WAVE PACKETS

Wave Packets is a multi-talented complex modulation and audio source. The module allows you to craft 'wave packets', with each of the 5 main outputs deploying a different recipe from the contour function (linear segments between each time stage) and frequency-dynamic oscillator (LFO or audio-rate oscillation which transitions through 3 target frequencies) to produce a unique modulation shape, burst of energy, or fragment of audio.

PANEL OVERVIEW

EXCITATION MODE SWITCH

The toggle switch position is used to determine the excitation mode (in conjuction with the presence of a cable in the TRIGGER INPUT). Refer to MODES on p.4.

TRIGGER INPUT

This input is used to excite a wave packet. The presence of a cable in this input is also used in conjunction with the EXCITATION MODE SWITCH above it to set the excitation mode. Refer to MODES on p.4.

3x D (DEPTH) SLIDERS

The 3 sliders draw out a contour function (linear segments from each T stage to the next), also referred to as the 'minimal contour line'.

>> (GLIDE)

The glide control determines the fluidity of change in the 3 F frequencies. With no glide at the counterclockwise position, turning the knob clockwise will progressively increase the width of the transition time about the T1/T2 and T3/T4 stage boundaries, with a linear-sounding glide always ensured.

D-CV (DEPTH CV)

CV Input with attenuverter for D (depth) parameter. Adds or subtracts to each of the 3 D slider positions.

V/OCT INPUT

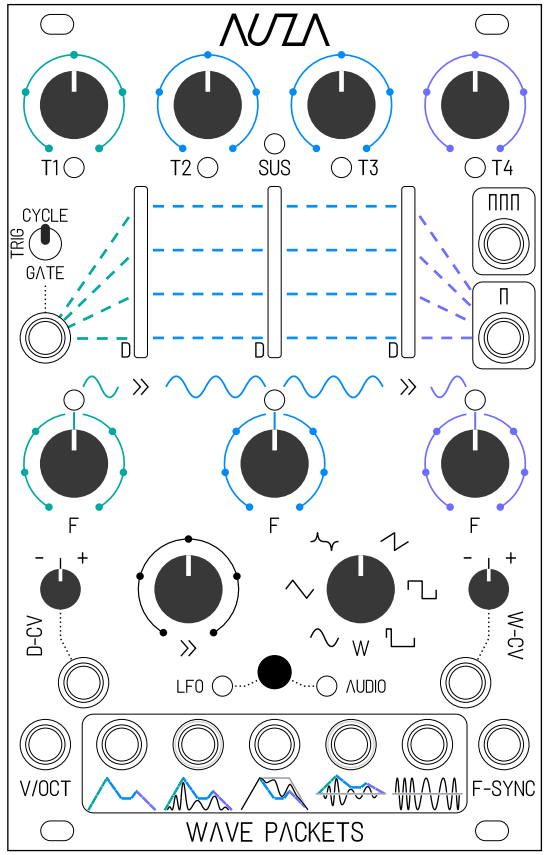
CV input (1V per octave) modulation of oscillator frequency - a global frequency shift to the entire wave packet. If in AUDIO frequency mode, plugging a cable in to V/OCT will semitone-quantise the frequency selection on the 3 F knobs. If F-SYNC is also used, V/OCT will modulate at 1V per octave from the F-SYNC frequency (plus the pitch offsets added to this from the 3 F knobs).

MAIN OUTPUTS

5 main outputs (3 unipolar and 2 bipolar). Output 1 (leftmost) provides a direct feed from the contour function, output 5 (rightmost) provides a direct feed from the oscillator, and the remaining 3 outputs use the contour function to sculpt the oscillator output in to various wave packet forms. Refer to the outputs description on p.3.

4x T (TIME) CONTROLS

Times for the 4 T stages. Max time is 10s, and min time is 0s (completely skipping the stage). If in CYCLE-PING excitation mode or LINKED LFO mode, the T knobs have a different functionality (refer to MODES on p.4/ p.5).



EOS OUTPUT ⊓⊓⊓

Trigger output at end of each stage

EOC OUTPUT ⊓

Trigger output at end of a full wave packet cycle

3x F (FREQUENCY) CONTROLS

The module's oscillator traverses through 3 target frequencies during the course of a wave packet, represented on the module panel from left to right with 3 colours: green (T1), blue (T2, SUS, T3) and purple (T4).

- In LFO frequency mode, the 3 F knobs operate as 3 independent rate controls, each centred at 4 Hz and spanning 5 octaves either side. Each LED above the 3 F knobs flashes a sine wave pattern at the corresponding rate.
- In AUDIO frequency mode, the middle (blue) F knob sets the 'base' frequency, centred on note C3 and spanning ±5 octaves, and the left and right F knobs set starting/ ending ± pitch offsets to the middle base frequency. Therefore a frequency transition profile similar to a pitch envelope can be constructed, trackable in pitch using V/OCT. The 3 LEDs represent frequency using a colour spectrum, and show the relationship between the 3 F knobs.

W (WAVE)

Waveform shape of the oscillator, with continuous morphing in between the 6 main shapes.

W-CV (WAVE CV)

CV Input with attenuverter for W (wave) parameter. Adds or subtracts to the W knob position.

