Modular

Add I

Dual Precision Adder/Comparator

I. Description

The new version of the Add1 module is containing two independent precision adders, with respective different functionalities. The provided basic functions and its versality – suitable both for audio and/or CV applications – makes this module to an useful part of any synthesizer equipment.
The 1st circuit (upper one on the panel) consists of an adder with 3 inputs, whereby the 3rd input is equipped with a polarizing level knob for attenuation, slightly amplification and inversion of this input channel. The sum output has a switch for determing the amplification factor (between *0,5, *1,0 or *2,0); an additional red led indicates if the output signal is becoming overdriven.
The 2nd (lower circuit on the panel) has two inputs and an addable voltage source with an amount control knob (level adjustable from 0 – 5V) and inversion/zeroing switch. The output is switchable between sum and comparator mode. In sum mode, it will provide the additioned sum of the two inputs and the generated voltage from the voltage source. In 'Comp' mode, the circuit works as a comparator with a slightly schmitt-trigger-like characteristic. This signal has only two states, low and high (depending on the threshold level), suitable as gate/trigger, squarewave/pulse audio signal etc.. The threshold level is ≈0V, but it can be shifted by using the internal voltage source or by an external signal. An yellow led is indicating the 'high' state; or in sum mode, the clipping of the output signal.

2. Features & Applications

- Audio sub-mixing
- High precision CV signal mixing
- Addition, substraction, offset control
- Attenuation, amplification, inversion
- Adjustable voltage source (polarity switchable)
- Comparator mode (with logic level output)
- Signal-to-squarewave/trigger/gate conversion
- LEDs for visual control

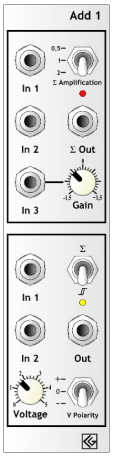
- Eurorack module
- Width: 6 HP
- Dimensions: 128,5 x 30,2 mm
- Depth: 30mm
- Supply voltage: ±12V
- Current consumption: +12V: ≤30mA; -12V: ≤20mA
- Available with banana or 3,5mm minijacks

Front view

Left side view

Right side view

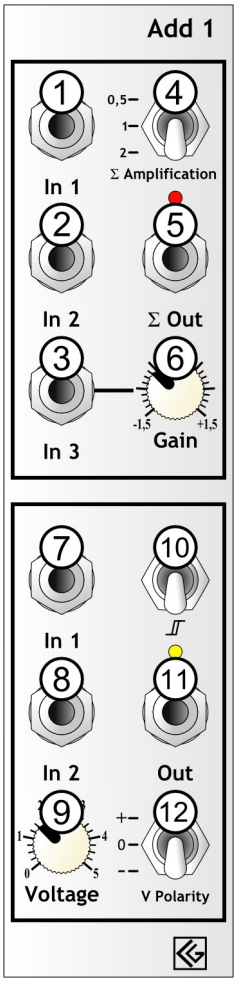
Banana version



Drawing

3. Functions

▲ 1st Adder



① **In1** 1st precision input for the 1st adder. Weighting factor (with switch ④ in middle position) is exactly 1,00. Input restistance is ≈100kΩ.

② **In2** 2nd precision input for the 1st adder. *See above!*

③ **In3** 3rd input for the 1st adder. This input can be attenuated or slightly amplified; the amount is adjustable by knob '**Gain**' ⑥ (cw from center position '0'). Max. amplification factor is ≈*1,5 (with switch '**Σ Amplification**' ④ in middle position). When turning the knob ccw, this input is becoming inverted (polarizing behaviour).

④ **Sum amplification factor switch** Determines the output amplification of the total sum from the inputs '**In 1**' ① (weighting factor *1); '**In 2**' ② (weighting factor *1) and '**In 3**' ③ (level and polarity adjustable with knob ⑥), provided on '**Σ Out**' ⑤. The sum amplification factors are:

- *Switch in upper position:* ***0,50**
  The attenuation may be useful e.g. when summing loud signals to avoid overdriving the output.
- *Switch in middle position:* ***1,00**
  E.g. when adding a frequency CV from a keyboard.
- *Switch in lower position:* ***2,00**
  When some extra amplification is being needed.

