PECS

Poly-Ensemble Construction Set

Version 1.0

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Presets and testing by kraftraum soundcloud.com/kraftraum

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Introduction

PECS is a software instrument plug-in for Microsoft Windows (VST2/VST3) and Apple macOS (VST2/VST3/AU) based on the classic KORG® *PE-2000 Poly-Ensemble S* string machine from 1976. It is written in native C++ code for high performance and low CPU consumption. The main features are:

- Humble recreation of 8 original presets
- Tweakable instrument parameters
- Vintage Vibe©
- All parameters can be controlled by MIDI controllers
- Plug-in supports Windows and macOS (32 bit and 64 bit)

PECS is based on the **iPlug2** framework maintained by **Oli Larkin and the iPlug2 team**. Big thanks, guys!!! Without your work it would not have been possible to create a resizable user interface.

To resize the plug-in you just grab the yellow triangle at the bottom right of the *PECS* window and drag it. You can save the current window size using the menu entry "Save Window Size" in the *Options Menu*.

Legal Statement

I, Björn Arlt, in full possession of all my mental powers, hereby declare that I never claimed nor will ever claim in the future that *PECS* does sound like or even close to the original *PE-2000*. *PECS* does not sound like the original *PE-2000* – it cannot because it is a digital plug-in and thus not blessed with the fairy dust of good old analog hardware. And everybody knows that it is a well-known fact that digital machines do not sound warmish-analog but coldish-harsh.

Having said that I hope that the inevitable shit storm might possibly get canceled.

The KORG *PE-2000*

To be honest, there does not exist a lot of information about the *PE-2000* on the interweb – I even was not able to find an owner's manual. But at least there is a service manual available (in fact a brief collection of schematics) plus a few mixed-quality videos and info pages.

The *PE-2000 Poly-Ensemble S* falls into the category of classic string machines and was released in 1976 along with its brother, the *PE-1000* (which is more focused on percussive sounds). The big difference to its competitor stringers from Eminent, ELKA, Logan etc. is that it does not use a BBD[1]-based delay unit to produce the essential *Ensemble* effect but implements three independent oscillator banks, each one equipped with its own tuning control and Vibrato generator. These oscillators are based on the common "Top Octave Synthesizer" (TOS) and "Octave Divider" schema which was the fundamental design pattern of almost all electronic organs (and string machines) of that era. Of course this offered full polyphony, but critics claimed this to be the reason for those instruments to sound cold and harsh…

Besides that there are not many controls on the *PE-2000*: *Master Tune*, *Tuning* of oscillator banks A and B, *Attack* and *Sustain* (i.e. release time), an equalizer section

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1 BBD: *Bucket Brigade Device*; an analog delay line.

with *Treble* and *Bass*, and a *Rate* knob including on/off switch for the built-in six-stage Phaser effect. It offers eight presets which can be combined by pressing the respective switches simultaneously: "Reed" and "Wind" ("Pipe Organ 1+2" on later models), "Chorus 1+2" ("Choir" should be more appropriate), "Brass 1+2", "Strings 1+2". Do they sound like their names suggest? Of course not. ☺

It is fair to say that the *PE-2000* is the direct predecessor of the better-known KORG *Lambda ES-50*, and while it is not that prominent it plays an important role in Jean-Michel Jarre's masterpiece *Equinoxe* (especially parts V + VIII).

Creating The *Poly-Ensemble Construction Set* (PECS)

I often wonder why people believe me to be able to recreate such a classic instrument and ask me to do so – see *Legal Statement* above. But they do, and me looking at interesting schematics from the past can hardly resist.

However, in case of *PECS* I took some more liberties than I did with my other plug-ins. For example I did not exactly recreate the half-paraphonic VCA envelope (except for the "Sustain" part) but extended it to a fully polyphonic ADSR, and I added a simple VCF *per voice* instead of the shabby pseudo VCF of the *PE-2000*. While (in my opinion) this does not destroy its sonic character compared to the original device, it does offer more flexibility to a rather inflexible instrument. Other extensions are:

- Almost all internal components and their parameters are modifiable.
- Signal pathways are stereo; oscillator banks can be stereo-panned.
- Oscillator banks can be transposed in half-tone steps.
- Oscillator banks offer seamless mixtures of sawtooth and square waves.
- Note-on velocity can control VCF and VCA envelope intensities.
- Stereo "Pan" mode for Phaser.
- Additional Modulator section for VCF and formant filters.
- Extended keyboard range (88 keys instead of 44).