F-SYNC INPUT

A tempo/ clock signal, LFO or audio oscillator output (primitive waveform shapes only) can be plugged in to this input to clock in the oscillator frequency. In LFO frequency mode, the 3 F knobs will then function as individual clock dividers/ multipliers to the F-SYNC clock rate. In AUDIO frequency mode, the 'base' frequency of the wave packet will be set by F-SYNC plus a pitch offset to the F-SYNC frequency set by the middle F knob. Like before, the left and right F knobs add starting/ ending pitch offsets to the base frequency.

BUTTON

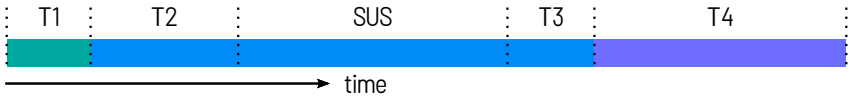
Tapping the button will toggle between LFO and AUDIO frequency modes, with the respective LED lighting to indicate the chosen mode.

Additional Modes/ Shift Parameters Access:

- Holding down the button for 3s while in LFO frequency mode will toggle LINKED LFO mode on and off.
- Holding down the button while toggling the EXCITATION MODE SWITCH to the up (CYCLE) position will activate CYCLE-PING excitation mode.
- Holding down the button while moving the >> (glide) knob will change the oscillator phase in 90° increments (along the knob 'dot' markings).
- Holding down the button while moving the W (wave) knob fully clockwise or counterclockwise will change the saw wave shape direction.

THE MODEL

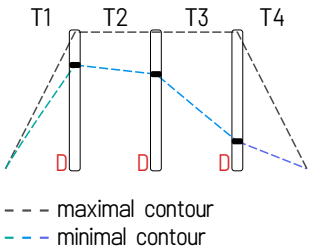
TIME STAGES



Common to every manner of using Wave Packets are the stages. As well as determining the overall duration of an individual wave packet (duration = T1 + T2 + optional SUS + T3 + T4), the stages are what unifies the core components of a wave packet together: the contour function and frequency-dynamic oscillator - orchestrating the movement in depth (D), frequency (F), and rate of change of frequency (>>). Each stage has a dedicated LED (underneath the T knobs) indicating the stage you are currently on, which can be used a visual reference for where you currently are in the contour function and oscilllator frequency trajectory.

The module will always have to be in one of the stages for the module to be outputting anything other than 0V. However this does not mean you need to use *all* of the stages. Setting a T knob to the fully left/ counterclockwise position means you are setting the stage to 0 seconds, i.e. skipping the stage. For example, if you want a simple looping ramp function or looping oscillator glide/ chirp sound, set the module in CYCLE or CYCLE FREE-RUNNNG excitation mode, start with all the T knobs at counterclockwise and then pick a stage to loop by turning one T knob clockwise - only bringing in additional stages after this to add further nuance and complexity. Alternatively, set the excitation mode to GATE FREE-RUNNING and the module will function as a continuously running oscillator or DC voltage source, frozen at the SUS stage forever, meaning only the middle D slider and middle F knob will be relevant.

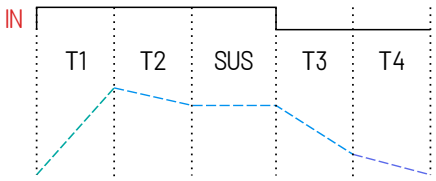
CONTOUR FUNCTION



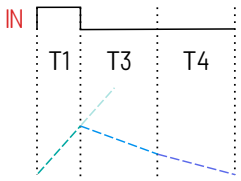
By positioning the 3 D (depth) sliders, linear segments are created from each time stage to the next - the 'minimal contour'. The only constraints are that the T1 segment starts at zero, and the T4 segment ends at zero. A complementary 'maximal contour' resembling an ASR envelope is also created - equivalent to setting all 3 D sliders at the maximum position. Refer to the OUTPUTS section on the next page to learn how the module utilises the contour function lines to generate each distinct output. Enter uncharted territory by modulating the position of the D sliders at full audio rate using the D-CV input.

In GATE excitation mode, in the event of an early falling edge at the TRIGGER INPUT, the contour function will create a smooth transition in depth to the proceeding stage boundary (ADSR-like behaviour):

Nominal GATE mode behaviour:



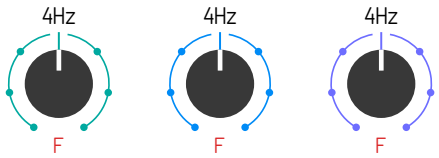
Falling edge before SUS:



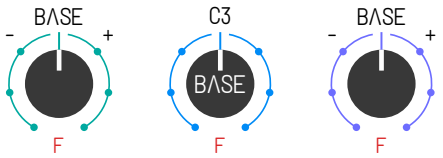
OSCILLATOR

Over the course of a wave packet, the oscillator will transition through 3 target frequencies. On the panel these are repesented with green, blue and purple colours. In LFO frequency mode, the 3 F knobs are 3 independent controls, centred at 4Hz. In AUDIO frequency mode, the middle F knob is the 'base' frequency, centred at note C3, with the left and right F knobs providing starting/ ending ± pitch offsets to the middle base frequency.

