1. Introduction

The **A-129 /x** series of modules forms a **modular vocoder**. 'Vocoder' is an abbreviation of 'voice coder'.

The basic components are an **analysis section** (**A-129 /1**) and a **synthesis section** (**A-129 /2**).

Like a ring modulator, the vocoder needs two input signals: a **speech element** which serves as the raw material for the tonal shaping, and is patched into the analysis section; and a **carrier signal**, which is patched via the instrument input into the synthesis section.

The speech signal is chopped up and analysed in the A-129/1 module, and then combined with the carrier signal in the A-129/2 synthesis section. As a result of this procedure, the carrier signal assumes the tonal character of the speech signal, but with its own pitch maintained.

Since the A-129 is a modular vocoder, and the connections between the analysis and synthesis section are external, using patch-leads, you can use this interface to **patch in** your choice of **modules** (eg. attenuator, slew limiter, CV-to-MIDI / MIDI-to-CV interfaces,, inverter, etc.).

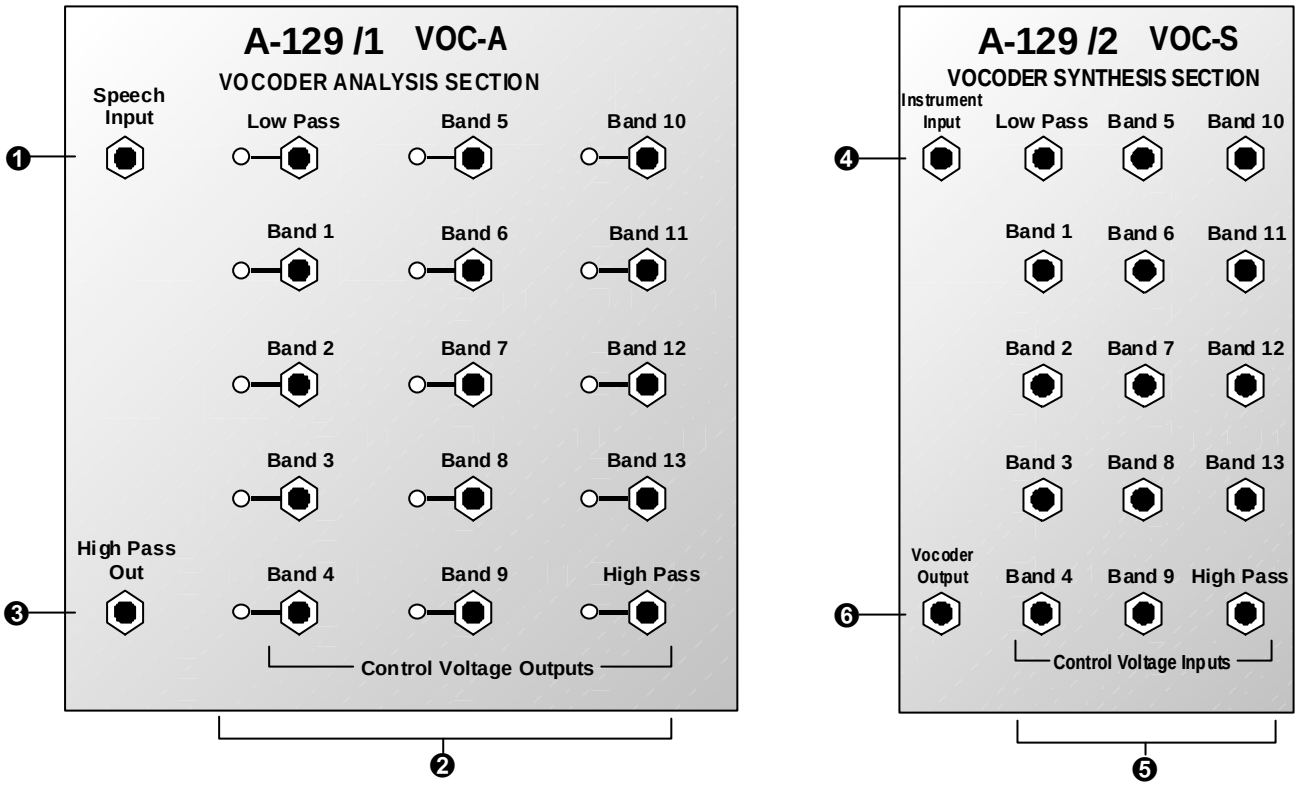
The **Five-way VC slew limiter / offset generator / attenuators (A-129 /3)** and **Slew controllers** (**A-129/4**) are particularly designed for this purpose.

