

FACTORIO CHEAT SHEET



Overview

⚙️ [Factorio](#) is a game in which you build and maintain factories.

This is a compendium of the most common Factorio facts (v0.16).

A huge thanks to the community who made the [previous cheat sheets](#) and other resources; such as the [Wiki](#), [Reddit](#), and [Factorio Discord](#) from which this is all based on. This is only a sliver of the info available, for more in depth information please visit those resources.

Some notes:

- The [Wiki](#) has the latest updates, if there is a discrepancy in data, please [let me know](#) so I can sync up with the Wiki.
- Any section that deals with ratios assume no modules and consistent assembly machines.
- Ratio sections are intended only as a starting point, for advanced ratios use a [calculator](#).
- Any of the sections can be collapsed/expanded by toggling the top right corner (-/+).
- Please report any errors/suggestions on [Github](#), [Discord](#), or [Reddit](#).
- [Known Issues](#)

If you found the cheat sheet useful, consider supporting me on [Patreon](#).

Cheat Sheets

Belt Throughput

Transport Belt Throughput - Items per second (i/s) passed over one belt tile.

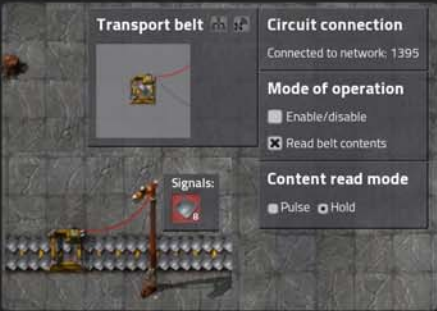
Transport Belt Density - Maximum Items fit in one tile. **(7.11 items for all belts)**

Note: **Red belt** is exactly twice as fast as a **Yellow belt**, and a **Blue belt** is exactly three times as fast a **Yellow belt**.

See [Belt Transport System](#) for all relevant belt information.

All belts can hold up to **7.11 items** on each tile
(In game oscillates b/w 6 and 8)

Tier	Belt Throughput		
	Single Side	Both Sides	
  	6.667 i/s	13.333 i/s	1x
  	13.333 i/s	26.667 i/s	2x
  	20.000 i/s	40.000 i/s	3x



Balancers are used to evenly distribute items over multiple belts.

- Balancers that are **input balanced** take evenly from input belts.
- Balancers that are **output balanced** distribute evenly to output belts.
- Balancers that are **throughput limited** may not be able to provide maximum output due to bottlenecks in the design.

4 to 4 balancer



1 belt lane balancer



Sample [Bilka's Balancer](#) Blueprints

Blueprint	Tiers included
1-8 belt balancers	
1-8 belt balancers	
1-8 belt balancers	
Big balancers*	
Lane balancers**	

* 12 to 4, 6, and 12; 16 to 16; and 24 to 24. 12 to 4 and second group of 16 to 16 are throughput unlimited.

** 1-belt output balanced; 2- and 4-belt input balanced; 1-, 2-, and 4-belt fully balanced.

[Old wiki balancer page](#) screenshot

[More balancers](#) from raynquist

[Balancer Guide](#) by CptTrifonius

[Balancer Guide](#) by EX_plode

Buildings needed* to		Empty Input Belt		
With	Input			
	  	47	94	140
 		24	47	70
		24	47	70
 		12	24	35
		18	36	54

Buildings needed* to		Fill Output Belt		
With	Output			
	  	47	94	140
 		24	47	70
		234	467	700
 		117	234	350
		178	356	534

*Buildings rounded up to nearest whole number

Smelting Facts

- Smelting iron, copper, and stone each take a base 3.5 seconds to finish.
Smelting steel takes base 17.5 seconds.
- [Stone Furnaces](#) have a crafting speed of 1.
Both [Steel](#) and [Electric](#) Furnaces have a crafting speed of 2.
- One furnace making iron can support one furnace making steel.
- Stone and Steel Furnaces consume 0.0225 coal/second.