LFO Mode: 3 independent rates



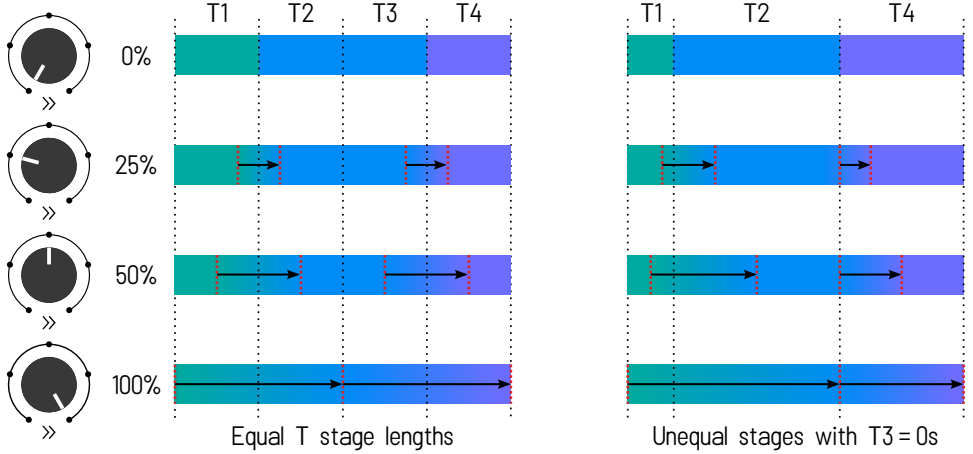
AUDIO Mode: Base frequency and offsets



In LFO frequency mode, the LED above each F knob flashes a sine wave pattern at each rate/ frequency. In AUDIO mode, a colour spectrum is used to indicate frequency. This also shows the relationship between the knobs - changing the middle base frequency knob will change the colour (frequency) to all 3 LEDs.

The glide (>>) parameter determines the fluidity of the change between the 3 frequencies. At LFO rate, the glide is heard as an acceleration or deceleration to the oscillation, and if used as an audio oscillator the glide is heard as a pitch envelope.

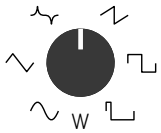
Relationship between T stages, 3 frequencies (green, blue, purple) and glide:



Assuming 0% glide (>>), the middle frequency (blue) is held at during the T2 and T3 time stages, with the left (green) frequency held during T1, and right (purple) frequency held during T4. Increasing the glide opens up a transition width about the T1/T2 and T3/T4 stage boundaries. At 50% glide, the green-blue glide starts at 50% of the way into T1 and ends at 50% into T2, and likewise with blue-purple T3/T4 glide. At 100%, a glide will occur during the entirety of the wave packet, excluding any SUS stage. A linear-sounding glide is always ensured regardless of the stage times, even if one the T stages is set to 0 seconds.

THE MODEL

OSCILLATOR ...continued



The oscillator's wave shape is determined by the W control, with additional modulation via the W-CV input. There are 6 distinct waveform shapes as well as continuous morphing in between. In AUDIO frequency mode, the morphing algorithm employs phase manipulations on band-limited wavetables for exceptionally low aliasing and maximal timbral variation. In LFO frequency mode, a different morphing algorithm maximises shape variability.

If the module is in LFO frequency mode, during an active wave packet the white LFO LED functions as a meter to the oscillator's output (i.e. a direct meter of output 5), thereby showing the combination of W with the current position in frequency (F) along the wave packet.

External Frequency Control:

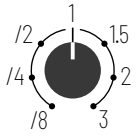
The V/OCT input tracks the oscillator's frequency according to the 1 Volt per octave standard, creating a global shift to the frequency of the wave packet. The input has a ±9V range and runs at full audio rate.

In LFO frequency mode, V/OCT is particularly useful for obtaining significantly lower or higher LFO rates if applying a DC voltage. At 0V, or without plugging in to the V/OCT input, the range on each F knob is from 0.125 Hz to 128 Hz. At a minimum -9V, the oscillation period can get as slow as taking over 68 minutes to complete! (See LINKED LFO mode on p.5 to learn how to also extend T stage times by matching the stage times to the oscillation period). Applying positive voltages will fully shift the range up to audio rate, although switching to AUDIO frequency mode is recommended if using the module as an audio source. In AUDIO frequency mode, V/OCT provides accurate pitch tracking of the 'base' frequency, and also quantises the selection of frequencies on the F knobs to semitones. Because in this mode the left (green) and right (purple) F knobs function as pitch offsets to the base frequency, frequency transition profiles can be easily created (example: pitch droop at the end of each note), which can then be 'played' by modulating the base frequency with V/OCT.

The V/OCT input can also be used as a more general bipolar exponential FM input, for adding vibrato effects, or at audio rate creating more complex timbres from the oscillator.

The F-SYNC input provides an additional method of frequency control. This input accepts periodic signals such as a tempo/ BPM/ clock pulse or LFO/ audio oscillator output (primitive waveform shapes only!) to control the frequency/ rate of the oscillator.

- In LFO frequency mode, the F-SYNC rate determines all 3 frequencies, but the 3 F knobs will function as individual clock dividers/ multipliers to this rate:



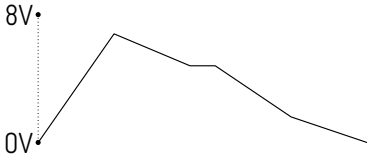
- In AUDIO frequency mode, the 'base' frequency is now determined by F-SYNC plus a pitch offset to the F-SYNC frequency set by the middle F knob. Like before, the left and right F knobs add starting/ ending pitch offsets to the base frequency. Wave Packets will track instantaneously to an external audio oscillator, mimicking its frequency characteric with no audible jumps as the frequency changes.

