

grendel

dc-2e

rare waves llc · austin, texas

semimodular analog music synthesizer

GRENDEL

DRONE

COMMANDER

A	B	C	D	E	0
OSC1	OSC2	MIX	CLK	LFO	0
0	1	2	3	4	5

grendel Drone Commander 2 DC-2E

for Eurorack modular synthesizers



Main Module



Expander

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Features

2 x Voltage controlled oscillator

Square, saw, & PWM waveforms
Pitch modulation effects

2 x Voltage controlled LFO

Tempo generator & clock-dividing sawtooth LFO
Bipolar depth control

2 x Fixed frequency LFO

Sine wave LFOs dedicated to pulse width modulation

1 x Slew-limited clock divider

Pitch slide + trapezoidal filter modulations

2 x Voltage controlled filter

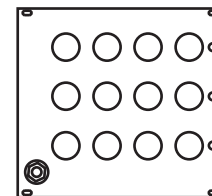
Original Grendel Drone Commander filter
4-Pole low pass gate (-24dB/oct VC-LPF)

1 x Envelope generator

Attack-release envelope, linear slope
Symmetrical attack and release times

Whats Included?

Main Module



Drone Commander DC-2E Main module
Power Cable type 16-26
Mounting hardware kit, M2.5 threads

Expander Module



Drone Commander 2 Expander module
Tether Cable, 26 pin ribbon
Power Cable, standard 16 pin
Mounting hardware kit, M2.5 threads

The Grendel Drone Commander 2 was designed to continue the legacy of its predecessor, the Drone Commander classic, which we manufactured in a volume of about 750 units between 2008-2015.

Over the years of feedback from dedicated musicians we collected a short list of features that were most frequently requested.

As a result, Drone Commander 2 contains many key upgrades including voltage-controlled oscillators, synchronization to external clock, and an LFO that can reach slower tempos. And of course, the numerous requests from the Eurorack community of musicians for a modular rack version have been honored with the design of the DC-2E Drone Commander 2 Eurorack + Expander module.

Naturally, we kept the features that we felt defined the best quality of the original. The filter is almost identical, with the addition of voltage control. In addition, Drone Commander 2 retains the solid aluminum knobs, handy push-pull switches, and sturdy metal construction that characterized the original.

Thank you kindly for your purchase, and we wish you many years of rewarding creative music.

Rare Waves LLC

Precautions

Fragile

The synthesizer modules are designed to be durable under normal use and should last many years.

Never drop the equipment onto a hard surface.

When shipping the synthesizer modules, please package them carefully to avoid shipping damage. An outer cardboard box is required for protection - the boxes included with the modules are not meant to be shipped without additional packaging. Use at least 2 inches (5 cm) of packing material on all sides. Only use bubble wrap as cushioning material - avoid newspaper or styrofoam peanuts as packing material.

Humidity and Moisture

It is not recommended to operate the synthesizer modules outdoors unless mild conditions with moderate humidity are assured.

If you are in a tropical climate or are experiencing wet weather conditions, there is a risk of humidity affecting the performance of the synthesizer modules. If you notice your glasses, camera lens, or other optics are becoming fogged, the same may be happening inside the synthesizer's circuitry. This typically happens when transporting equipment from an air conditioned room or vehicle to the outdoors on a wet day, such as loading gear into a vehicle just after a rainstorm.

Simply put, don't expose this equipment to high humidity, especially if it has just come from air conditioning. It is best to protect it inside a sealed case if gigging and travel are planned.