Furnaces supplied by coal belt

			
 	593	1186	1778

Buildings = Belt Throughput / Material Consumption Rate

Uranium Facts

- [Uranium processing](#) has a 99.3% chance to produce 1 uranium-238 and a 0.7% chance to produce 1 uranium-235 from 10 ore.
- It's recommended save up 40 U-235 to kick off the [Kovarex Enrichment Process](#) in order to speed up U-235 production.



- **Mining speed** relies on more variables than most other machinery.
- Ores have *mining hardness* and *mining time*, and miners have *mining power* and *mining speed*.
- Luckily, many of ores' values are the same, so things aren't as complicated as they could be.
- See various **mining arrangements** with varying mining coverage.

In order to **mine uranium ore**, sulfuric acid must be fed into the electric mining drill.

Per 10 uranium ore mined, 10 sulfuric acid are consumed.



Miners needed to fill a belt

Ore	Miner				Mine Rate
		48	96	143	0.28 i/s
		26	51	77	0.53 i/s
		37	73	109	0.37 i/s
		21	42	62	0.65 i/s
		51	102	153	0.26 i/s

$$\text{Miners} = \text{Belt Throughput} / \text{Mining Rate}$$



Tip: Mining drills will output resources directly without the need of inserters.

Science Research Unlocks



The Vanilla game has all research balanced in number of different science packs required, so optimally all science should be produced at the same rate.

However the different science pack themselves have various crafting times and outputs, thus you'll need a different number of assemblers making each science to prevent bottlenecks.

Number of assemblers needed to produce science equally



Check the [ratios for each science pack](#).

Check your [Resource requirements](#) to keep production steady.

Space Science

For 1 space science pack per second you need to launch a rocket with satellite every 16.67 minutes.

$$\text{Rockets launch interval (in minutes)} = (1000 \text{ science} / (\text{assembler speed} * \text{ratio multiplier})) * (1\text{min}/60\text{sec})$$

Rocket launch every	22	Minutes
Science Per Launch	1000	
Assembler Speed	0.75	
Ratio Multiplier	1	

Steam Power Build Ratio

1 20 40 → 36 MW

Solar Power Build Ratio

25 21 → 1 MW

Steam Power

- An [offshore pump](#) provides 1200 water per second.
- A [steam boiler](#) can turn up to 60 water units to steam per second, providing 1.8 MW of steam (at 165C).
- Steam boiler consumes fuel at 50% efficiency, using up $1.8 \text{ MW} * 2 = 3.6 \text{ MW}$.
- A [steam engine](#) can turn up to 0.9 MW of steam to electric energy (30 steam units at 165C).
- 40 steam engines will provide 36 MW of power.

Boilers supported by belt of fuel
(Rounded up to nearest whole number)

			
4MJ	15	30	45
8MJ	30	60	89
25MJ	93	186	278
225MJ	834	1667	2500

Boilers supported by belt of fuel = Belt Throughput(i/s) * Fuel Energy(MJ) / 3.6MW

Solar Power

- [Solar panels](#) only provide energy during the day. (60 kW Max, 42kW avg per solar panel)
- During the day, excess power generated is stored in [accumulators](#), and during the night, those accumulators release their charge to power your factory.
- Place accumulators until they can keep your factorio powered through the night
- Then place solar panels until those accumulators are fully charged by the end of the day.
- User [Cilya on the forums](#) did the [math](#) to figure out exactly how many solar panels we need per accumulator.

Simple Build Ratio



Common Build Ratio



Pump Ratio



Note: Pumps and Steam Turbines are rounded up for build ratios. See table for precise numbers.