⑤ **Sum output** Total sum of the three inputs ① , ② , ③ , multiplied with the amplification factor set by switch ④; the total output voltage is:

(In 1 ① + In 2 ② + In 3 ③ * Gain factor ⑥) * Σ Amplification factor ④ = Σ Out ⑤

The red LED • is for indicating saturation/overdriving of the output (limit is ca ±10V)

⑥ **Level/polarity knob for input 'In3'** Level and polarity for input socket ③ can be adjusted by this knob. In center position, the level is 0V; when turning the knob clockwise, the level increases up to max. *1,5 of the input value. When turning the knob ccw from '0'; the signal is becoming inverted (negative polarity for positive input voltages and vice versa) – for substracting operations etc. – with an adjustable level up to max. *–1,5 of the input value.

▼ 2nd Adder/Comparator

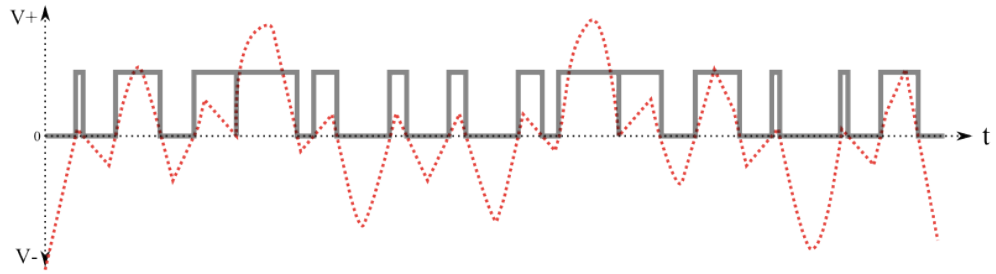
<u>This circuit has two different operation modes:</u>

- **With switch ⑩ in upper position 'Σ' it is working as a precision adder with an amplification factor of *1,00; adding the 2 inputs 'In1' ⑦, 'In2' ⑧ and the voltage controlled by knob ⑨ – polarity switchable or 0-ing by switch 'V polarity' ⑫ .**
  In this mode, the voltage on output ⑪ is:

  In1 ⑦ + In2 ⑧ + Voltage V ⑨ / ⑫ = $\Sigma_{In1+In2+V}$ (Out ⑪)

- **With switch ⑩ in lower position '⎍' the circuit is working as a comparator with a threshold of ≈0V and a slightly schmitt-trigger characteristic (Read below *).**
  In this mode the output signal on output ⑪ has only the two states 'High' and 'Low' (Logic signal level).
  The 'high' level (indicated by the yellow LED •) is +5V for a sum signal larger than 0V (positive voltage sum). 'Low' level is 0V/-5V (depending on position of jumper 1) for a sum signal lower than 0V (negative voltage sum).

  $\Sigma_{In1+In2+V}$>0V ⇒ V_{out}=+5V
  $\Sigma_{In1+In2+V}$<0V ⇒ V_{out}=0V/-5V (depending on position of jumper 1)
  ⇒ The threshold may be shifted by knob ⑨ and switch ⑫ or by a CV applied on 'In1' ⑦ or 'In2' ⑧
  ***Note:** The threshold level is not exactly 0V; to avoid undefined states by noise there is a little difference (hysteresis) between switching from one state to the other. The hysteresis is ≈ ±50mV ('Schmitt-trigger'); please also read chapter *4.Examples & settings* **4.**



red (dotted): Input; grey: output in comparator mode

⑦ **In1** 1st precision input for the 2nd adder. With switch ⑩ (adder mode) in upper position, weighting factor is exactly 1,00 (for summing: no attenuation/ extra amplification on output ⑪).

⑧ **In2** 2nd precision input for the 2nd adder. With switch ⑩ ('adder mode') in upper position, weighting factor is exactly 1,00 (for summing: no attenuation/extra amplification on output ⑪)

⑨ **Voltage source** The knob controls a voltage from 0V to ≈ +5V (polarity invertable or nullable by switch ⑫) which is added to the sum signal. In ***adder*** mode (switch ⑩ in upper position 'Σ'), this sum is the output voltage on 'Out' ⑪ ; in ***comparator*** mode (switch ⑩ in lower position '⎍') the voltage shifts the comparator's working point).