There's also the possibility of connecting the frequency bands of the analysis and synthesis sections arbitrarily, so that, for instance, a low frequency band in the speech signal can control a high frequency band in the carrier signal.

The **Voiced / unvoiced detector** (**A-129 /5**) can recognise voiced and unvoiced sections in the speech signal, and switch the carrier signal accordingly.

The A-129 /2 synthesis section can also be used as a stand-alone voltage-controlled filter bank (see chapter 6, User examples).

2. A-129 /1, /2 - Overview



In / Outputs:

A-129 /1

! **Speech In** : Input for the speech signal

" **CV Outputs** : 15 CV outputs with control LEDs

§ **High Pass** : Signal output from the high pass filter

A-129 /2

$ **Instrument In** : Input for the instrument signal

% **CV Inputs** : 15 CV inputs

& **Vocoder Out** : Audio output from the vocoder

The following Table 1 shows the cut-off frequency of the low pass filter, the middle frequency of the band pass filters (Band 1 to Band 13) and the cut-off frequency of the high pass filter.

Filter	Frequency	Filter	Frequency
Low Pass	100 Hz	**Band 8**	1.3 kHz
Band 1	120 Hz	**Band 9**	1.6 kHz
Band 2	160 Hz	**Band 10**	2.3 kHz
Band 3	230 Hz	**Band 11**	3.3 kHz
Band 4	330 Hz	**Band 12**	5 kHz
Band 5	500 Hz	**Band 13**	7.5 kHz
Band 6	750 Hz	**High Pass**	10 kHz
Band 7	1.1 kHz		

Tab. 1: Filter frequencies in the analysis and synthesis sections

3. Basic principles

The fundamental modules in this vocoder are the **analysis section A-129 /1** and the **synthesis section A-129 /2** (see Fig. 1).

The **speech signal** is analysed in the A-129 /1, by being passed through a set of steeply sloping **band pass filters**, with a **low-** and **high- pass filter** mopping up the bottom and top frequencies respectively. Attached to each of these filters is an envelope follower, which analyses the audio signal level passing through, and sends a proportional voltage out of its dedicated **CV output** (see below for further details).

The **instrument signal** is likewise sent through another set of steeply sloping band pass filters, and a low- and high-pass filter in the A-129 /2 synthesis section, and is split into individual frequency bands. This time, each filter has an associated **VCA (voltage controlled amplifier),** which is governed by the voltage present at its **CV input**.

In this way, each frequency band in the instrument signal has the dynamics of the corresponding band from the speech signal superimposed onto it. The pattern of the speech signal is thus re-constructed from the tonal raw material of the instrument signal. The closer the audio spectra of the speech and carrier signals are, the more speech-like the resulting reconstruction.

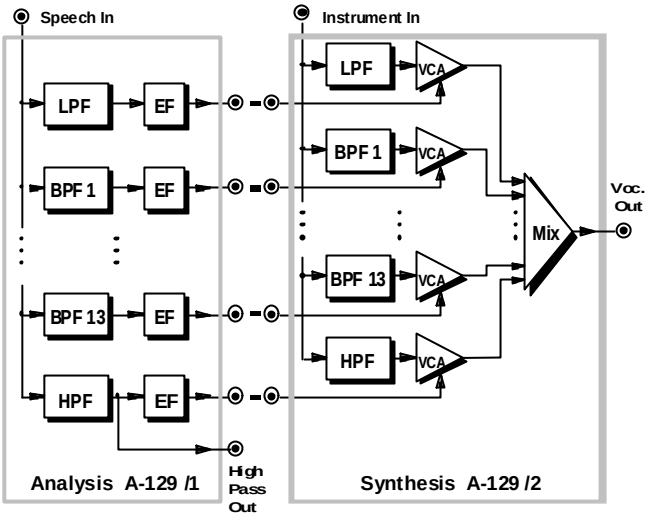


Fig. 1: Block diagram of the A-129 analysis and synthesis sections

H In most standard vocoders the voltage signals from the analysis section are fed straight into the synthesis section. With the A-129 modular vocoder, they are patched externally via 15 leads.