Summary

- One uranium fuel cell will **always last** 200s, even if the produced heat does not get consumed, so the rest of the energy is wasted if not used.
- To prevent energy waste, unused energy should be buffered and the nuclear reactor setup switched off before the energy buffer, such as steam tanks or accumulators, is full.
- Nuclear reactor can buffer 500C worth of energy after heat up as well as heat pipes, steam pipes and heat exchangers in addition to steam tanks and accumulators.
- A Storage tank holding 25k units of Steam at **500°C** contains 2.425 GJ of energy, equal to 485 fully charged Accumulators!
- Reactors** experience a 100% increase in energy output when placed directly next to another reactor.
- One Offshore pump can fully supply 12 (11.64) **Heat Exchangers** driving 20 **Steam Turbines** producing **116.4 MW**.

You will need about 1 centrifuge to produce U-235 to make fuel for 1 Reactor continuously.

It takes 1 U-235 and 19 U-238 to create 10 **fuel cells**, but you can reprocess 10 used up fuel cells for 6 U-238, making the ratio be 13 U-238 to 1 U-235.



SRE Diagrams

Single Reactor Equivalence: Because of the neighbor bonus; 1 reactor can be equivalent to up to 5 reactors in certain patterns.

2xN Configuration

3 4 4 4 4 4 3

16 reactors: 2x8, is

3 4 4 4 4 4 3

$4*3 + 12*4 = 60$ SRE

NxM Configuration

3 4 4 3

16 reactors: 4x4, is

4 5 5 4

4 5 5 4

3 4 4 3

$4*3 + 8*4 + 4*5 = 64$ SRE

Most efficient setup:** a series of repeating 2x1 reactors



**That gives access to every reactor

Nuclear Ratio Table

Count	Config				*Tanks		Efficiency
1	1	1	4	7	4	40 MW	100%
2	2x1	2	16	28	14	160 MW	200%
4	2x2	5	48	83	40	480 MW	300%
6	2x3	7	80	138	66	800 MW	333%
8	2x4	10	112	193	93	1.12 GW	350%

***Note:** This is steam tanks per 1 effective (neighbor bonus) nuclear reactor using 1 fuel rod not including the reactor warmup, or heat stored in the reactor or pipes (both heat and steam).

Formulas

See [Nuclear Ratios](#) Post and, [Nuclear Guide](#) Wiki for more details.

Heat Exchangers (even config) = [Heat Exchangers Per Reactor * 4 * reactors] - [Heat Exchangers Per Reactor * 4]

Power (even config) = [Reactor Power * 4 * reactors] - [Reactor Power * 4]

Turbines = [Heat Exchangers * Heat Exchanger Power(10MW)] / [Turbine Power(5.8MW)]

Pumps = [Turbines] * [Water Per Turbine / Water Per Pump]

Steam Tanks: 1 fuel cell creates 8 GJ per reactor (eg 2 reactors puts out 4 solo reactors of energy = 32 GJ).

Each tank can hold 2.425 GJ worth of steam, or 3.29 tanks per reactor.

Worst

40 → 30 → 20 → 10

Fluid Wagon Transfer

- **Fluid wagons** require at least one pump and at most 3 pumps per fluid wagon.
- If more than 3 pumps can be active on the fluid wagon, only 3 will “latch on” and be in use with the remaining pumps inactive.
- **Pumps** and Storage Tanks have a maximum throughput of 12,000 fluids/s.
- To keep 1,200 **fluid/s** (offshore pump rate), place **18 pipes between pumps**.
- Fluid wagons can hold 25,000 units of fluids which is equal to 1 **Storage Tanks**.



- It is recommended that a fluid wagon's pump is connected directly to a tank. Otherwise due to pipe pressure, the loading and unloading times may **increase significantly**.

Direct connection (no pipes)



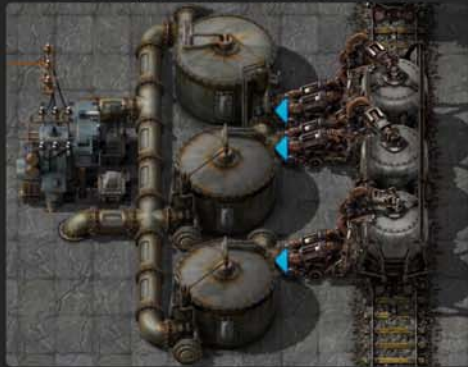
Loading & Unloading Times

1	2.083s
2	1.042s
3	0.694s

Tanker-Pump Alignment



Example Fast Transfer Build



Transfer Rate Comparison








Cargo Wagon Transfer

The table shows the time (in seconds) it takes to load or unload a [Cargo Wagon](#) assuming you are using 6 fast or stack inserters. With seven optional inserter capacity research bonuses, there are a lot of different loading and unloading rates.