If both V/OCT and F-SYNC are used, V/OCT will modulate at 1 Volt per octave from the F-SYNC frequency.

OUTPUTS

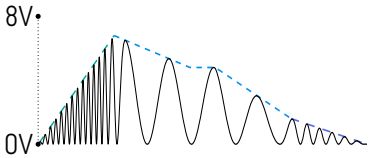
The contour function and oscillator provide the main ingredients of how the five simulatenously utilisable 24-bit outputs are formed - each output deploying a different recipe to produce a different shape.

OUTPUT 1 *'The Pure Contour'*



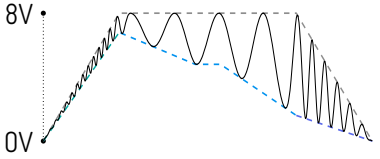
A unipolar (0V to 8V) output which is a direct feed from the contour function - the 'minimal' colour line, i.e. the shape drawn with the 3 D sliders. This output operates entirely independently from the oscillator, and can be used as a multistage envelope generator output. Or by self patching output 5 in to D-CV, an extra wave packet model is unlocked.

OUTPUT 2 *'The Unipolar Wave'*



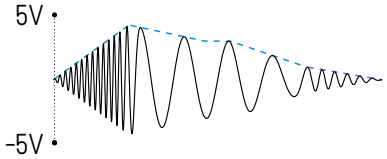
A unipolar (0V to 8V) output which sandwiches the oscillator feed between 0V and the minimal contour line. Excellent for forming dynamic oscillatory CV shapes to control a synthesis parameter on any Eurorack module in one offset direction; always dampening back down to 0V (no modulation) at the end of each generated wave packet.

OUTPUT 3 *'The Resonating Contour'*



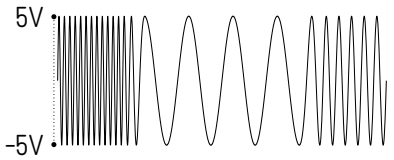
A unipolar (0V to 8V) output which resonates between the minimal (coloured) and maximal contour (grey) lines. The maximal contour is outputted when the 3 D sliders are at the maximum position. As the sliders are moved downwards, spaces for oscillation are opened up during specific T stages. Excellent for crafting very unique envelope'y CV shapes.

OUTPUT 4 *'The Capsulated Oscillator'*



A bipolar (-5 to 5V) output, which uses the contour function (minimal contour line) to envelope the oscillator. The generated packets of amplitude-varying bipolar oscillations makes this output a useful CV source. Or in AUDIO mode, VCA'd segments of audio can be generated, using a slightly exponentially scaled contour line for an improved amplitude response.

OUTPUT 5 *'The Pure Oscillator'*



A bipolar (-5 to 5V) output, which is a direct feed from the oscillator. While this output still uses the T stages to create dynamic changes in frequency over time, it is independent of the contour function. As the signal is not enveloped, anti-popping is implemented to achieve a minimal 'pop' sound at the start/ end of wave packets if used as a direct audio source.

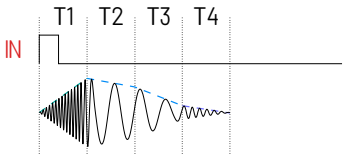
MODES

EXCITATION MODE

The mode is set by the EXCITATION MODE SWITCH and presence of a cable in the TRIGGER INPUT jack. The mode determines how wave packets are triggered and how the time stages are controlled.

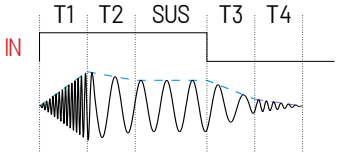
TRIG

A single pulse (rising edge) initiates the wave packet. Time stages progress once from T1 to T4, without a SUS stage.



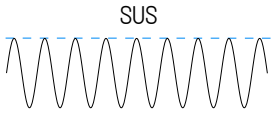
GATE

A rising edge initiates the wave packet. After T2, a SUS stage is held at for as long as the TRIGGER INPUT remains high.



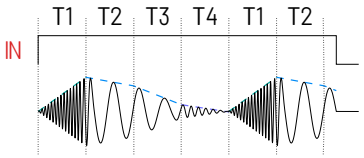
GATE FREE-RUNNING

Unplug the TRIGGER INPUT cable, and the SUS stage is held at indefinitely. The outputs can be used as continuously running oscillators/ LFOs or DC voltages.



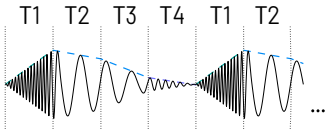
CYCLE

A rising edge initiates the wave packet. Wave packets repeat through T stages for as long as the TRIGGER INPUT remains high.



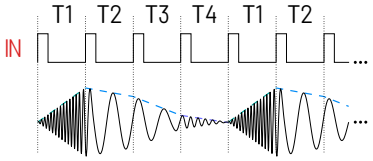
CYCLE FREE-RUNNING

Unplug the TRIGGER INPUT cable. Like normal CYCLE mode but Wave packets now repeat through T stages indefinitely with no input needed.