That means it's possible to modify the control voltages by patching any sensible choice of module (for instance attenuators, slew limiters, LFO, CV-MIDI / MIDI-CV interfaces, inverters, etc.), between the analysis and synthesis sections. Not-so-sensible choices may produce interesting results, too.

It's also possible to interconnect control voltages to synthesis section inputs in a non-standard way, so that for instance the output from a low frequency band from the speech signal can control a high frequency element of the carrier signal.

With a modular vocoder, the only constraints on experimentation are the limits of your imagination (and you can also always have a look at chapter 6, User examples).

4. In / Outputs

! Speech In

Socket ! is the **input** to the analysis section. This is where the speech signal is patched in.

Don't forget that the speech signal needs to be at the high level the A-100 uses internally. **Plugging a microphone directly in** to the vocoder **won't work.** You need to use an **A-119** External Input module, into which you can plug a microphone or other external signal. Then the output of the A-119 can be patched into input socket ! on the analysis section.

" Low Pass • Band 1 to Band 13 • High Pass

These are the **CV outputs** " from the analysis section, whose voltages are determined by each filter's envelope follower. Each CV output has an **LED** connected to it, showing the strength of the voltage generated.

§ High Pass

Socket § on the analysis section is the **high pass filter output**. Unlike the other sockets, this is an **audio output**, which sends out the part of the speech signal which the high pass filter lets through. This is most usually added to the vocoder output, to make the modified carrier signal more speech-like still, by including these high frequency elements of the sound.

$ Instrument In

Socket $ on the synthesis section is where you patch in the instrument that will provide the carrier signal (see below).

P Experiment with different sorts of sound for the carrier signal, for instance

- sawtooth or square waves from a VCO,
- noise (A-118),
- digital noise (A-117).

H With an **A-129 /5** voiced / un-voiced detector module, you can switch the carrier signal depending on whether a speech signal is present.

% Low Pass • Band 1 • Band 13 • High Pass

The **CV inputs** % on the synthesis section are where the **control voltages** from the analysis section are patched in.

& Vocoder Out

Output & on the synthesis section is the audio output for the whole vocoder.

5. User examples

Basic principles

To get the best results from the vocoder, it's essential to take note of the following important points:

- For professional results, the quality of the speech signal is crucial.

  If you use a cheap and cheerful microphone, connecting it up to the vocoder via the A-119 won't guarantee good results.
  Any unwanted noise (rumble, airborne background sounds, etc.) will greatly reduce the effectiveness of the vocoding.
  According to various musicians including Kraftwerk, the speech signal is easier to use if it isn't live, but has been taped or sampled, and thus has reliable levels and signal-to-noise - and is repeatable.

- For early experiments, radio news stations provide good raw material, because they are nearly always putting out a steady stream of human speech.

- In addition, we plan to bundle an audio cassette of speech with each vocoder.

- For the best results, speech and carrier signals need to have similar frequency spectra. A quiet female voice, or a child's, needs a different carrier signal compared with a low-register male voice. If you use a VCO as the carrier signal, you can tune it to find the ideal frequency.

- Basically, the instrument's carrier signal needs to be as overtone-rich as possible, with a dense audio spectrum. With a VCO the sawtooth output is best suited to the task. An exact square wave has only half as many harmonics, and triangle and sine waves are completely unsuitable (see the notes to the A-110 and/or A-111).

- For professional results, it's recommended to use a graphic or parametric EQ to equalize the speech signal to produce the most speech-like results at the vocoder's output. Good results can also be obtained using computer-generated speech (as on the A-100 demo CD).

Using just the basic modules

Just with the A-129 /1 and A-129 /2 modules (and an A-119 external input), all the common vocoder effects can be produced (see Fig. 2).

- First patch all the CV outputs on the analysis section to their respective CV inputs on the synthesis section (band 1 to 1, 2 to 2, and so on)

- Use an **A-119 (External Input)** to patch an audio signal (see above, chapter 5, Basic Principles) into the speech input socket of the analysis section at normal A-100 operating level.

- Experiment with different audio signals for the carrier frequency (instrument input), for instance:-
  - different overtone-rich waveforms from a VCO,
  - pink or coloured noise from an A-118,
  - digital noise from an A-117,
  - ring modulator outputs,
  - two VCOs modulated in the audio range by FM or AM.