If you use 12 fast or stack inserters (6 on each side of the wagon), divide the time listed by 2 to get the approximate time required.

Time to transfer inventory b/w wagon and chests

					
Items / swing	* 10 items per stack	50 items per stack	100 items per stack	200 items per stack	
1	29.03 s	144.73 s	289.03 s	578.07 s	
2	14.73 s	72.37 s	144.73 s	239.03 s	
3	9.97 s	48.53 s	96.63 s	192.83 s	
4	7.37 s	36.4 s	72.37 s	144.73 s	
5	6.07 s	29.03 s	58.07 s	115.7 s	
6	5.2 s	24.27 s	48.53 s	96.63 s	
8	3.9 s	18.2 s	36.4 s	72.37 s	
10	3.03 s	14.73 s	29.03 s	58.07 s	
12	3.03 s	12.13 s	24.27 s	48.53 s	

Cargo Loading Setup



Notes:

- The times are very slightly off as inserters ready themselves after the wagon leaves, therefore the first swing loading/last swing unloading are not needed.
- These times are for unloading/loading using chests. If inserters are directly fed by or directly feeding belts, loading times will be higher.
- *Barrel transfer rate doesn't change between 10 and 12 because inserters only do a stack at a time.

Inserter Throughput - Items per second (i/s) moved by the inserter between targets (chests, belts, assemblers, trains, etc...)

Inserter capacity research is used to increase the throughput.

The inserter throughput displayed in the tables below could be used to calculate the exact number of inserters needed for your task.

$$\text{Inserters Required} = (\text{Target Item Rate}) / (\text{Inserter Throughput})$$


		Inserter Throughput			
		Inserter Bonus Level		7	
	Stack Size	 → 	 → 	 → 	 → 
	3	1.76 i/s	1.62 i/s	1.70 i/s	1.71 i/s
	3	2.50 i/s	2.22 i/s	2.37 i/s	2.40 i/s
	3	3.46 i/s	2.95 i/s	3.21 i/s	3.27 i/s
	3	6.92 i/s	5.14 i/s	6.00 i/s	6.21 i/s
	12	27.69 i/s	6.21 i/s	10.14 i/s	12.86 i/s

- Taking items from belts is slightly slower than placing them.
- It takes ~1.5 stack inserters (exclusive swinging time) to fill half a blue belt.
- As always check the [Wiki](#) for more in depth information.

Inserter Capacity Bonus

Inserter capacity research is used to increase the stack size of the inserters.

The bonus is more effective when moving from stack to stack (chests, wagons, machines) than when moving from stack to belt or belt to stack as inserters will wait to collect a stack full from a belt, but instantly grab a stack from containers.

	Grabbed Items					
						
	1 (base)					2 (base)
 1						3 (+1)
 2	2 (+1)					4 (+1)
 3						5 (+1)
 4						6 (+1)
 5						8 (+2)
 6						10 (+2)
 7	3 (+1)					12 (+2)













Common Ratios

Description: First Item represents the type of machine thats expected to assemble the following components.
Following items represent the amount of machines needed making them. If there is no machine mixing (assemblers/chemical plants/furnaces) then ratios stay the same b/w assembly tiers.

For example: To make rails, the right ratio is 1 iron stick assembler feeding 2 rail assemblers.
Using the level 3 assemblers you can produce 10 rails every second.