CYCLE-PING

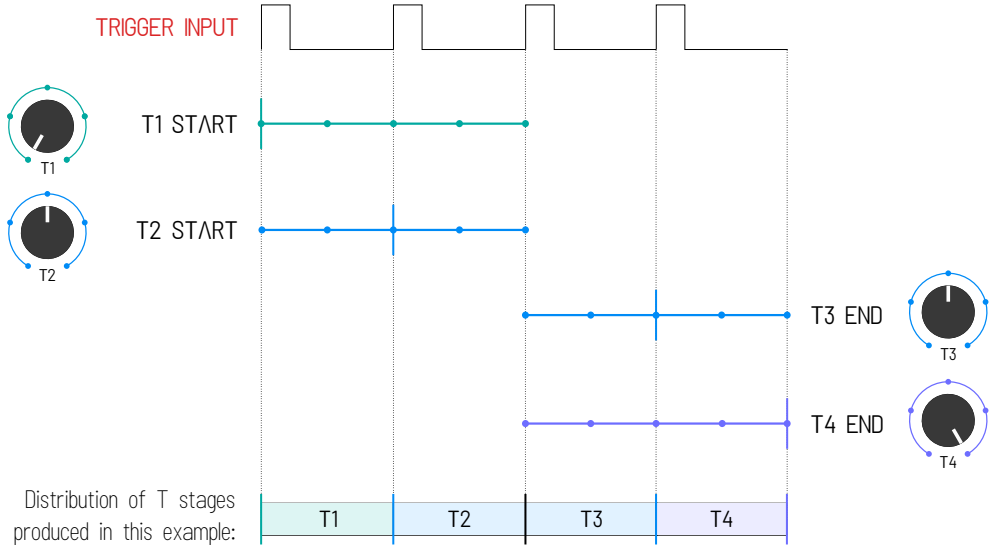
Hold down the BUTTON while flicking the EXCITATION MODE SWITCH up. T stages are pinged by an input pulse train, and the T knobs control stage timing offsets within the pulse pattern. T1 LED oscillates while waiting for initial pulses, and all T LEDs flash on each new pulse.



CYCLE-PING Exposition:

In CYCLE-PING excitation mode, time stages are pinged by an input pulse train (such as a clock signal) from the TRIGGER INPUT. Each new pulse enables the wave packet to proceed to the next time stage, and the difference in time between the pulses (the pulse period) is used to determine the stage time lengths. Each complete wave packet cycle (T1 to T4) always takes place over 4 pulses, but timing offsets from the pulse pattern are created by the T knobs; the T1 and T2 knobs determine stage starting time positions within the first 2 pulses, and the T3 and T4 knobs determine stage ending time positions within the last 2 pulses. The diagram below shows this relationship, using an example of T knob settings which create an even time stage distribution over the pulses:

CYCLE-PING excitation mode - Relationship between input pulses and T knob positions:



The T2 control takes precedence over T1, and the T3 control takes precedance over the T4. This means that if the T1 knob is set further to the *right* of the T2 position, the T1 stage will be skipped (in idle state until the start of T2). Likewise if the T4 knob is set further to the *left* of the T3 position, T4 stage will be skipped (in idle state after T3 until the end of the current wave packet cycle). The module uses a clever catch-up algorithm to cope with variable tempo signals while preventing audible glitches or sudden jumps in amplitude.

Starting/ Stopping/ Restarting:

- To enter the mode, hold down the BUTTON while flicking the EXCITATION MODE SWITCH up to CYCLE position.
- The cycle of wave packets will then start immediately on the second detected pulse, and the T1 LED will oscillate in the meantime to denote that pulses are pending.
- Alternatively, the start can be delayed by continuing to hold down the BUTTON when entering this mode - the wave packet cycling will start on the first pulse after the button is released.
- If the input pulses terminate, the module will soon go back in to pending state (T1 LED oscillating). After this, cycling will restart on the first detected pulse, using the pulse period time clocked in from before termination.

MODES

FREQUENCY MODE

This mode is set by tapping the BUTTON, which will toggle a light between the LFO and AUDIO LEDs.

The mode determines the frequency range of the oscillator, and therefore the intended use as either a control or audio source. Wave Packets will also adapt its behaviour in a number of other ways to optimise the intended use. All of the differences (many also discussed elsewhere in the manual) are summarised below.

LFO

- Centre of F knobs at 4 Hz, spanning 5 octaves either side
- 3 F knobs are independent controls
- Selection on the F knobs is never quantised
- F LEDs flash at each F knob rate. During a wave packet, the LFO LED is a meter of the oscillator feed
- If using F-SYNC, the 3 F knobs function as 3 clock multipliers/ dividers
- Uses a wave generation and morphing algorithm to maximise shape variation. Not optimum as an audio source
- Oscillator phase is always reset at the start, so each triggered wave packet follows the same shape

AUDIO

- Centre of middle (blue) F knob at note C3, spanning 5 octaves either side
- Left (green) & right (purple) F knobs provide starting/ ending pitch offsets to the middle 'base' F knob
- Selection on the F knobs is quantised to semitones if V/OCT is plugged in, to aid quicker tuning
- The F LEDs represent each frequency using a colour spectrum
- If using F-SYNC, the 'base' frequency is the F-SYNC frequency plus a pitch offset set by the middle F knob
- Uses a wave generation and moprhing algorithm to maximise timbral variation with exceptionally low aliasing
- Oscillator phase will NOT reset at a wave packet overflow (e.g. T4 back to T1 in a CYCLE excitation mode)
- Slightly exponentially scaled contour function used on output 4 for an improved VCA-like amplitude response

LINKED LFO MODE

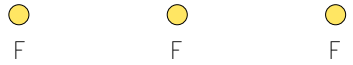
This mode is toggled ON and OFF by holding the BUTTON for 3 seconds while in LFO frequency mode.