- Swap the connections between analysis and synthesis sections (see above).

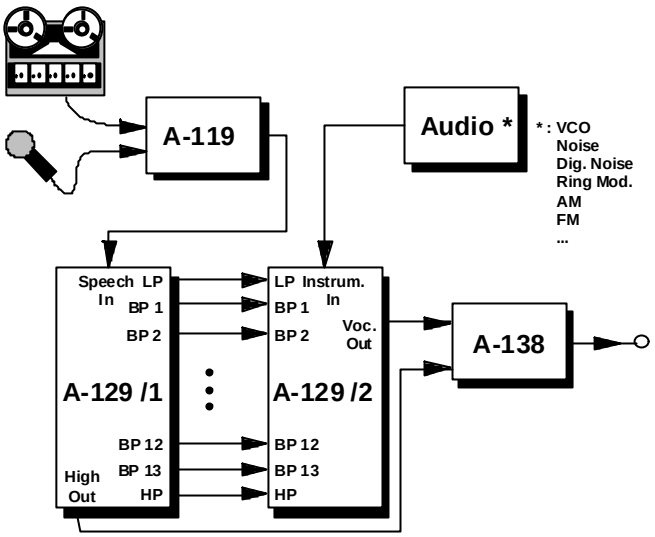


Fig. 2: Basic vocoder schematic

"Frequency displacement"

If instead of patching the outputs from the analysis section to their 'proper' respective inputs in the synthesis section, you swap them about instead, interesting frequency displacements occur in the vocoder output.

Fig. 3 shows some simple variations; experiment withall sorts of other possibilities.

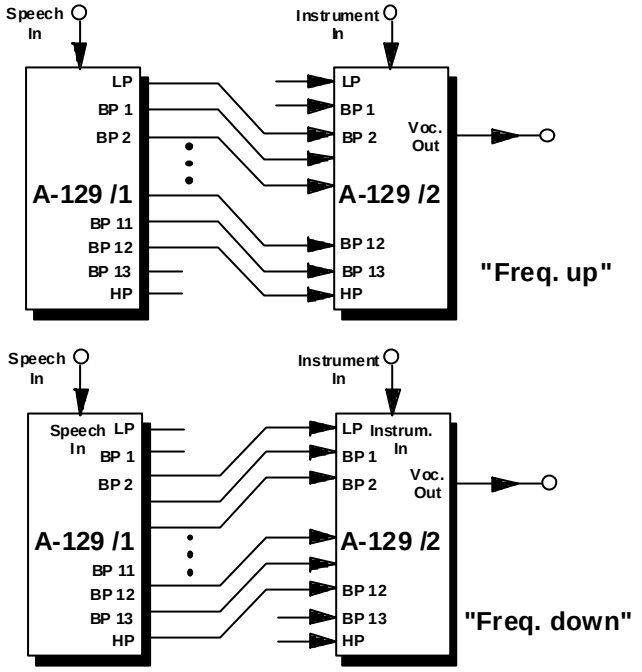


Fig. 3: "Frequency displacement"

"Chopped up" speech

The patch in Fig. 4 produces chopped-up speech: the vocoder chops speech up rhythmically, in time with the trigger signals. The vocoder output is patched into a VCA, which is controlled by a rhythmical pulse from an ADSR (A=0, R=0, D and S to taste). The source of the trigger signal could be an MAQ 16/3, Schaltwerk or trigger from a MIDI sequencer via a MIDI Interface such as the A-190.

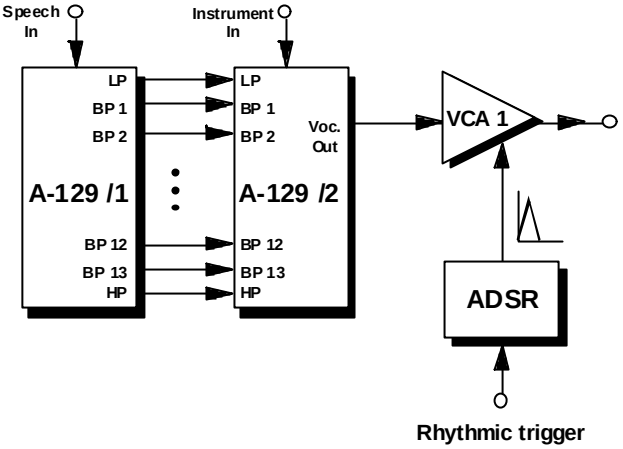


Fig. 4: Rhythmically chopped-up speech

Using with the other modules (/3, /4, /5)

While extremely usable vocoder sounds can be produced with just the two basic modules, total flexibility and unlimited possibilities are offered by adding on the extra modules (A-129 /3, A-129 /4, A-129/5).