 2.5/s	↔	 10	 1
 2.5/s	↔	 12	 1 0.5
 1.25/s	↔	 12	 6 10 2
 1.25/s	↔	 5	 4 4 1.5
 1.25/s	↔	 7	 5 2.5
 1.25/s	↔	 7	 2.5 15 7.5

 1.25/s	↔	 10	 3 1
 10/s	↔	 2	 1
 1.25/s	↔	 20	 10 10 10 1 0.5
 1/s	↔	 24	 24
 6.25/s	↔	 25	 2 5
 12.5/s	↔	 100	 1

 5/s	↔	 2	 3
 1.25/s	↔	 6	 1 1 1
*Doesn't take into account Wire for GC			
 .625/s	↔	 5	 6 5
*Doesn't take into account GC for RC			
 .042/s	↔	 2	 5 10
*Same for Other Modules			
 .042/s	↔	 2	 10 38 18
 2/s	↔	 2	 4/s 14 7
 6/s	↔	 4	 12/s 42 21
 10/s	↔	 4	 20/s 70 35

Rocket Components

Rocket Ratio

 1	 22	 21	 20
---	--	--	--

Rocket Part Ratio

 1	 10	 10	 10
---	--	--	--

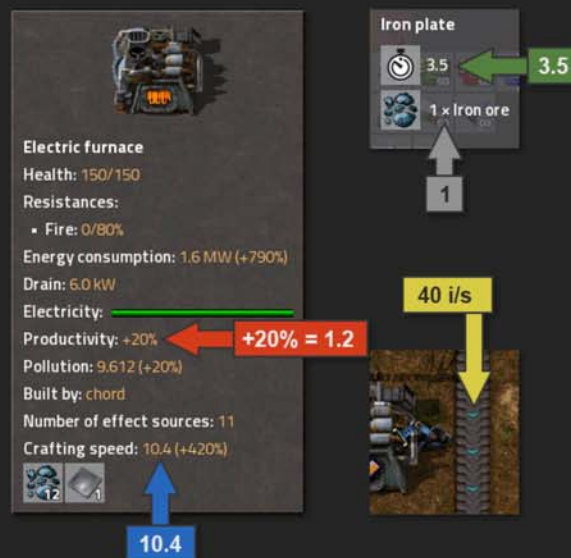
A Rocket needs 100 [Rocket Parts](#).

With no productivity modules a rocket needs 1000 of each component of the rocket part + the requirements for the [satellite](#).
This is a ratio of 1100:1050:1000 or simplified of 22:21:20 (divide by 50).

As these components all have the same crafting time, this ratio applies.

As the satellite can't get productivity bonus, you need a ratio of [~814:764:714](#) per rocket (to be precise: 5700:5350:5000 per 7 rockets), which makes it a ratio of 114:107:100. (4x lvl 3 prod modules in silo, no speed beacons)

- Modules allow to change how fast, efficient, or productive your machines are working.
- Beware of [Diminishing Returns](#).
- Also see [Beacon Arrangement Power Efficiency](#).
- Having *faster* machines with [Speed Modules](#) means you'll need less to fill a belt than you did before.
 - While generally space is infinite, this becomes very useful in bot networks to minimize flight distance.
 - Another example is to speed up oil/ore generation.
 - Speed Modules however increase the energy consumption esp with beacons so be wary.
- Putting [Productivity Modules](#) in your machines means you'll need to get less raw resources.
 - This is absolutely critical for late game with big factories, esp when doing infinite research.
 - Be wary, Productivity Modules increase the energy consumption and pollution, while decreasing factory speed.
 - Best used with speed moduled beacons to make up the speed penalty.
- [Efficiency Modules](#) make your factory green, reducing power usage.
 - Best to put in energy hogs.
 - Reducing Energy = Reducing pollution if you are not running on clean energy.



[Machines Needed 53.33] =

Item Consumption Rate 40

*

Recipe Base Craft Time 1

Items per Craft 1

*

Machine Craft Speed 0.75

*

Machine Productivity 1
































Use the formula above to calculate how many machines satisfy a target consumption rate of items they produce.