I designed all of these additions in a reasonable way: With only a few resistors less the *PE-2000* oscillator banks would have produced square waves instead of sawtooth waves (thanks to the engineers they do not!); with different capacitor values the "Chorus" preset might have sounded duller or sharper; with doubled hardware the *PE-2000* could have been a real stereo machine, etc. etc.

However I respected many of the original features (or constraints): The oscillator banks strictly simulate the behavior of classic Octave Divider circuits (the wave of a given key is strictly in sync with wave of the same key one octave below), the Pre-Filters 1 and 2 are set up exactly as in the *PE-2000* and so forth.

Funny enough it turned out that recreating the original 8 presets of the *PE-2000* was pretty tough. According to my SPICE[2] simulations of the schematics everything should have been crystal-clear, but the result partly deviated from the sound examples I heard on YouTube or elsewhere. Thus I had to tweak the auto-generated presets a little bit. If you feel that these presets are a bit off – go to the Tweak Mode and do your own thing!

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2 SPICE is a general-purpose, open-source analog electronic circuit simulator.

The *PECS* "N" Version

Many users with older operating systems (Windows 7, macOS 10.10 or below) and/or incompatible graphic cards/drivers may have problems with the resizable user interface of version 1.0. Thus, I decided to provide a non-resizable version of the *PECS* based on the old iPlug framework – this is called the "N" version. It should work on almost all machines.

Acknowledgments

Big thanks to:

- **kraftraum** (https://soundcloud.com/kraftraum) who has again designed the factory patches 36 to 62 and once again was THE Beta tester!
- **Oli Larkin** and the iPlug/iPlug2 team.
- **Laurent Bergman** for translating the *Full Bucket* manuals to French.

And at this point I would also like to say **Thank you!** to all the people who share their information about the *PE-2000* via the Internet. Last not least another THANK YOU! to the KORG engineers.

No, I am not affiliated with KORG in what relation ever except that I always find myself entangled with their instruments. ☺

Overview

PECS is a 64 voice polyphonic string machine consisting of three oscillator banks with individual Vibrato LFOs, a VCF and VCA plus envelope generators (EG) per voice, two formant filters (Pre-Filters 1 + 2), two static filters, a six-stage Phaser effect, and a Modulator section. The fully stereo audio signal flow is show in the following diagram.

Oscillator Bank A — Oscillator Bank B — Oscillator Bank C — 64 Voices (VCF, VCA) — Pre-Filter 1 — Pre-Filter 2 — VCF — RAW — Voice Mixer — O+S Filter — Chorus Filter — Direct — Master Mixer — Phaser
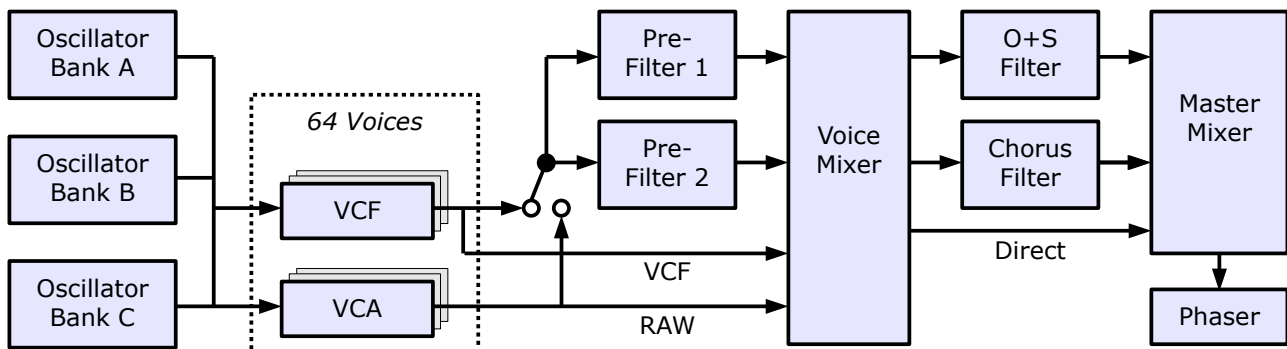
Note that the four separate fixed one-pole lowpass filters of the *PE-2000* for the four "Organ" and "Strings" presets are combined in the O+S Filter of the *PECS*.