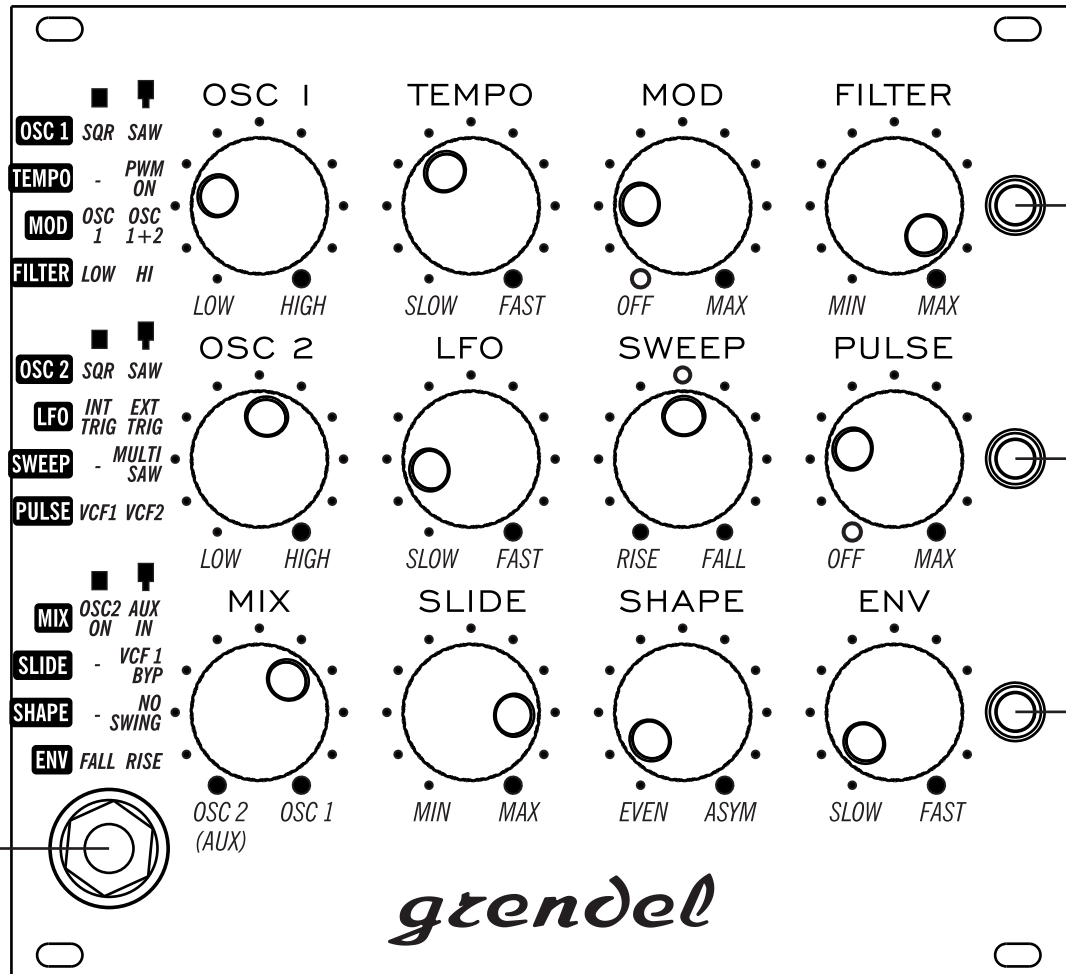
If condensation of moisture occurs, it is recommended to leave the equipment in a warm, dry indoor location for 48 hours before powering it up again.

When storing or shipping the modules, keep them inside sealed anti-static bags with a packet of moisture-absorbent material (included).

Temperature

For normal performance, keep this equipment in a climate controlled indoor space in the range of 55 - 95 degrees F (12 - 35 degrees C).

Main Module



Tempo LED

- Indicates the tempo of the internal clock

LFO LED

- Represents LFO activity with varying brightness

Gate LED

- Gate LED shows the envelope generator status
- Pull up ENV to hold Gate open. The LED will remain on.
- LED also lights to indicate GATE IN activity on the Expander module.

1/4" Audio Line Out

- Mixer input
- FX processor
- Volume pedal
- Instrument amp
- Digital audio interface

Installation

Main Module

The Main Module's width is 28HP (~ 142 mm). Its depth behind the mounting rails is about 78 mm (3.07"), with its cable attached. There must be at least 113 mm vertical clearance between the mounting rails, in order for the module to fit properly. (Figure 1)

The Main Module has one connector on its rear panel. You should connect it to your system power supply bus using the type 16-26 cable (included), or connect it to the Drone Commander 2 Expander Module using the 26 pin tether cable that comes with the Expander. And, while we're on the subject, we might as well remind you...

Don't experiment with connecting the main module's rear panel port to other equipment that happens to have a similar 26-pin connector.

To use the DC-2E Main Module on its own as a manually controlled instrument, connect it to your system power supply bus with the 16-26 pin ribbon cable provided. (Figure 2). Orient the red stripe on the cable toward pin 1 on your power bus connector, in the usual manner.

When unplugging the ribbon cable, pull with a slow steady pressure, grasping the housing of the connector and applying a gentle rocking motion.

In stand-alone mode, the DC-2E uses 80mA at +12V (+15V). The negative supply rail is not used.

Main Module (no Expander)

volts DC	+12(+15)	-12(-15)
mA	80	0

The cable port is designed to prevent the plugs from being inserted the wrong way.

The Main Module has reverse polarity protection (backwards diode type). In case of faulty connection, the module will not power up, but your power supply's fuses will not blow.



