



# Manual

## Audioplayer

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# 1. Introduction

## 1.1. Motivation

This application allows demodulation and audio playback of signal recordings. Multiple parallel tracks are supported. Each track represents a single recording. For long signal recordings the time range is divided into pages.

The main purpose is to generate a comprehensible audio signal and to allow easy navigation within the demodulated data. Signal or modulation analysis are outside of primary use-cases of this application.

In most cases, the parameters for demodulation are preset by an external systems. Within the application only minor tweaks to improve the audio quality should be required.

## 1.2. Overview

The main window is shown in Figure 1. It shows a toolbar at the top with application-wide controls for audio playback and navigation, and an overview display. Below that, audio tracks are displayed row by row, with each row consisting of an RF spectrum plot with level meter and an envelope plot. The frequency or time axis respectively is displayed at the very bottom of the main window.

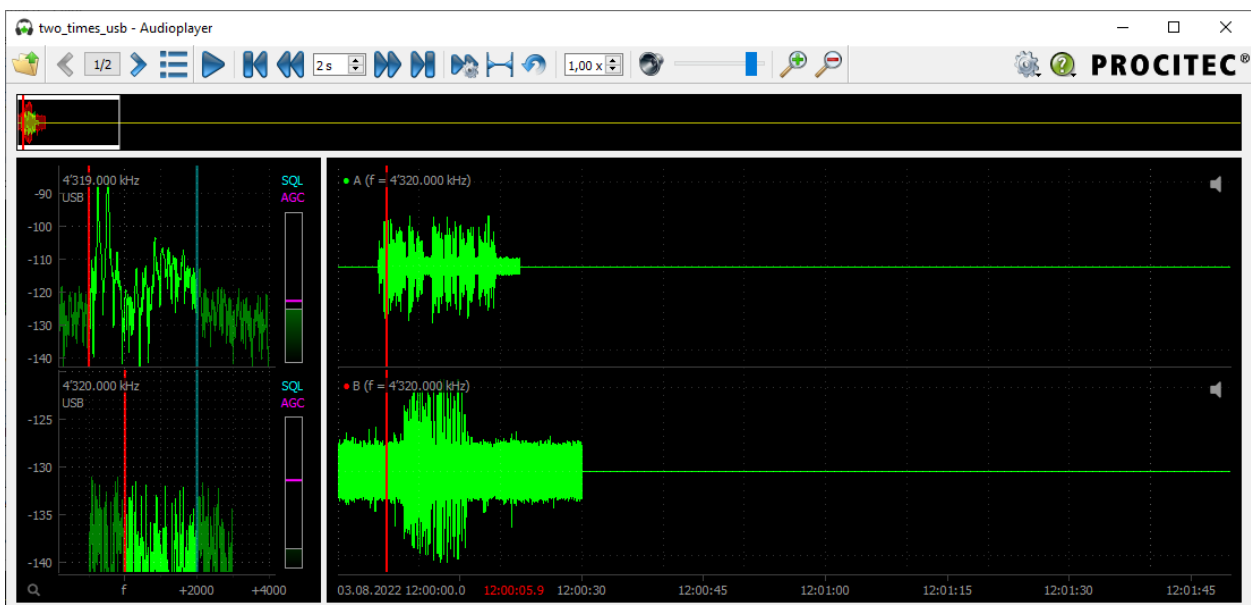


Figure 1: Main window of the audio player with two tracks

## 2. Audioplayer

This chapter discusses the control and display elements for audio playback and navigation within the recordings. The RF spectrum plots and audio demodulation setting are covered in chapter 3.

### 2.1. Toolbar

The toolbar can be seen at the top of the application's main window. The included controls from left to right are:

- open: file selection dialog for signal file (.wav) and configuration files (.zap).
- page navigation and position, see section 2.5
- playback controls, playback interval, repeat, and playback speed, see section 2.4
- zoom level for timeline
- settings, see sections 3.2 and 3.6
- help, keyboard shortcuts, see appendix A

### 2.2. Envelope Display

The envelope and time-amplitude displays show the amplitude of the demodulated signals over time. These are generated when loading the signals. Changes to the settings of a demodulator triggers an update.

