Example:**

:LOOP

JMP :LOOP

* 1. **NOP**

**Syntax:** NOP

NOP stands for no-operation. It has no effect on the state of the internal registers. It will still take 1 tick for an FMCU to read a NOP instruction.

## MOV

**Syntax:** MOV <SRC:W/R> <DST:R>…

Takes the Signal at <SRC> and writes it to all <DST> Register(s).

## SET

**Syntax:** MOV <SRC:I> <DST:R>

Takes the Value at <SRC> and write it to <DST>.

## SWP

**Syntax:** SWP <SRC:R> <DST:R>

Swaps the Signals in <SRC> and <DST>.

## CLR

**Syntax:** CLR < DST:R>…

Writes NULL to all <DST> Register(s).

## Find In Green

**Syntax:** FIG <SRC:R>

Looks for a Signal in the Green Wire Input where the Signal Type is equal to the type at <SRC>. If a signal is found it is written to MEM1.

**Example:**

fig MEM21

mul MEM1 2

mov MEM1 OUT

## Find In Red

**Syntax:** FIR <SRC:R>

Looks for a Signal in the Red Wire Input where the Signal Type is equal to the type at <SRC>. If a signal is found it is written to MEM1.

## JMP

**Syntax:** JMP <SRC:I/R/L>

Jumps the instruction pointer to <SRC>. If <SRC> is a literal integer, the instruction pointer jumps to that line. If <SRC> is a Register, the instruction pointer jumps to line N where N is the value at the Register. If <SRC> is a Label, the instruction pointer jumps to the first declaration of that Label.

**Example:**

:LOOP

jmp :LOOP

## HLT

**Syntax:** HLT <SRC:R>

Halts the program

# ARITHMETIC INSTRUCTIONS

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## ADD

**Syntax:** ADD <SRC:I/R> <DST:I/R>

Adds the Value at <SRC> to the Value at <DST> and writes the result to MEM1.

## SUB

**Syntax:** SUB <SRC:I/R> <DST:I/R>

Subtracts the Value at <DST> from the Value at <SRC> and writes the result to MEM1.

## MUL

**Syntax:** MUL <SRC:I/R> <DST:I/R>

Multiplies the Value at <SRC> by the Value at <DST> and writes the result to MEM1.

## DIV

**Syntax:** DIV <SRC:I/R> <DST:I/R>

Divides the Value at <SRC> by the Value at <DST> and writes the result to MEM1.

## MOD

**Syntax:** MOD <SRC:I/R> <DST:I/R>

Executes <SRC> modulo <DST> and writes the result to MEM1.

**Example:**

:60 second clock.

add mem1 1

mod mem1 60

jmp 1

## POW

**Syntax:** POW <SRC:I/R> <DST:I/R>

Raises <SRC> to the power of <DST> and writes the result to MEM1.

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| Arithmetic instructions ignore Signal Type. |

## DIG

**Syntax:** SWP <SRC:I/R>

Reads the digit at position <SRC> from MEM1 and writes the result to MEM1.

## DIS

**Syntax:** DIS <SRC:I/R> <DST:I/R>

Writes <DST> to the digit at position <SRC> in MEM1.

If <DST> is more than 1 digit long, it writes the 1st digit.

## BITWISE AND

**Syntax:** BND <SRC:I/R> <DST:I/R>

Executes <SRC> AND <DST> then writes the result to MEM1.

## BITWISE OR

**Syntax:** BOR <SRC:I/R> <DST:I/R>

Executes <SRC> OR <DST> then writes the result to MEM1.

## BITWISE XOR

**Syntax:** BXR <SRC:I/R> <DST:I/R>

Executes <SRC> XOR <DST> then writes the result to MEM1.

## BITWISE NOT

**Syntax:** BND <SRC:I/R>

Executes NOT <SRC> then writes the result to MEM1.

## BITWISE LEFT SHIFT

**Syntax:** BLS <SRC:I/R> <DST:I/R>

Shifts bits in <SRC> by <DST> to the left, then writes the result to MEM1.

## BITWISE RIGHT SHIFT

**Syntax:** BRS <SRC:I/R> <DST:I/R>

Shifts bits in <SRC> by <DST> to the right, then writes the result to MEM1.