Productivity Module Payoffs

What are the best things to invest productivity modules into?

Based on [MadZuri's ROI \(Return on Investment\) Calculations](#).

Ordered by best Payoff Time with beacons

Priority	Product	Payoff Time (no Beacons)	Payoff Time (8x8 Beacons)
0		2m 4s	17s
1		24m 5s	7m 17s
2		55m 32s	7m 39s
3		01h 40m 17s	13m 49s
4		02h 26m 53s	20m 14s
5		01h 39m 17s	20m 14s
6		02h 45m 46s	22m 50s
7		03h 52m 04s	31m 58s
8		04h 21m 44s	36m 03s
9		04h 50m 05s	39m 57s
10		4h 59m 26s	41m 14s
11		4h 41m 18s	57m 21s
12		4h 41m 18s	57m 21s
13		9h 40m 10s	1h 19m 54s
14		9h 40m 10s	1h 19m 54s
15		9h 40m 10s	1h 19m 54s
16		10h 05m 23s	1h 23m 23s
17		10h 44m 38s	1h 28m 47s
18		11h 36m 12s	1h 35m 53s
19		12h 28m 36s	1h 43m 06s
20		16h 34m 34s	2h 16m 59s
21		21h 29m 16s	2h 57m 34s
22		17h 34m 51s	3h 35m 04s
23		12h 05m 13s	3h 39m 16s
24		29h 00m 30s	3h 59m 43s
25		32h 13m 53s	4h 26m 21s
26		18h 25m 05s	5h 34m 07s
27		28h 07m 45s	5h 44m 06s
28		24h 10m 25s	7h 18m 31s
29		24h 10m 25s	7h 18m 31s
30		24h 10m 25s	7h 18m 31s

Train Speed

- [Fuel](#) affects train max speed and how fast trains accelerate.
- The [braking force research](#) affects how fast trains slow down.
- The faster a train can slow down, the longer it can stay at higher speeds.
- Single locomotive can go [31,176.5 blocks](#) on 1 rocket fuel.

Acceleration bonus

























			
0	+20%	+80%	+150%

Max speed per fuel type and number of wagons for a single locomotive

			
0	259.2 KPH	272.2 KPH	298.1 KPH
1	258 KPH	272.2 KPH	298.1 KPH
2	244 KPH	272.2 KPH	298.1 KPH
3	229 KPH	272.2 KPH	298.1 KPH
4	214 KPH	272.2 KPH	298.1 KPH
5	198 KPH	257 KPH	298.1 KPH
6	186 KPH	242 KPH	298.1 KPH
7	170 KPH	228 KPH	298.1 KPH
15	50 KPH	105 KPH	285 KPH

Additional information and discussion on [Reddit](#).

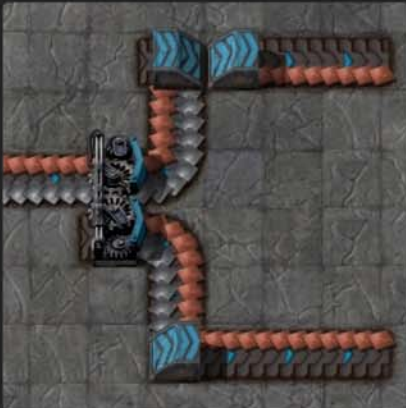
Suggested [locomotive colors](#) based on cargo

Train Type	RGB String	Color
 Iron Ore	0, 140, 255	
 Copper Ore	255, 55, 0	
 Coal	0, 0, 0	
 Stone	150, 100, 80	
 Uranium Ore	100, 180, 0	
 Iron Plates	210, 210, 255	
 Copper Plates	255, 125, 85	
 Steel	200, 200, 200	
 Gears	150, 150, 150	
 Uranium	40, 100, 50	
 Green Circuits	0, 255, 0	
 Red Circuits	255, 0, 0	
 Blue Circuits	0, 0, 255	
 Oil	0, 0, 30	
 Lubricant	0, 170, 0	
 Acid	255, 255, 0	
 Plastic	255, 255, 255	
 Explosives	165, 60, 15	
 Red Science	255, 50, 50	
 Green Science	100, 255, 100	
 Blue Science	80, 180, 255	
 Grey Science	200, 200, 255	
 Purple Science	255, 80, 255	
 Yellow Science	255, 180, 80	
 Space Science	200, 200, 255	
 Solar	0, 100, 150	
 Rocket Supply	255, 0, 100	
 PAX Shuttle	255, 0, 255	