Flat washers are included with the mounting hardware. It is recommended to mount the washers on the screws. The washers protect the control panel from being scratched by the screws.

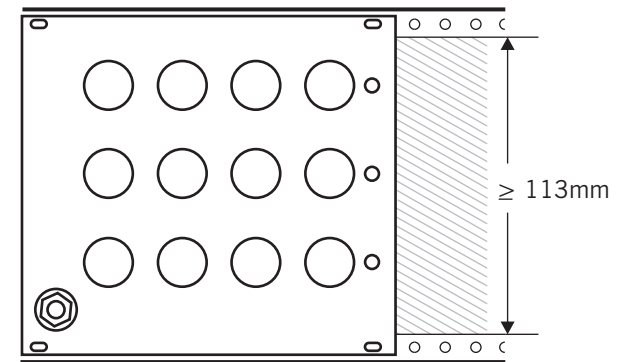


Figure 1. Minimum clearance for mounting

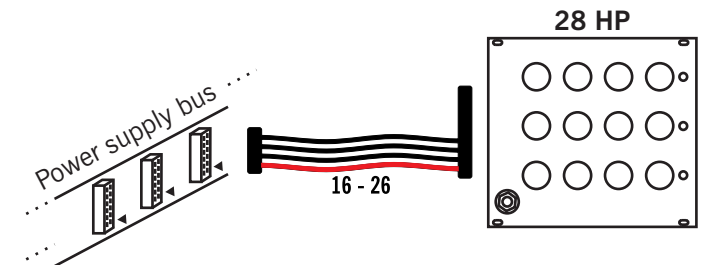
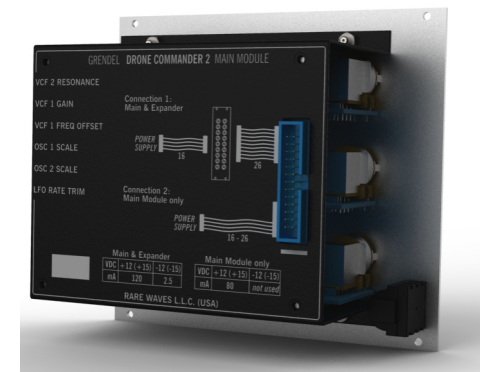