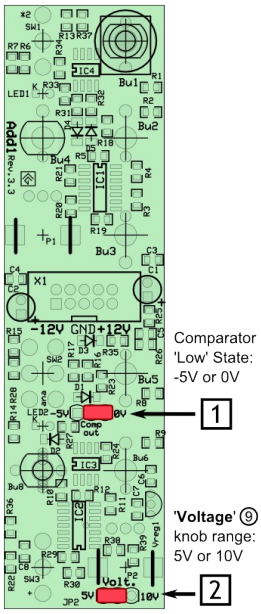
⑩ **Adder/comparator mode switch** *see above* ↑

⑪ **Output 'Out'** (*see above* ↑)

- **Adder** mode (switch ⑩ : Σ)
  Sum output of the signals applied on In1' ⑦ and 'In2' ⑧ plus voltage source (⑨ / ⑫)
  The yellow LED • is indicating when the signal sum is becoming overdriven.
- **Comparator** mode (switch ⑩ : ⎍)
  '**High**'-Level for a signal sum > 0V ; '**Low**'-level for a signal sum < 0V
  The yellow LED • is indicating the '**High**' state of the comparator.

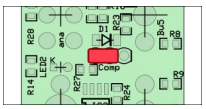
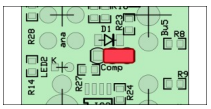
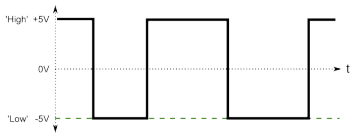
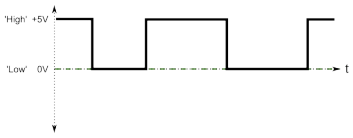
⑫ **Voltage source polarity/nulling switch** Determines the polarity of the voltage regulated by knob '**Voltage**' ⑨ :

- Switch in upper position '+': 0⟷+5V
- Switch in center position '0': 0V (mute)
- Switch in lower position '-': 0⟷-5V



Jumper 1 : Comparator's '**low**' output voltage

Determines the 'low' state in comparator mode:
Depending on the position of jumper 1 on the backside board, the comparator's output voltage in its '**low**' state can be chosen either to be 0V or -5V.

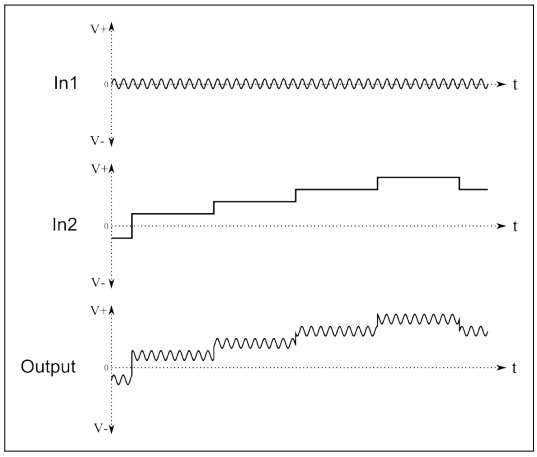
 Jumper in left position	 Jumper in right position
Comparator '**Low**' state: -5V	Comparator '**Low**' state: 0V
	

Note: *The common logic levels (for gate/trigger signals etc.) are [0V ≙ ' low'] and [+5V ≙ 'high'].*
The [-5V = 'low']-mode can be used for other applications; e.g. when the comparator is used in combination with a 4-quadrant multiplier (CGProducts' X): A signal multiplication with -5V will result in an inversion of the input signal - while a multiplication with 0V will result in its muting.