When designing wave packet CV shapes using the T, D and F knobs, in many applications having these controls operate independently is perfectly adequate. However sometimes you may require a closer relationship between the number of oscillator cycles and stage time lengths. For example, what if you wanted to fit exactly half a sine wave oscillation in to stage T1, and then exactly 4 oscillations in to T2? LINKED LFO mode enables a tighter relationship between the stage times and the oscillator by allowing the T knobs to set lengths for each T stage in terms of mulitplies of the oscillator periods (the time to complete 1 wave oscillation) set by the 3 F knobs. In this mode, the oscillator becomes the master time controller. If for example you have a particular oscillator pattern in T1 which you want to oscillate quicker or slower but still contained within T1 - now you only need to change the left/ green F knob (or V/OCT or F-SYNC inputs!) and the T1 stage time will adjust automatically to fit the oscillations. This can be a powerful method of creating unique CV shapes, particularly at slow LFO rates when there can be a very nuanced relationship between the contour function and oscillator feed.

LINKED LFO MODE OFF

This is the normal functioning of Wave Packets, where there are 4 T stage time controls, each selectable between 0s - 10s, which operate entirely independently from the oscillator settings.

The 3 F LEDs are yellow when LINKED LFO mode is OFF:

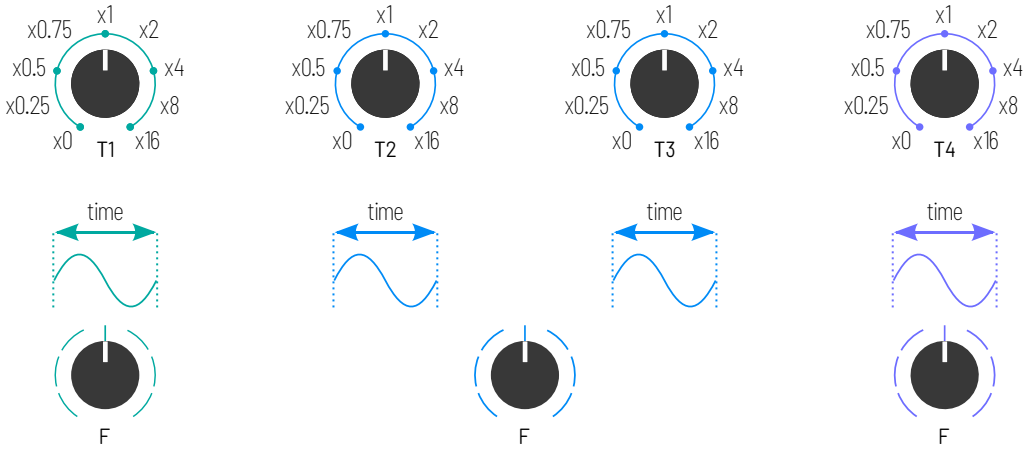


LINKED LFO MODE ON

The 4 T knobs set stage lengths as multiples of the oscillator period (time to complete one oscillation cycle/ inverse of frequency) set by the 3 F knobs.

The 3 F LEDs are green-blue-purple when LINKED LFO mode is ON:

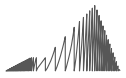
LINKED LFO mode - T knob time multiplier values (discrete options):



As T stage lengths are linked to the oscillator period, V/OCT will now also scale stage lengths at 1V per doubling/ halving of time. Therefore V/OCT can be used to shrink or stretch the entire wave packet shape:

V/OCT 0V

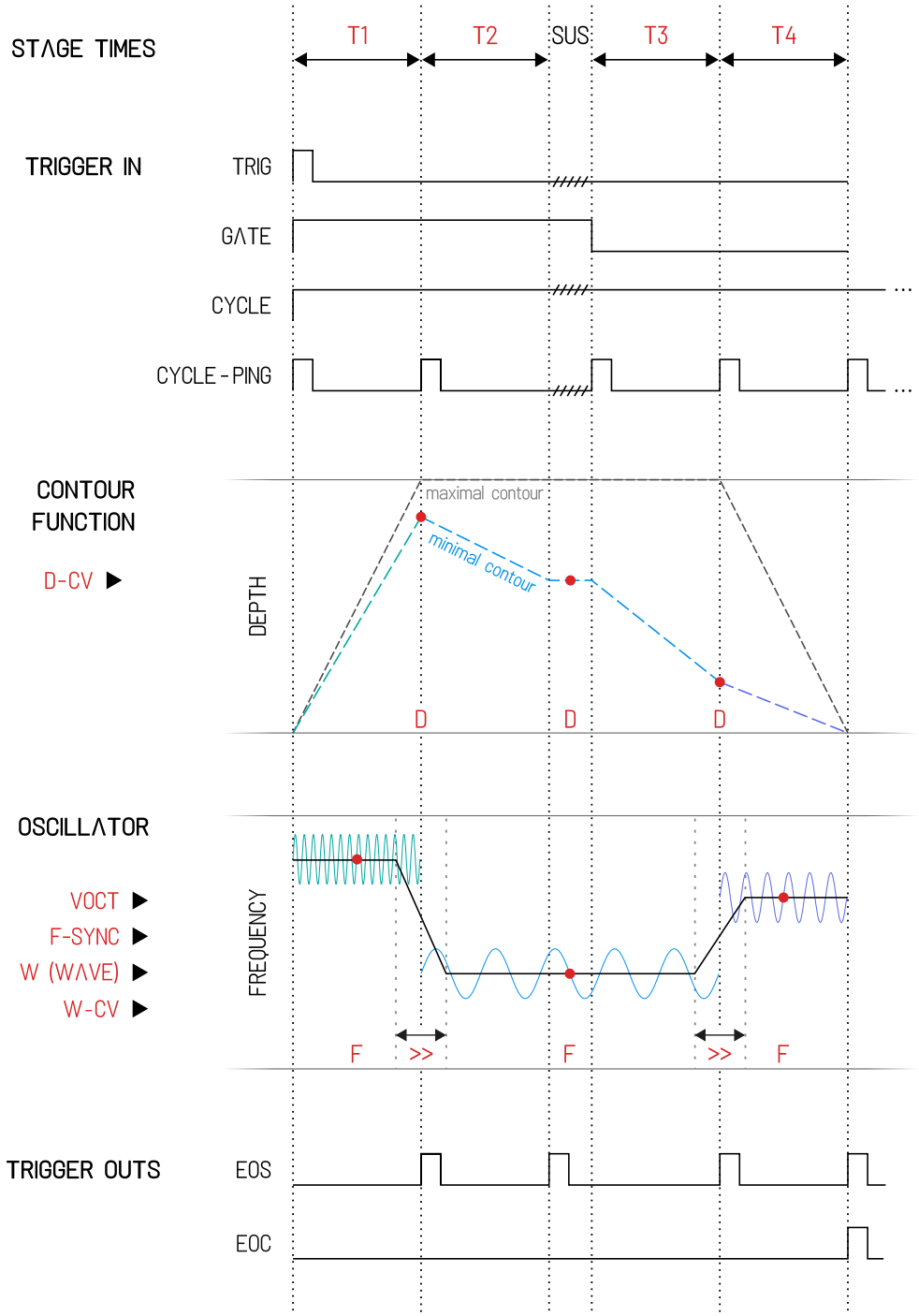
V/OCT -1V:

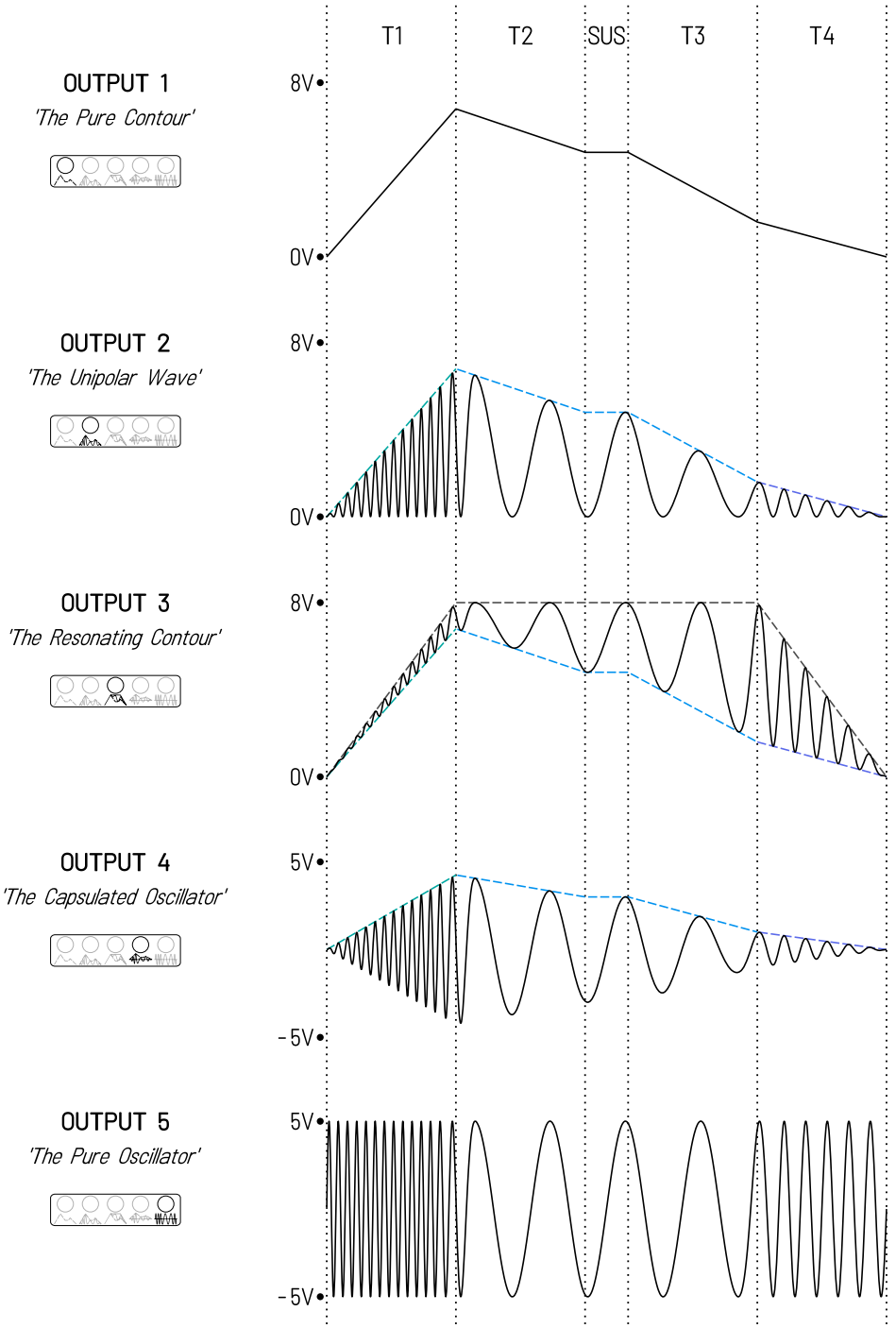


V/OCT 1V:

Because CYCLE-PING excitation mode uses input pulses to determine stage lengths, LINKED LFO mode (which derives stage lengths from the oscillator) is not compatible with CYCLE-PING excitation mode. Entering CYCLE-PING mode while in LINKED LFO mode will turn off LINKED LFO mode.