Figure 2. Cable connections for Main Module without Expander



Expander Module

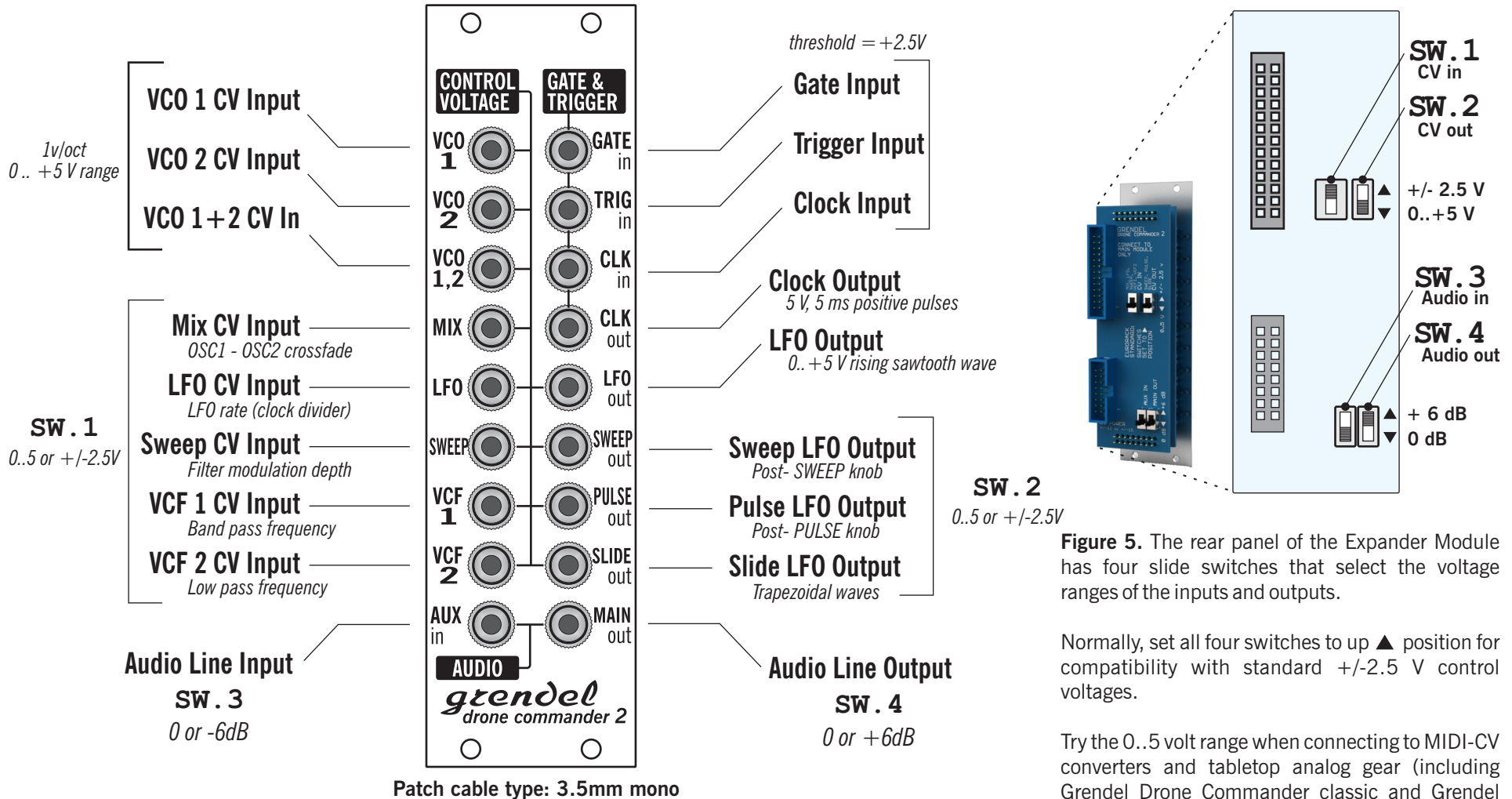


Figure 5. The rear panel of the Expander Module has four slide switches that select the voltage ranges of the inputs and outputs.

Normally, set all four switches to up ▲ position for compatibility with standard +/-2.5 V control voltages.

Try the 0..5 volt range when connecting to MIDI-CV converters and tabletop analog gear (including Grendel Drone Commander classic and Grendel RA-9 Grenadier)

If SW.3 is down, the AUX IN gain is + 6dB.
If SW.4 is up, the MAIN OUT level is + 6dB.

It is OK to experiment. All jacks are protected against short-circuit and overvoltage. **Never apply more than +/- 15 volts to any patch point.**

The VCO CV inputs work with signals in the range of 0 to +5 volts only. Voltages outside this range are limited by internal protection circuitry. That means:

- VCO CV inputs work ideally with MIDI-CV converters or CV-Gate keyboards that use the 0-5 volts range.
- To connect a bipolar LFO for vibrato or FM effects, its output should to be offset by +2.5 volts with a utility module (not included). This can be accomplished with a DC-coupled CV mixer and bias voltage source.