Mouse Clicking Convention

Some functions of the *PECS* are triggered or activated by clicking at various buttons or labels in the user interface (UI). Since older Macs mouses may have only one button, *PECS* uses the following convention:

- **"Left Clicking"**
  Denotes that the left (or single) mouse button is clicked.

- **"Right Clicking"**
  Denotes that the right mouse button is clicked or that the CTRL, ALT, or COMMAND key is held while (left) clicking.

Note that this convention applies for the whole manual.

MIDI Learn And The Config File "pecs.ini"

Every parameter of the *PECS* can be controlled by one MIDI controller. If you want to change the assignment of MIDI controller (CC; *MIDI Control Change*) to a *PECS* parameter the *MIDI Learn* function comes in quite handy: Just click the *LEARN* button on the Sound Manager panel and wiggle both the MIDI controller and the parameter you want to assign (you can abort *MIDI Learn* by clicking the button again). If you want to unlearn the assignment, right-click the *LEARN* button (the label now reads "UNLEARN") and activate it. Now wiggle the MIDI controller or the parameter that you want to unlearn. To save the controller assignments use "Save Configuration" in the *Options Menu* (see below); they are stored in the `pecs.ini` configuration file. The exact location of this file depends on your operating system and will be displayed when you click on "Reload" or "Save Configuration".

Options Menu

When clicking on the *OPTIONS* button a menu opens with the following options:

Command	Description
Copy Program	Copy current program to internal clipboard
Paste Program	Paste internal clipboard to current program
Init Program	Initialize the current program
Load Program	Load *PECS's* current program from a FXP file
Save Program	Save *PECS's* current program to a FXP file
Load Bank	Load 64 patches from a FXB file into *PECS*
Save Bank	Save *PECS's* 64 patches to a FXB bank file
Select Startup Bank	Select the bank file that should always be loaded when *PECS* is started
Load Startup Bank	Load the Startup bank file; can also be used to check what the current Startup bank is
Unselect Startup Bank	Unselect the current Startup bank
Start In Edit Mode	Set globally if *PECS* should by default start in *Edit Mode*
Default Path for Program Files	Sets the default path for program and bank files
MIDI Thru	Set globally if MIDI data sent to *PECS* should be sent through to its MIDI output
Ignore Program Change	Set globally if MIDI Program Change data sent to *PECS* should be ignored
Reload Configuration	Reload *PECS's* configuration file
Save Configuration	Save *PECS's* configuration file
Window Size...	Change the window size of *PECS*
Save Window Size	Stores the current window size to the configuration file so that it will be restored on the next loading of *PECS*
Check Online for Update	When connected to the Internet, this function will check if a newer version of *PECS* is available at fullbucket.de
Visit fullbucket.de	Open fullbucket.de in your standard browser

Standard Mode

In Standard Mode, *PECS* simulates the basic functionality of the *PE-2000* and displays only a limited control set (Standard Mode is activated when the "EDIT" button is not not activated; also see section *Edit Mode*).

Preset Buttons

Using the preset buttons you can select the eight original presets of the *PE-2000* ("Pipe Organ 1+2", "Chorus 1+2", "Brass 1+2", "Strings 1+2") or the special *PECS*-only "Tweak Mode" preset which offers a much wider sound variety (see section *Edit Mode*). The eight original presets can be combined by right-clicking the respective buttons – the "Tweak Mode" cannot, but this is no real restriction as you will see later.

Tuning

The "PITCH" knob controls the overall master tune while "TUNING A" and "TUNING B" can be used to (de-)tune the oscillator banks A and B relatively to the third oscillator bank C. The range is limited by ± 50 cents.

A pretty confusing concept is the "Pull Calibration"[3] feature. On the original *PE-2000* it is possible to pull the "TUNING" knobs out: The idea is to "calibrate" the respective oscillator bank i.e. to set it into tune with bank C. However, this only has an effect for the "Pipe Organ" presets where oscillator bank A is tuned one octave higher and oscillator bank B one octave lower than bank C. To facilitate the tuning process, pulling out the "TUNING A" knob *turns off bank B* (!) and *sets bank A* to *the same octave* as bank C. Likewise pulling out "TUNING B" knob turns off bank A and sets bank B to the same octave as bank C.