Full user instructions will be found in the modules' own manuals.

A-129 /2 as a MIDI-controlled filterbank

The vocoder's synthesis section can also, in conjunction with a special A-191 MCV16 module, be used as a MIDI-controlled filterbank (see Fig. 3).

The level of each of the control voltages (Input &) determines the relative level of each of the frequency bands at the A-129/2's output socket %.

These CVs are patched from a special **A-191** MIDI-CV-Interface (with 16 CV outputs and no MIDI-LFO) and are controlled by various continuous controllers - see the A-191 manual for details.

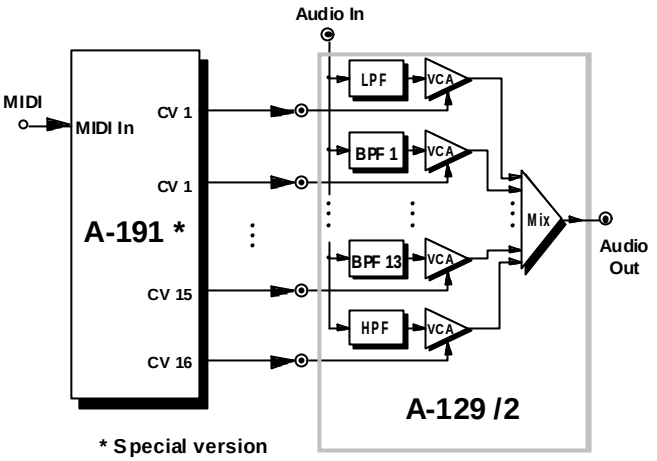


Fig. 3: The A-129 /2 as a MIDI-controlled filterbank

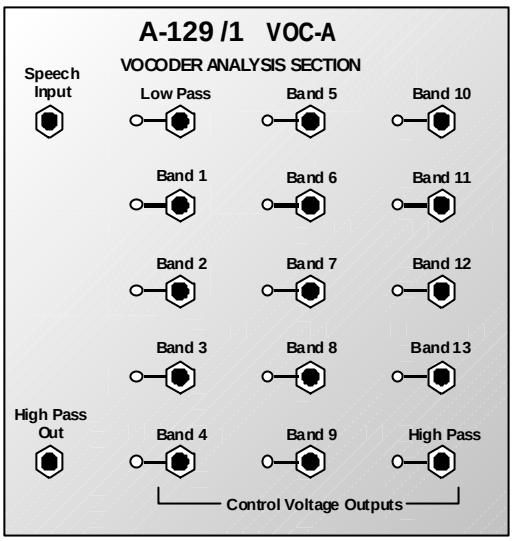
6. Patch-Sheet

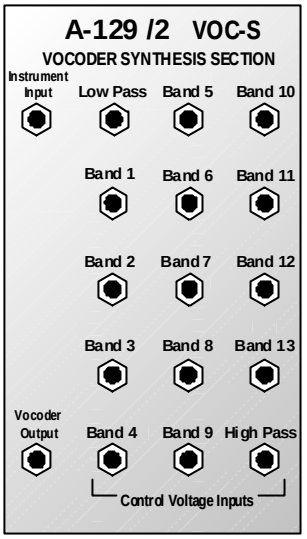
The following diagrams of the module can help you recall your own **Patches**. They're designed so that a complete 19" rack of modules will fit onto an A4 sheet of paper.

Photocopy this page, and cut out the pictures of this and your other modules. You can then stick them onto another piece of paper, and create a diagram of your own system.

Make multiple copies of your composite diagram, and use them for remembering good patches and set-ups.

P • Draw in patchleads with colored pens.




A-129 /2 VOC-S
VOCODER SYNTHESIS SECTION
Instrument Input
Low Pass
Band 5
Band 10
Band 1
Band 6
Band 11
Band 2
Band 7
Band 12
Band 3
Band 8
Band 13
Vocoder Output
Band 4
Band 9
High Pass
Control Voltage Inputs