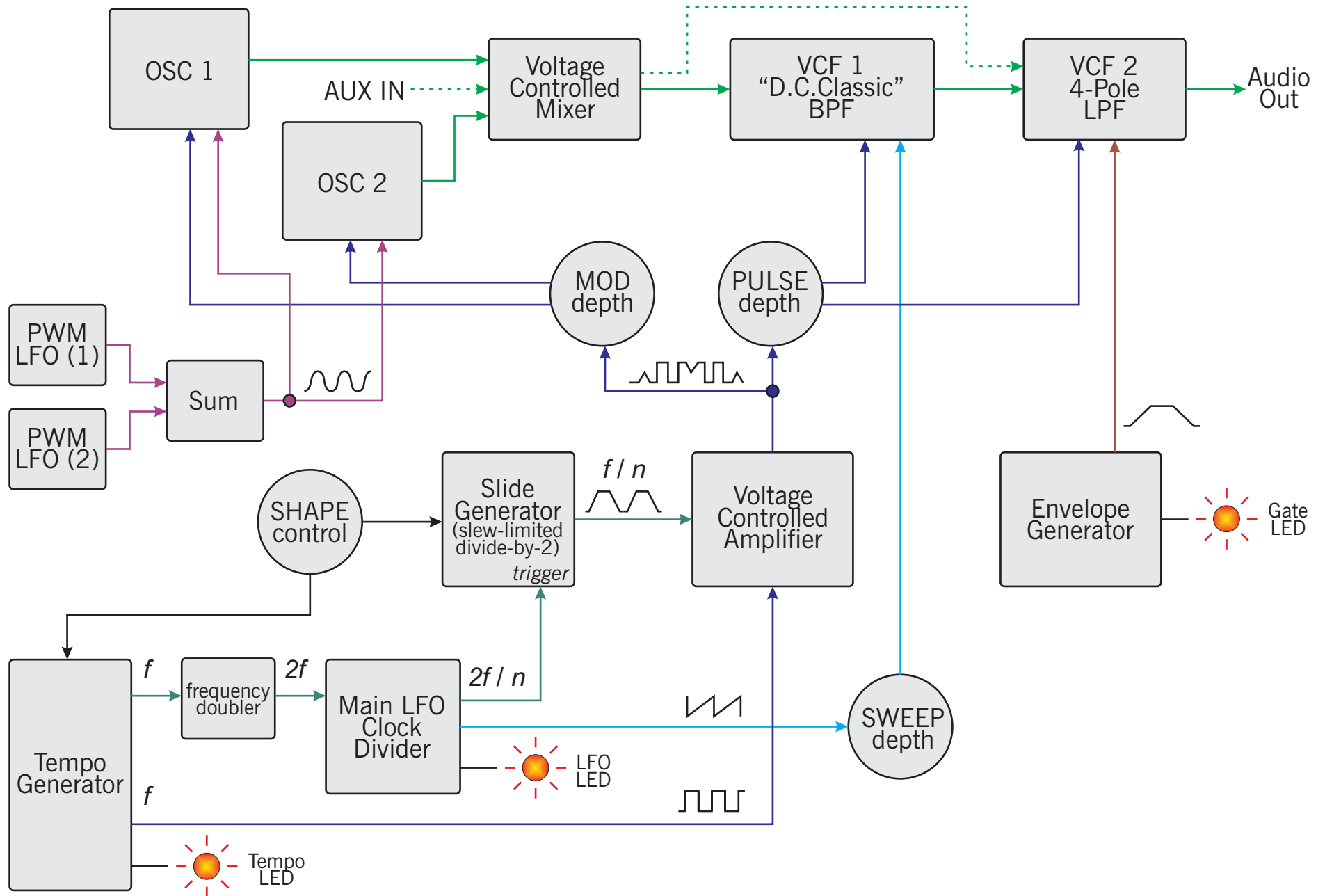


Figure 6. Main Module signal flow diagram

Oscillator Controls

OSC 1



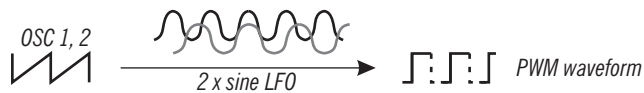
The OSC 1 knob manually controls the pitch of oscillator 1.

The pitch of OSC 1 is modulated by the MOD knob.



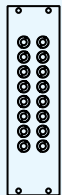
OSC 1's waveform is selected by the built-in push/pull switch. Push = square/PWM, Pull = sawtooth

Pulse width modulation (PWM) for both oscillators is activated by pulling up the TEMPO knob. Pulse width modulation is provided by a pair of dedicated sine wave LFOs at the frequencies of 0.55 Hz and 0.75 Hz. These are summed together to provide a smoothly varying PWM waveform, without a strongly implied tempo.



OSC 2

The OSC 2 knob manually controls the pitch of oscillator 2. Its functions are identical to OSC 1.



Expander: Each oscillator has its own CV input (1 v/oct). A third input, VCO 1+2, controls both oscillators simultaneously.

The CV input range for OSC 1 and OSC 2 is fixed at 0..+5 volts.

A MIDI-CV converter with clock outputs is ideal for controlling your Drone Commander 2.

There are two trim controls on the right side of the main module that affect the oscillators' tuning accuracy. The oscillators are temperature compensated.



OSC 1 SCALE : V/oct adjust for oscillator 1



OSC 2 SCALE : V/oct adjust for oscillator 2

MIX



The MIX knob controls the blend ratio of oscillator 1 and 2.

The mixer's output normally feeds the input of VCF 1. Pull up the SLIDE knob to send the mixer's output direct to VCF 2, bypassing VCF 1.



When the MIX knob is pulled up, oscillator 2 is muted. This lets you work with the pure sound of the filter's self-oscillations.



Expander: The MIX CV input allows voltage control of the blend ratio. The MIX knob remains active when MIX CV is patched.

An external audio signal patched to AUX IN will take the place of oscillator 2 in the mix when the OSC 2 knob is pulled up.

TIP: You can also use the MIX CV input as a VCA for OSC 1. This is useful if you need fast attack sounds, or more complex effects from an external envelope generator module.