The KORG engineers obviously understood that it is more difficult to tune oscillators when they are separated by one octave. And since selecting a "Chorus", "Brass" or "Strings" preset already sets the three oscillator banks to the same octave, they simply turned the "Pull Calibration" feature off for those. But musicians are using every feature for their creative benefit (especially when an instrument does not offer that much features)...

PECS simulates pulling the "TUNING" knobs with two flip switches right above the respective knobs.

Envelope

Standard Mode offers a simple AR volume envelope and thus provides an "ATTACK" and a "SUSTAIN" control. Note that here the name "Sustain" follows the convention

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3 On early models of the *PE-2000* this was erroneously named "Pull Caliblation".

used for electronic organs and corresponds to the envelope's release time. Since the release phase of the *PE-2000* envelope is paraphonic, it will be cutoff when you have released all keys and press one or more new keys. This behavior can be overcome in *Edit Mode*.

Equalizer

Not much to say about it; a lowpass and a highpass shelving filter which easily can lead to clipping. ☺

Phaser

PECS features a six-stage Phaser effect with controllable modulation rate. Of course the effect can be switched off.

Vintage Vibe

Wanna get some extra cool vintage vibes? Flip this flippy flip switch and experience the pleasures of old analog hardware! Full Bucket Music engineers spent hours to recreate THAT retro feeling using the new innovative ground-breaking CRACKLE© technology[4]. Yummy!

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4 Constantly Recurring Analog Circuit marKeting bulLshitE.

Edit Mode

The real fun comes when you click the "EDIT" button and switch to Edit Mode which offers full access to the "hidden" parameters of *PECS*.

Preset Buttons

As in Standard Mode you can select the eight original presets of the *PE-2000* or the special *PECS*-only "Tweak Mode" preset using the respective buttons. However, when one of the *PE-2000* presets is selected, all parameters that are not available in Standard Mode are disabled. To enable them you have to select the "Tweak Mode" preset. When you right-click on the "Tweak Mode" button you can decide whether you like to copy the parameter settings of the current *PE-2000* preset to the "Tweak Mode" preset or not. This way you can easily create you own variation of a *PE-2000* preset.

Master Section

The master section contains the controls for master tune, the equalizer (see section *Equalizer*), and the master volume. Furthermore it adds two knobs for settings the amount of Velocity modulating the intensity of the VCF and VCA EGs (the *PE-2000* was not velocity-sensitive but to avoid another shit storm I better added it to the *PECS*).

Oscillator Banks

Each oscillator bank features seven controls:

- "PITCH" transposes the bank about ±12 notes.
- "TUNING" (de-)tunes the bank about ±50 cents.
- "WAVE" sets the mixture between the sawtooth and square waveform output of the oscillator bank (the *PE-2000* only features sawtooth waves).

- "LEVEL" sets the output level of the bank's output signal.
- "PAN" controls the stereo placement of the bank's output signal.
- "RATE" and "DEPTH" control the rate and depth of the Vibrato effect.

Note that it *would have been possible* to implement these extensions in the *PE-2000*, too – of course with some more hardware components and thus costs.

Voltage Controlled Amplifier (VCA)

Edit Mode gives you some more control over the VCA envelope (VCA EG): In addition to the attack time you can set the decay and release times and the sustain level, too.

Here, the Standard Mode's "SUSTAIN" control is labeled "PE-2000 SUSTAIN" and behaves as follows: As long as its value is *higher* than "RELEASE" it sets the paraphonic "Sustain" time. Once it is *lower* than "RELEASE" it has no effect.

Note that "RELEASE" always controls the release time of the individual notes even when at least one other key is still pressed. Conclusion: "RELEASE" works polyphonically, "PE-2000 SUSTAIN" works paraphonically. So if you want to get rid of paraphony, turn the "PE-2000 SUSTAIN" to zero.

Voltage Controlled Filter (VCF)

This is an addition to the original unit I take full responsibility for. Come on, without it the *PECS* would only be 50% the fun. Sure enough it is not *voltage-controlled*, but hey...

The VCF is a two-pole filter modeled after the classic KORG K35 chip as it was built into the *PS-3X00* series (i.e. without the option of self-oscillation) and comes with its own ADSR envelope generator (EG). Note that there's one VCF *per voice* so the whole setup is in fact polyphonic. Controls are pretty standard: Type (lowpass or highpass) Cutoff frequency, Peak (resonance), keyboard tracking, and EG intensity.