There is a single time axis used by all tracks. Time offsets between tracks as well as signal gaps within a track are represented by a zero signal. The absolute signal time is displayed in the time axis at the very bottom of the application window. A complete time stamp including date and time is always shown at the left-hand side of the axis. It corresponds to the signal time at the left edge of the envelope display. The following axis labels may be shown as partial timestamps, depending on the zoom level.

Navigation within the envelope displays is done using the mouse. Scrolling with the mouse wheel shifts the time range. When the Ctrl key is pressed the wheel changes the zoom level.

At the top left of the display, the track id and reference frequency are indicated. This serves as reference for the zero point of the spectra described in section 3.1.

In the upper right corner, a speaker icon is displayed, which is used to control the audio output for this track. A left-click opens a menu with controls for muting, output channel selection and volume. In addition, the mute function can be activated or deactivated directly by right-clicking on the speaker icon.

## 2.3. Overview Display

The overview display serves as a graphical scroll bar for the envelope displays. The amplitudes of the demodulated signals are displayed for all tracks together. Each track is assigned a color, which can be seen as the color of the track id in the upper right corner of the envelope display.

The currently visible time section in the envelope displays is indicated with a white frame which can be moved with the mouse by dragging and the mouse wheel. A single click on the display moves the visible area by its width.

Furthermore, if defined and active, the playback interval is illustrated, see section 2.7.

## 2.4. Audio Playback

Audio playback is controlled using the controls in the toolbar. This includes starting and pausing playback, jumping to the beginning and end, and jumping with adjustable jump distance. For all elements the use of the keyboard is alternatively possible, see appendix A.

The playback position is shown by a red marker, i.e. a red vertical line, in the envelope displays of the individual tracks. By double-clicking, it is moved to the desired position. Moving by dragging is only available when playback is paused. The timeline at the bottom shows the absolute timestamp of the playback position in red. In addition, the playback position is also shown in the overview display.

The operating system's default sound output is used. If this changes during operation, an automatic change takes place.

The volume of the playback can be adjusted per track and additionally globally in the toolbar. Also in the toolbar the playback speed can be adjusting from 0.25 to 4.00 in steps of 0.25.

## 2.5. Page and Track Selection

Configurations with a long time span and/or many parallel tracks are handled by selecting a subset of the available data: Long signal recordings are divided into several pages. Only one page is loaded and displayed at a time. If there are many tracks, only a part of them is loaded and displayed at the same time. All in all, this results in a fast and better overview as well as navigation in larger time intervals. In particular, a fixed time reference is always given in the overview display.

The division into pages is based on the period spanned by all signal recordings on all tracks. The division is done according to a fixed grid, where the page duration is longer than the grid duration, resulting in an overlap of the pages.

The current page determines the time interval for audio demodulation and displays. When the audio reaches the end of one page, it switches to the next page. The overlapping period is skipped automatically and the playback position is therefore not at the beginning of the next page, so that it is still possible to rewind quickly.

The toolbar of the main window contains controls for fast switching to the previous as well as the next page. The button in between shows the index of the current page as well as the total number of pages. Clicking on it opens or closes a dialog for the page and track overview.

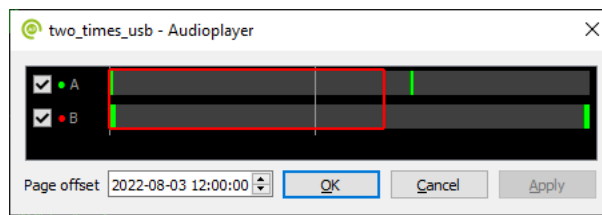


Figure 2: Page and Track Overview

The page and track overview dialog can remain permanently open and is used for page navigation and to show/hide individual tracks. An example configuration with two tracks and two pages is shown in Figure 2.