Jumper 2 : Knob '**Voltage**' source ⑨ range

Left position: 5V output range. ***Right*** position: 10V output range on output ⑪

4. Examples & settings

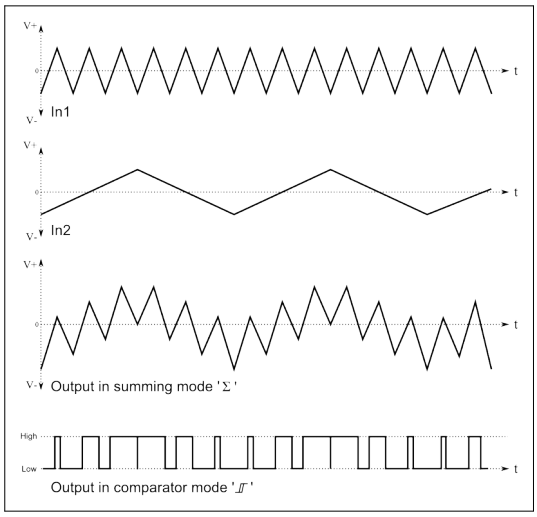


1. Addition

Addition of two signals; Sum signal is provided on the output:

<u>Voltages In1 + In2 = Output voltage</u>

▲ 1st adder: Inputs ① + ② ; output Σ **Out** ⑤ ; Switch Σ
Amplification factor ④ = 1,00
or
▼ 2nd adder: Inputs ⑦ + ⑧ ; output **Out** ⑪ ;
Switch ⑩ in upper position 'Σ'

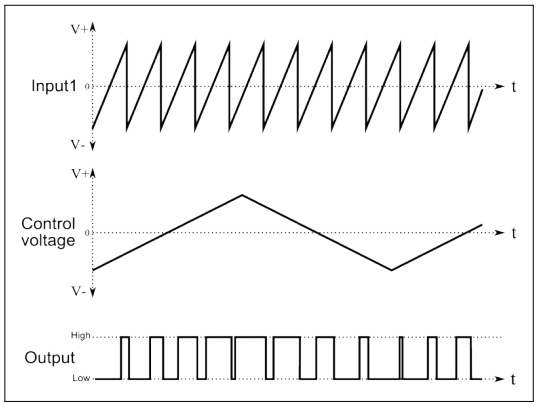


2. ▼ Adding/comparation comparison

Output waveforms in 'addition' and 'comparator' mode, switched by ⑩

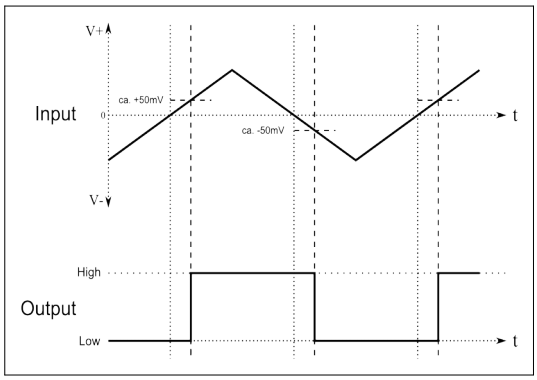
With two signals applied on Inputs ⑦ + ⑧ :

- Switch ⑩ in upper position 'Σ' (addition)
  (Yellow LED • is indicating voltage on limit)
- Switch ⑩ in lower position '⎍'
  (Yellow LED • is indicating comparator state 'high')



3. ▼ Pulse width modulation

The comparator can be used to convert any signal to a squarewave.
Using a triangle or ramp waveform as one input (⑦ or ⑧) , the second remaining input and/or the integrated voltage source (knob ⑨ and switch ⑫) can be used for controlling the pulsewidth of the squarewave output signal.



4. ▼ Schmitt-trigger

The comparator's switching threshold is not exactly at 0V; to avoid undefined states caused by noise (or even with very small input signals), the switching threshold to 'High' is shifted a little bit into the positive voltage range, while the switching to 'Low' is shifted into the negative range ('Schmitt-trigger'). The switching threshold is at ca. ±25mV (Hysteresis = 50mV).

5. Contact & Support

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This is the documentation for Revision 3.3(+)
https://www.cg-products.de/documentations/Add1_documentation.pdf

Dokumentation of the previous models Rev.3.0 and Rev. 1:
https://www.cg-products.de/documentations/Add1_documentation-Rev.3.0.pdf
https://www.cg-products.de/documentations/Add1_Rev.1_documentation.pdf