Pre-Filters

To recreate an intended sound like "Strings", "Brass", "Piano" or the like[5], almost all "ensemble" instruments of the *PE-2000* era (string ensembles as well as electronic organs and pianos) use filter banks for generating (better: extracting) the required formants. Therefore the *PE-2000* (and thus *PECS*) features two different banks called "Pre-Filters".

The first one (Pre-Filter 1) is used for the Chorus presets and consists of six two-pole bandpass filters – their individual inputs are derived from different keyboard ranges. While the Q factor (corresponding to the bandwidth or *Quality*) of these filters can be set from 0.2 to 10, the center frequencies can be shifted by a factor ranging from 0.25 to 4.

The second filter bank (Pre-Filter 2) is used for the non-Chorus presets and consists of six one-pole lowpass filters. The architecture is identical to Pre-Filter 1 but here only the center frequencies can be shifted.

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5 Modern samplers achieve this by using multi-samples, but here we have no samples at all – just a plain sawtooth wave.

Voice Mixer

In sum there are four signals that are derived from the 64 voices and are mixed in the Voice Mixer: The VCF signal, the two Pre-Filter signals, and the raw unfiltered signal coming from the oscillator banks. Using the filter arrangement switch one can decide whether the Pre-Filter signals are derived directly from the oscillator banks ("PARALLEL") or from the VCF signal ("SERIAL"; also see the diagram in the *Overview* section).

Static Filters And Master Mixer

The output of the Voice Mixer is sent to another pair of parallel static filters: The O+S Filter ("Organ and Strings" Filter), a simple one-pole lowpass, and the Chorus Filter, a two-pole bandpass. Their outputs along with the unfiltered Direct signal are added using the Master Mixer. The frequencies of both filters and the Q factor of the Chorus Filter can be modified, too.

Phaser

The Phaser section was already described in the previous Standard Mode section, see *Phaser*. However, in Edit Mode you have access to another switch that controls how the LFO modulates the two stereo channels of the Phaser: "NORM" (both channels the same way) or "PAN" (right channel inverted to left channel). This is a *PECS*-exclusive feature.

Modulator

And this is another *PECS*-exclusive feature: You can chose a modulator signal either from a triangle-wave LFO or from the Modulation Wheel MIDI control to modulate one of five targets: The VCF, Pre-Filter 1, Pre-Filter 2, O+S Filter, or Chorus Filter cutoff/ frequencies. Not that much, I know, but enough to add some (real) extra vibe.

Parameters

Master Section

parameter	ID	description
Button State	0	State of the 8+1 preset buttons
Master Volume	1	Master volume
Master Tune	2	Master tune
Bass	7	Gain of low-shelving EQ
Treble	8	Gain of high-shelving EQ
Velocity to VCF EG	11	Velocity to VCF EG intensity modulation
Velocity to VCA EG	12	Velocity to VCA EG intensity modulation

Oscillator Banks

parameter	ID	description
Bank A Transpose	16	Pitch/transpose of bank A
Bank A Tuning	3	Tuning of bank A
Bank A Wave Mix	13	Sawtooth/rectangle mix of bank A
Bank A Level	14	Volume level of bank A
Bank A Pan	15	Stereo panorama of bank A
Vibrato A Rate	17	Vibrato rate of bank A
Vibrato A Depth	18	Vibrato depth of bank A
Bank B Transpose	22	Pitch/transpose of bank B
Bank B Tuning	4	Tuning of bank B
Bank B Wave Mix	19	Sawtooth/rectangle mix of bank B
Bank B Level	20	Volume level of bank B
Bank B Pan	21	Stereo panorama of bank B
Vibrato B Rate	23	Vibrato rate of bank B
Vibrato B Depth	24	Vibrato depth of bank B
Bank C Transpose	28	Pitch/transpose of bank C
Bank C Tuning	29	Tuning of bank C
Bank C Wave Mix	25	Sawtooth/rectangle mix of bank C
Bank C Level	26	Volume level of bank C
Bank C Pan	27	Stereo panorama of bank C
Vibrato C Rate	30	Vibrato rate of bank C
Vibrato C Depth	31	Vibrato depth of bank C