To the left of the track labels (here A and B) is a control box that determines the visibility of the tracks in the main window, as well as the color assigned to them. The number of simultaneously displayed tracks is limited. If no more tracks can be displayed, their control boxes are deactivated until another track is hidden. Changes to the selection must be confirmed with the buttons <OK> or <Apply> before they are applied in the main window.

To the right of the track labels is the page overview: This is a schematic representation over the entire time range. Vertical lines mark the beginnings of the pages. All pages have an identical time duration, which means that the last page may have more overlap to the one before last. Time intervals for which a track contains a signal recording are highlighted in green in the page overview. The page currently loaded in the main window is shown with a red frame. Selection another page by clicking into the corresponding area is denoted with white frame. After confirmation with one of the buttons at the bottom right, this page will be loaded in the main window. Alternatively, a new page can be selected by double-clicking on it and it will be loaded immediately.

The time stamp shown at the bottom left of the dialog corresponds to the beginning of the selected page. If a different time is entered here, the corresponding page is selected, if possible.

## 2.6. Fast Navigation

Keyboard shortcuts (appendix A) can be used to quickly navigate forward and backward between the individual segments - across pauses. In the simplest case to the next or previous signal file.

With automatic level adjustment enabled (see AGC in section 3.5) and squelch enabled (see squelch in section 3.6), a fine-grained jump target selection is used. Audio segments between the muted (squelched) passages are skipped.

In the case of jumps, the "Fast forward" (see settings menu Figure 6) is taken into account. If the navigation reaches a page boundary, the page is switched automatically. Jumps directly after page switches are delayed until the envelope has been calculated.

Automatic: In addition to manual forward navigation, automatic jumps can be activated in the toolbar. This triggers a jump whenever a pause exceeds the lead-out time (see Figure 6).

## 2.7. Playback Interval and Repetition

When the playback position reaches the end of a page, it switches to the next page. When the end of the signal is reached, playback stops. If the loop-mode is activated in the toolbar, the program automatically jumps to the beginning of the page and continues playback from there.

To further limit the playback position, a playback interval can be defined. This mode is activated via the corresponding element in the toolbar. Start and end of the playback interval are shown by blue markers in



the envelope displays. These can be moved with the mouse. To select a new playback interval, hold down the Ctrl key and select the desired section by pressing and dragging with the mouse.

In the overview display, time sections outside the playback interval are darkened. In addition, the beginning and end of the playback interval are highlighted by white triangles.

The playback position is limited to the active playback interval. Audio playback ends automatically when the end of the interval is reached. In loop-mode the playback position jumps to the beginning of the interval. Double-clicking outside the interval moves the playback position to the beginning of the interval.

### 3. Demodulation

This chapter describes the signal processing for demodulation and the associated settings. Note, each track has its own independent demodulation.

The most important demodulation parameters can be set interactively in the spectrum and level displays. A complete list as well as an overview of the exact parameter values can be found in the context menu of the spectrum display, see Figure 3. This menu is also called demodulator menu in the following.

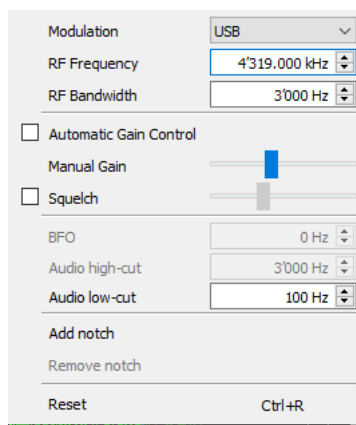


Figure 3: Demodulator Menu

#### 3.1. Spectrum and Level Displays

The spectrum shows the power distribution over frequency before any filters are applied. A common frequency axis is used for all tracks and therefore relative to the track reference frequency. The zero point of the axis is marked "f" and corresponds to the value shown in the corresponding envelope plot in the upper left corner.