- Connect an envelope generator to MIX CV input
- (Don't patch to AUX IN)
- Pull up the MIX knob and position it straight up (12 o'clock)

When your envelope generator is triggered, the mixer will respond by controlling the volume level of OSC 1. (Self-oscillation from the filter will remain at full volume.)

LFO Controls

TEMPO



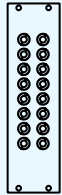
The TEMPO knob controls the rate of Drone Commander 2's internal clock and LFO waveforms.

The repetition rate can be varied between roughly 0.15 - 10 Hz. Temperature can affect the range to some extent.

Clock Pause: When the TEMPO knob is turned fully counterclockwise, the internal clock stops completely.



The TEMPO knob serves as a switch to activate the PWM waveforms for OSC 1 and OSC 2.



Expander: Patch an external clock signal to CLK IN to synchronize Drone Commander 2's modulations. Typically it is suggested to use a square wave or pulse wave signal with repetition rate of 1/8th note intervals.

The TEMPO knob acts as a variable clock divider, and also affects the swing ratio of the PULSE waveform.

You can tweak TEMPO until you like the synchronization effect, or use this simple procedure for finding the best TEMPO setting:

- Patch a clock source with 1/8th-note pulses to CLK IN
- Turn TEMPO to its fastest setting.
- Reduce TEMPO while observing the Tempo LED. Find the point where the flashing LED suddenly drops to half-time as you turn TEMPO counterclockwise.
- Leave the TEMPO knob set just slightly faster than the half-time break point.

This procedure gives the fullest range of control from the SHAPE knob when using an external clock source.

The maximum frequency of TEMPO is approximately 10 Hz.

LFO



The LFO knob controls the rate of sawtooth modulations that are applied to the filter via the SWEEP knob.

The LFO is always synchronized to the clock pulses from the TEMPO knob. The LFO's frequency is $2 * \text{TEMPO} / n$, where n is a whole number. At the fastest setting ($n=1$) the LFO sawtooth sweep is twice as fast as TEMPO. In other words, if TEMPO is eighth-notes, the LFO can generate sixteenth notes (double time) when turned to max. The double time effect works for tempos of 150 BPM or less.

LFO rate is automatically scaled by the TEMPO knob. That is to say, the LFO tracks the TEMPO. This helps Drone Commander 2 maintain consistent modulation effects when TEMPO is varied. It also means that if you want a very slow LFO, you must also turn TEMPO to a slow setting.

The LFO also controls the SLIDE effect. When the LFO knob is in push position, the SLIDE effect is triggered once per LFO cycle.



Pulling up the LFO knob cancels the SLIDE effect. This gives PULSE modulations very much like the classic Drone Commander.



Expander: The LFO CV jack controls the LFO rate.

The expander module has a dedicated output for the LFO sawtooth wave. It is a rising sawtooth waveform.

Pull up the LFO knob to route TRIG IN to the slide generator. Patch an external Trigger or Gate signal to TRIG IN to get rhythmic control over the SLIDE events.

There is a trimmer on the right side of the main module that affects the LFO



LFO RATE TRIM : Fine adjust for LFO rate. Non-critical. Leave it in the middle unless you feel like experimenting.

Modulation Controls

SLIDE



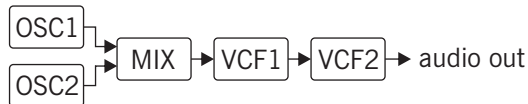
The SLIDE effect is normally triggered once per LFO cycle. SLIDE alters the square wave modulations of PULSE and MOD in a special way: When SLIDE is triggered, the square wave is cross-faded with an inverted version of itself. The crossfade (slide) duration is set by the SLIDE pot. The SHAPE knob controls the symmetry of the slides, making them alternately longer and shorter.

Pulling up the LFO knob cancels the SLIDE effect. This gives PULSE modulations with a character much like the classic Drone Commander.

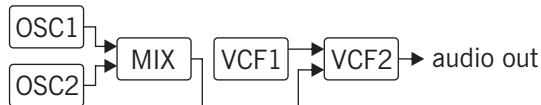


The SLIDE knob also serves as a switch to change the signal routing between mixer and filters.

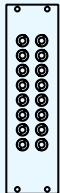
When SLIDE is in the **push** position, the signal chain is normal:



When SLIDE is in the **pull** position, the signal chain is altered. The mixer output is sent directly to VCF 2, and the pure self-oscillations of VCF 1 are heard.



TIP: To get the classic subtractive synthesis timbre of two sawtooth oscillators and a 4-pole low pass filter, pull up SLIDE, OSC 1, and OSC 2. Adjust FILTER, SWEEP, and PULSE to stop any self-oscillation of VCF 1.