See more [keyboard shortcuts](#) on the wiki.

- The **Alt** key will reveal detailed information on entities.
- Trains snap into position when placed at train stations.
- You can rotate entities with **R**, even when already placed, **Shift+R** for the opposite.
- Inserters will always place items on the furthest side of the belt, and prioritize taking items from the closest.
- Hold **Shift** while building to place a ghost of the item (single entity blueprint).
- **Shift+RightClick** will copy entity configurations, **Shift+LeftClick** will paste them.
 - This works for: filter inserters, assemblers, requester chests, combinators, ...
 - You can paste across multiple entities by dragging.
 - You can copy from assemblers into requester chests (requests the required amount to craft 30 seconds worth of the item production).
- Placing over ghosts will preserve the recipes
- Hover over an entity and press **Q** to quick-select it from your inventory.
 - Press **Q** on ores to select miners.
- Any item with a "fuel value" in its description can be used as fuel (including wooden chests & wooden power poles).
- You can move science packs between labs with inserters.
- Fluids can move through boilers, tanks, and electric mining drills (only when mining uranium).
- Using underground pipes counts as less entities then if straight pipe for same distance, increasing game performance.
- Blueprints can be used from map view when zoomed in on a revealed area of the map (near the player or by radar).
- **Numpad+** / **Numpad-** can be used to increase / decrease the size of any placed tile (such as landfill or concrete).
- You can build rails outside your normal build range as long as you start inside the range.
- Clear Blueprint or Deconstruction Planner Filters by **Shift+RightClick**
- For **Lazy Bastard Achievement** Open Console, type `/permissions`, Disable *Craft*
- [Display signal states](#) on the map by enabling "**show-rail-signal-states**" in the **F4** debug menu.

Underground belts can be side loaded, this will drain only 1 lane of a belt.



Splitters can have an item filter set on a specific lane



Official Links

- [Factorio](#) - The official website
- [Factorio Wiki](#) - More in depth info.
- [Factorio Reddit](#) - Lots of helpful users.
- [Factorio Discord](#) - Discuss the game in realtime.
- [Factorio Forums](#) - Help make the game better!
- [Factorio Blog](#) - Unreleased features and News.
- [Factorio Youtube](#) - Maybe they will make a new Factorio Trailer
- [Factorio Mod Portal](#) - Browse and download mods.

Community Links

- Blueprint Hubs
 - [Factorio Blueprint Library](#)
 - [Xterminator's Blueprints](#)
 - [Teoxoy's Blueprints](#)
 - [Train Intersections](#)
 - [Discord Blueprint Bot](#)
- Ratio Planners/Calculators
 - [Kirk's Calculator](#)
 - [Doomer's Calculator](#)
 - [Barrykin's Cost Calc](#)
 - [Generic Ratio Calculator](#)
- Tools
 - [Interactive Tech Tree Viewer](#)
 - [Blueprint Modifier & Ore and oil outpost generator](#)
 - [Blueprint Editor](#)
 - [Convert MIDI to blueprints](#)
- Guides
 - [Belt Balancers](#)
 - [Train Automation](#)
 - [Smelting](#)
- [Recipe Reference](#)
- [Expensive Mode Recipes](#)

Credits

[Factorio Wiki](#)

[Factorio 0.15 Cheat Sheet](#)

[Factorio 0.14 Cheat Sheet](#)

[Factorio 0.12 Cheat Sheet](#)