## BITWISE LEFT ROTATE

**Syntax:** BLR <SRC:I/R> <DST:I/R>

Rotate bits in <SRC> by <DST> to the left, then writes the result to MEM1.

## BITWISE RIGHT ROTATE

**Syntax:** BRR <SRC:I/R> <DST:I/R>

Rotate bits in <SRC> by <DST> to the right, then writes the result to MEM1.

# TEST INSTRUCTIONS

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Test instructions will skip the next instruction if the test is successful.

## TEST GREATER THAN

**Syntax:** TGT <SRC:I/R> <DST:I/R>

Tests if <SRC> Value is greater than <DST> Value.

## TEST LESS THAN

**Syntax:** TLT <SRC:I/R> <DST:I/R>

Tests if <SRC> Value is less than <DST> Value.

## TEST EQUAL TO

**Syntax:** TEQ <SRC:I/R> <DST:I/R>

Tests if <SRC> Value is equal to <DST> Value.

## TEST TYPES EQUAL

**Syntax:** TTE <SRC:R> <DST:R>

Tests if <SRC> Type is equal to <DST> Type.

## TEST TYPES NOT EQUAL

**Syntax:** TTN <SRC:R> <DST:R>

Tests if <SRC> Type is not equal to <DST> Type.

# BLOCKING INSTRUCTIONS

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Blocking instructions will pause the program until the operation is complete.

## SLP

**Syntax:** SLP <SRC:I/R>

Program will sleep for <SRC> ticks.

## BKR

**Syntax:** BKR <SRC:I/R>

Pause the program until there is at least <SRC> Signals on the Red Wire Input.

## BKG

**Syntax:** BKG <SRC:I/R>

Pause the program until there is at least <SRC> Signals on the Green Wire Input.

## SYN

**Syntax:** SYN

Pause the program until all other connected FMCUs call SYN.

# INTERRUPT SIGNALS

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There are 5 special signals that can be used to interrupt a program. When an FMCU receives an interrupt signal on either it's Green or Red Wire Input I will immediately execute the interrupt.

## HLT

Halts the program

## RUN

Runs the program

## STP

Steps the program (executes the current instruction then halts).

## SLP

Program will sleep for N ticks, where N is the Signal’s Value.

## JMP

Jumps the Program Instruction Pointer to N, where N is the Signal’s Value.

# POINTERS

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When specifying a memory address as a parameter to an instruction, you may also pass a memory pointer. A pointer is a special address were the literal address is evaluated at run-time.

Typically a memory address takes the form MEM1. This instructs the FMCU to access the 1st Register. A pointer takes the from MEM@1. This instructs the FMCU to read the Value at Register 1 and then read the Value at Register N, where N was the Value at Register 1.

## MEM@N

Access register X, where X is the Value at Register N.

## RED@N

Access Red Wire Input X, where X is the Value at Register N.

## GREEN@N

Access Green Wire Input X, where X is the Value at Register N.

# EXAMPLE PROGRAMS

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## MULTIPLY INPUT

This program takes the 1st Red Wire Input, doubles it and outputs the result.

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| mov red1 mem1  mul mem1 2  mov mem1 out | # Write Red wire Input 1 to Register 1  # MEM1 = MEM1 \* 2  # Write Register 1 to Output |

## ACCUMULATE INPUT

This program takes the first 4 Signals on the Red Wire Input and accumulates them over time. It requires a FRAMM at North Port 01.

|  |  |
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| clr  set 11 mem2  set 3 mem2  :loop  mov red@3 mem1  add mem1 mem@2  mov mem1 mem@2  add mem2 1  tlt mem1 15  set 11 mem1  mov mem1 mem2  add mem3 1  tlt mem1 5  set 1 mem1  mov mem1 mem3 | # Clear all registers  # Set MEM2 to 11  # Set MEM2 to 3  # Create a label  # Write RED[MEM3] to MEM1  # MEM1 = MEM1 + MEM[MEM2]  # Write MEM1 to MEM[MEM2]  # MEM1 = MEM2 + 1  # Skip next line if MEM1 < 15  # Set MEM1 to 11  # Write MEM1 to MEM2  # MEM1 = MEM3 + 1  # Skip next line if MEM1 < 5  # Set MEM1 to 1  # Write MEM1 to MEM3 |