DIAGRAMMATIC MODEL OVERVIEW



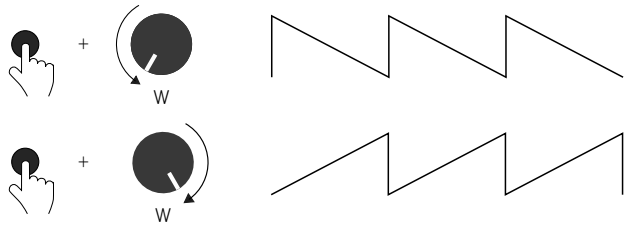


ADDITIONAL INFORMATION

SHIFT PARAMETERS

SAW WAVE DIRECTION REVERSAL

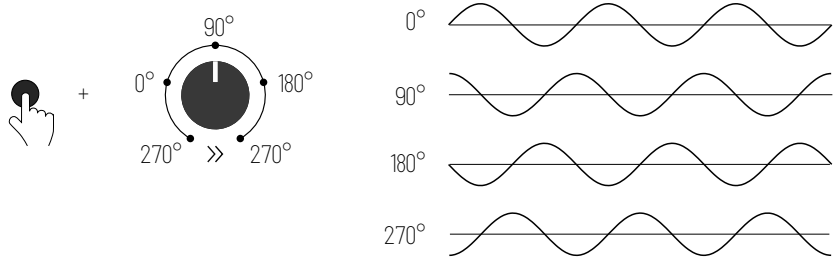
Holding down the BUTTON while moving the W knob fully clockwise or counterclockwise will flip the saw wave direction between rising and falling.



After releasing the button, the new knob position will determine the normal wave shape parameter.

OSCILLATOR PHASE

Holding down the BUTTON while moving the >> knob will change the oscillator phase in 90 degree increments.



After releasing the button, the new knob position will determine the normal glide parameter.

CALIBRATION

All inputs and outputs of the module are factory calibrated, although to compensate for variance between Eurorack systems and pitch CV sources you may wish to recalibrate V/OCT using the following procedure:

1) Position D-CV and W-CV in the counterclockwise (most left) position and hold the BUTTON for 8 seconds.
2) The left F LED will blink in green. Send 1.000V from your pitch source in to V/OCT.
3) Press the BUTTON.
4) The middle F LED will blink in green. Send 3.000V from your pitch source in to V/OCT.
5) Press the BUTTON. Your module is now calibrated to your source.

MODULE INSTALLATION

Wave Packets requires a standard 12V/-12V Eurorack power supply. Only ever connect or disconnect the module with your power supply completely switched off and powered down. The ribbon cable (supplied) must be connected from a 2x8 pin power supply header to the module's 2x5 pin header such that the red stripe of the ribbon cable (-12V side) aligns with the ⊖ marking on the PCB.

SPECIFICATIONS

- 16 HP width, 25 mm depth
- Current draw: 200mA on +12V rail, 12mA on the -12V rail
- ARM Cortex-M4 architecture, with 32-bit floating point internal processing
- 5 main outputs: 24-bit, 48kHz audio-grade DAC, DC-coupled
- V/OCT Input: +/-9V input range, 16-bit, 48kHz w/ 2x oversampling
- D-CV Input: +/-8V input range, 12-bit, 48kHz w/ 10x oversampling
- W-CV Input: +/-8V input range, 12-bit, 48kHz w/ 10x oversampling
- F-SYNC Input: Digital input capture at 180MHz
- Output frequency range: DC to 20kHz
- 100K input impedance on all inputs

WARRANTY

A one-year limited warranty is provided from the date of manufacture to the first owner. The warranty covers the repair or replacement of the module only and is limited to manufacturing defects. Return shipping is to be paid by the customer and the choice of repair or replacement is to be solely determined by Auza upon inspection of the returned module. The warranty does not cover any damages resulting from incorrect use, or any damages or costs beyond the repair or replacement of the module. Examples of incorrect use include but are not limited to: physical damage as a result of the use of excessive force or misuse, dropping or submerging the module; exposure to moisture or liquid; damage caused by incorrect power conditions, excessive or poorly regulated voltages; overexposure to heat or direct sunlight; placement of the module in conditions that do not facilitate good heat dispersion or are in any way comburant; the use of unofficial firmware. No responsibility for harm to persons or property caused by use of this module is implied or accepted. If you suspect your module to be faulty, you must immediately power off the module and contact team@auzaaudio.com for assistance. Please do not attempt to return a module without express consent and instruction from us.

Does your panel have a slightly different design to what is shown here?
Try our alternate manual: docs.auzaaudio.com/wavepackets-manual-panela.pdf