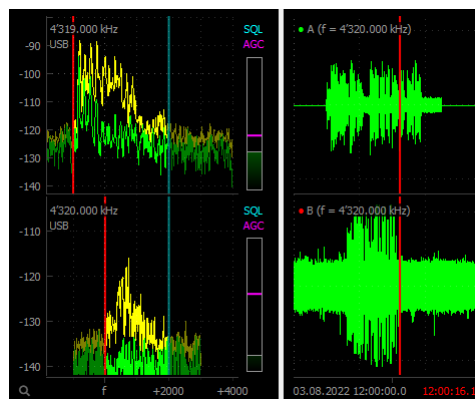


Figure 4: Spectrum and Level Displays (left)

Figure 4 shows the spectra of two tracks as an example.

An additional yellow graph shows the last maximum values reached over the frequency (peak hold). Historical maximum values slowly drop down to the current green values.

On the right-hand side spectrum display, the current signal level is shown. The level represents the signal power after applying the filter to select the demodulation frequency interval as well as the notch filters.

The button above the level display, as well as the markers within it, are discussed in the sections on squelch and automatic level adjustment.

A magnifying glass icon is shown in lower right corner of the application window. On click the zoom along the frequency axis is reset. A right-click a menu opens with additional options for zooming.

## 3.2. Demodulation, Nominal Frequency and Bandwidth

The application supports the following modulation types:

- Single Sideband Modulation in the upper band (upper side band – USB)
- Single Sideband Modulation in the Lower Side Band (LSB)
- Amplitude Modulation (envelope demodulation, AM)
- Frequency Modulation (FM) - no FM broadcasting or stereo
- Morse (continuous wave – CW)
- Digital Modulation for other modulations (DIG)

The signal to be demodulated is defined with the parameters nominal frequency and bandwidth. Depending on the modulation, this defines a certain frequency interval in the spectrum, which is isolated by a bandpass filter and then demodulated. For USB and LSB, the nominal frequency specifies the lower and upper limit frequency, respectively. Otherwise the nominal frequency is the center of the frequency band specified by the bandwidth.

The selected frequency interval and the nominal frequency are shown by markers as vertical lines in the colors red and blue, respectively, in the spectrum. These markers are interactive, i.e. they can be moved with the mouse. Additionally, nominal frequency and bandwidth as well as the modulation itself can be set in the demodulator menu. The nominal frequency and the modulation are also displayed in the upper left corner of the respective spectrum, see Figure 4. A left-click on these labels allows changing their values.

The beat frequency offset (beat frequency oscillator – BFO) setting can be made in the demodulator menu. The BFO setting is only available for Morse.

For the Digital modulation mode, the frequency interval for demodulation is set with the center frequency and bandwidth, similar to Morse. The bandwidth is flexible and easily adaptable to the signal. Therefore the effective BFO is automatically preset based on min. audio frequency and preferred BFO in the settings menu for all tracks together, see Figure 6. If the specified band to be demodulated for the preferred BFO would fall below the min. audio frequency, the BFO is increased accordingly.

### 3.3. Notch Filters (Band Stop Filter/Notch)

Multiple notch filters can be defined to suppress unwanted signal components. Center frequency and rejection bandwidth can be freely selected. The notch filters are applied directly to the signal input.

A new filter can be added from the demodulator menu. For display the stop-band of the filter is shown as a rectangular marker in purple directly in the spectrum, see Figure 5.