Expander: You can trigger SLIDE with an external trigger signal patched to TRIG IN. (Pull up the LFO knob to enable TRIG IN)

The expander has a dedicated output jack for the SLIDE waveform. It is a trapezoidal waveform with a peak-to-peak spacing of five volts.

MOD



The MOD knob sets the depth of pitch modulation for the oscillators. Its range of control is approximately zero to +5 octaves.

The modulation source is the same as the PULSE effect, and its exact behavior is controlled by the TEMPO, LFO, SLIDE, and SHAPE controls.

The SLIDE effect is most obvious when MOD is turned up.



When MOD is in push position, only OSC 1 is modulated. When MOD is in pull position, both OSC 1 and OSC 2 will be pitch modulated.

Modulation Controls

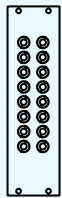
SWEEP



The SWEEP knob modulates VCF 1's center frequency with sawtooth waves from the LFO. SWEEP is a bi-polarity control. Its zero position (no modulation) is close to straight-up 12 o'clock. Turn SWEEP clockwise for falling sawtooth modulation. Turn SWEEP counter-clockwise for rising sawtooth modulation.



Pulling the SWEEP knob up activates the multi-saw waveform. This adds in a second sawtooth waveform at the TEMPO rate. The resulting modulation shape depends on the relative setting of TEMPO and LFO.



Expander: There is a patch point for SWEEP LFO output. Its amplitude is variable (post- SWEEP knob)

The sweep effect can be varied with the SWEEP CV input. Position the SWEEP knob straight up when using SWEEP CV IN.

SHAPE



The SHAPE knob controls the symmetry of the PULSE and MOD waveforms. It is similar to a swing ratio control. When SHAPE is fully counter-clockwise, the modulations are symmetrical (no swing). As SHAPE is rotated clockwise, the modulations will become asymmetric.

SHAPE also controls the symmetry of the SLIDE effect. When SHAPE is fully counterclockwise, the SLIDE effect has the same crossfade time at every transition. Turning SHAPE clockwise makes the even slides longer, and the odd slides shorter.



Pulling up the SHAPE knob disables its effect on PULSE and MOD symmetry (no swing). SHAPE symmetry is still affected.

PULSE



The PULSE knob controls the depth of modulation to Drone Commander 2's filters. The pulse waveform can be as simple as a square wave or a more complex combination of sloped and straight line segments with syncopation and polyrhythmic character.



PULSE's push-pull switch gives a quick change of tone when contrast is needed. It can modulate either VCF 1 (the original Drone Commander bandpass filter), or VCF 2 (4-pole low pass).

- In push position, PULSE modulates VCF1. VCF2 is biased to its high frequency range (brighter tone).
- In pull position, PULSE modulates VCF2. VCF1 is biased to its middle range (darker tone).

TIP: When the clock is paused (TEMPO knob fully off), you can use the PULSE knob as a cutoff frequency control for the 4-pole filter. Pull up the PULSE knob. Turn PULSE counterclockwise for a darker tone. Note that the cutoff frequency is still affected by the envelope generator.



Expander: There is a patch point for the PULSE waveform output. Its amplitude is variable (post- PULSE knob).

Filter Controls

FILTER

The Drone Commander filter is designed for strong coloration of the signal with a unique combination of overdrive, band pass filter, self-oscillation, and nonlinear wave shaping effects ... in other words, there is no 'clean' setting!

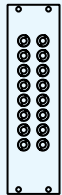


Operation of the FILTER knob is similar to Drone Commander classic. It simultaneously controls the frequency and resonance of VCF 1. The filter will strongly self-oscillate at low frequencies when FILTER is turned counterclockwise.



The FILTER knob's push-pull switch affects the tone range of the bandpass effect. In push position, the low frequency range is selected. In pull position, the high frequency range is selected.

VCF 1 self-oscillation is more dominant in the low frequencies.



Expander: The band pass filter center frequency can be controlled by patching to the VCF1 CV input jack.

The low pass gate filter frequency can be controlled by patching to the VCF2 CV input jack. An ADSR envelope generator can be connected to VCF2 CV input.

There are two trim controls on Main Module that affect VCF 1's behavior.



VCF 1 GAIN sets the input gain for the filter. You may wish to experiment with it to hear the difference when VCF 1 is driven harder or more lightly. A good place for VCF 1 GAIN is in the middle.