VCF and VCF EG

parameter	ID	description
Type	46	Filter type (lowpass or highpass)
Cutoff	47	Cutoff frequency
Peak	48	Peak (resonance)
Key Track	49	Keyboard tracking
EG Intensity	50	VCF EG intensity
Attack	51	Attack time of VCF EG
Decay	52	Decay time of VCF EG
Sustain	53	Sustain level of VCF EG
Release	54	Release time of VCF EG

Pre-Filters and Voice Mixer

parameter	ID	description
Filter Arrangement	32	Arrangement of VCF/Pre-Filters ("PARALLEL" or "SERIAL")
Pre-Filter 1 Shift	40	Pre-Filter 1 frequency shift
Pre-Filter 1 Q	41	Pre-Filter 1 Q factor (bandwidth)
Pre-Filter 2 Shift	42	Pre-Filter 1 frequency shift
VCF Level	35	Volume level of VCF
Pre-Filter 1 Level	33	Volume level of Pre-Filter 1
Pre-Filter 2 Level	34	Volume level of Pre-Filter 2
Raw Level	36	Volume level of unfiltered signal

Static Filters and Master Mixer

parameter	ID	description
O+S Filter Frequency	43	Frequency of O+S Filter
Chorus Filter Frequency	44	Frequency of Chorus Filter
Chorus Filter Q	45	Chorus Filter Q factor (bandwidth)
O+S Filter Level	37	Volume level of O+S Filter
Chorus Filter 1 Level	38	Volume level of Chorus Filter
Direct Level	39	Volume level of unfiltered signal

VCA EG

parameter	ID	description
Attack	5	Attack time of VCA EG
Decay	55	Decay time of VCA EG
Sustain	56	Sustain level of VCA EG
Release	57	Release time of VCA EG
PE-2000 Sustain	6	Paraphonic "Sustain" time

Phaser

parameter	ID	description
Phaser Mode	9	Phaser mode ("NORM" or "PAN")
Phaser Rate	10	Rate of Phaser modulation (0 = off)

Modulator

parameter	ID	description
Modulator Destination	58	Destination of Modulator (VCF, Pre-Filter 1, Pre-Filter 2, O+S Filter, Chorus Filter)
Modulator Source	59	Source of Modulator (LFO or Mod. Wheel)
Modulator Rate	60	Rate of Modulator LFO
Modulator Depth	61	Depth of Modulator

Frequently Asked Questions

How do I install the PECS (Windows VST2 32 bit version)?

Just copy the files `pecs.dll` from the ZIP archive you have downloaded to your system's or favorite DAW's VST2 plug-in folder. Your DAW should automatically register the *PECS* VST2 plug-in the next time you start it.

How do I install the PECS (Windows VST2 64 bit version)?

Just copy the file `pecs64.dll` from the ZIP archive you have downloaded to your system's or favorite DAW's VST2 plug-in folder. Your DAW should automatically register the *PECS* VST2 plug-in the next time you start it.

Note: You may have to remove any existing (32 bit) `pecs.dll` from your VST2 plug-in folder or else your DAW may screw the versions up...

How do I install the PECS (Windows VST3 64 bit version)?

Just copy the files `pecs.vst3` from the ZIP archive you have downloaded to your system's or favorite DAW's VST3 plug-in folder. Your DAW should automatically register the *PECS* VST3 plug-in the next time you start it.

How do I install the PECS (Mac VST2/VST3/AU 64 bit)?

Locate the downloaded PKG package file `pecs_1_0_0_mac.pkg` in Finder (!) and do a right- or control-click on it. In the context menu, click on "Open". You will be asked if you really want to install the package because it comes from an "unidentified developer" (me ☺). Click "OK" and follow the installation instructions.

What is the "N" version of the PECS?

The "N" version is the non-resizable version of the *PECS* that should run on almost any older Windows or Mac machine. So if you have problems with the standard *PECS* version, this is the one to go for.

What is the plug-in ID of the PECS?

The ID is **p e c s** .

How do I know if a new version of the PECS is available?

When connected to the Internet, open the File menu (see section *Fehler: Verweis nicht gefunden*) by clicking the disk icon and select the entry "Check Online for Updates". If a new version of the *PECS* is available on fullbucket.de the respective information will be shown in a message box.

How do I resize the PECS window?

Just grab the yellow triangle at the bottom right of the *PECS* window and drag it. You can save the current window size using the menu entry "Save Window Size" in the *Fehler: Verweis nicht gefunden*.