VCF 1 FREQ OFFSET controls the range of modulation from the PULSE and SWEEP controls. It sets the lowest frequency of VCF 1's self oscillation. You can experiment with it while tweaking PULSE and SWEEP. Normally leave it set at its center position.

There is also a trim control for VCF 2



VCF 2 RESONANCE adjusts the Q factor of the 4-pole low pass filter from zero to about 0.75. (Self-oscillation not possible)

ENV



The ENV knob controls the parameters of Drone Commander 2's envelope generator.

It is an AR (attack-release) envelope with linear slope. The attack and release times are equal.

The envelope controls the cutoff frequency of VCF 2. VCF 2 is a 4-pole low pass filter (-24dB/oct) with discrete transistor analog circuits. In contrast to VCF 1, it has a clean and precise sound. It takes the place of a volume knob in the signal chain. When the envelope is fully off, VCF 2's cutoff frequency is below 20 Hz, and the main output is silent.

The range of envelope times is roughly 0.25 - 45 seconds. It is deliberately biased toward slow envelopes. This gives useful hands-free fade-in and fade-out effects.



Pull up ENV to open the gate. VCF 2's cutoff frequency will rise from sub-audio (silence) to >20kHz (fully open).

The LED next to the ENV knob lights when the gate is open.

At its slowest setting, it may take a few seconds before you hear the silence giving way to low frequency tones, which steadily grow in detail as the cutoff frequency rises.

Push down ENV to close the gate. VCF 2's cutoff frequency will smoothly glide downward to dull the bright edge, leaving silence.



Expander: The envelope generator can be controlled by an external gate signal to the GATE IN jack.

The LED next to the ENV knob lights when GATE IN is active.

Set the ENV knob in push position for normal GATE IN effect.

Pull up the ENV knob to hold the gate open regardless of the GATE IN activity.

Synchronization (Expander only)

CLK IN

Connecting a suitable source of clock pulses to the Expander's CLK IN jack will allow you to synchronize Drone Commander 2's modulations with other instruments.

Normally, a clock rate of one pulse per eighth note (2ppqn) gives good results. DC-2E's clock rate doubling LFO can multiply eighth notes up to sixteenth notes, when BPM < 150.

See page 9, *Tempo: Expander* section, for tips on setting the TEMPO knob when using CLK IN.

It is OK to connect a higher frequency clock to CLK IN, in which case DC-2E's LFOs will work as a clock divider, but you may have to listen carefully while setting the TEMPO control so the LFO timing sounds accurate and in-phase.

- A MIDI-to-CV converter with analog clock pulse outputs is ideal for synchronizing DC-2E with digital audio workstation (DAW) software.
- To synchronize with a drum machine or sequencer that works with DIN SYNC (such as TR-606, TR-808), it is recommended to use a MIDI sequencer or DAW as the master clock. Connect a MIDI-to-DIN SYNC converter (such as Doepfer MSY2) to control the drum machine. Then use a separate MIDI-to-CV converter to control Drone Commander DC-2E. This way, both synths will play in synchronization with the DAW.
- To use DIN SYNC equipment as the master clock for DC-2E *without* any MIDI connections, you'll need to connect a clock divider module that converts DIN SYNC (24ppqn) to analog clock output. A divide-by-12 ratio will create Drone Commander 2's eighth note analog clock from DIN SYNC.

DC-2E's clock detector circuit responds to the rising edge of CLK IN. The duty cycle of the clock input is not critical but its positive pulse width should be at least 1 ms. The switching threshold of CLK IN is +2.5 volts.

Five volt clock pulses are normal, but it is OK to use higher voltage clock (up to 10 volts), as long as the waveform transitions cross through +2.5 volts.

CLK OUT

DC-2E's CLK OUT jack delivers 5 volt positive pulses of 5 milliseconds duration, at the same rate as the Tempo LED.

Connect CLK OUT to an analog sequencer's clock input, or any module that is designed to accept 5-volt analog clock pulses.

If CLK IN is at a faster rate than the maximum TEMPO, CLK OUT will be a frequency-divided version of CLK IN.

It is not generally possible to use the CLK OUT from DC-2E as a master clock for MIDI or DIN SYNC equipment.

Warranty

Your purchase is guaranteed to be free from manufacturing defects for one year from the date of purchase. Rare Waves LLC will replace or repair, at our discretion, any components found to be defective, at no charge beyond the costs of shipping.

Service

Certain parts of the DC-2E are designed to be field-replaceable with no soldering required.

Contact us for a current list of replacement part prices.

For service and technical support inquiries, please contact us by email
service @ rarewaves.net