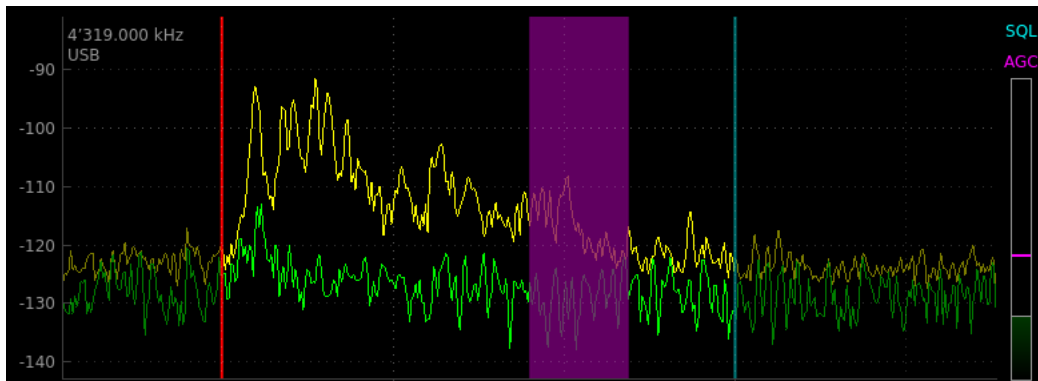


Figure 5: Notch Filter in Spectrum

This marker can be positioned by dragging its center with the mouse. The rejection bandwidth is adjusted by dragging the edges of the marker.

This way multiple filters can be created and adjusted. To remove a filter use the Remove Notch from its context menu.

### 3.4. High and low pass filters in the audio range

These two filters can be used to suppress disturbing artifacts in the audio signal. They are applied after demodulation and before noise reduction.

The high-pass filter removes low-frequency signal components up to the set cutoff frequency. Analogous, the low-pass filter serves to attenuate high-frequency signal components. Note, depending on the modulation the selected bandwidth also acts like a low-pass filter.

With some modulations (AM, LSB, USB, CW), the low-pass filter is set automatically via the bandwidth.

### 3.5. Automatic Level Adjustment (AGC)

The automatic gain control (AGC) adjusts the audio signal to a well audible target level. AGC can be switched on/off either via the button above the level display (see Figure 4) or in the demodulator menu. If the AGC is inactive, the gain can be adjusted manually (manual gain control – MGC). This is done via a marker that then appears in the level display or via a slider in the demodulator menu.

### 3.6. Squelch – SQL

With AGC activated, even weak/quiet passages are amplified, resulting unpleasantly loud noise-only sound output. In addition, in the envelope and overview displays, speech and noise-only signal parts can no longer be distinguished easily.

With squelch enabled, signal parts with a low signal level, usually only containing noise, are muted.

As an alternative to muting, the maximum gain of the AGC can be limited (soft squelch). Parts with low signal levels result in audible, but not over-amplified, output. The desired audio volume - instead of muting - can be adjusted via the squelch volume setting in the toolbar (Figure 6). With a still perceivable squelch volume, voice sections with a low signal level can still be heard, in case the squelch level was set too coarse. Depending on the frequency band, the noise level can change over time, so manual adjustment of the squelch level is useful.

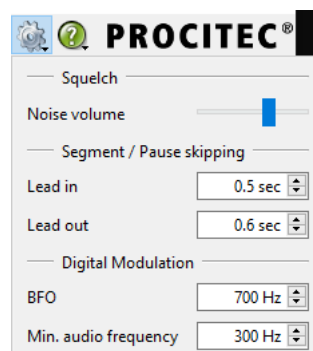


Figure 6: Settings Menu with Squelch

The squelch mode is abbreviated with SQL and can be switched on/off in the demodulator menu as well as directly by clicking SQL above the level meter.

For the squelch mode, a RF threshold must be set, below which the signal is set to zero or reduced in volume. To set a value left-click the desired level in the level display. On right-click the current level is used as threshold instead. Alternatively, the corresponding slider in the demodulator menu can be used.

Note, that the squelch mode also affects the envelope display as well as the envelope overview. In signal sections that are below the set threshold, only the zero line is visible.

The soft-squelch is available for all modulation types except FM. With FM, only hard-squelch can be used, which completely mutes the signal.

Another property of FM is that in absence of a carrier the audio signal can become quite loud. Therefore, with FM, even if squelch is deactivated, an internal level-independent squelch function is always applied, which mutes the audio signal if necessary.

## A. Shortcuts

The following tables list the default keyboard shortcuts for the application. These can be overwritten system-wide. The currently valid settings can be displayed via the <Shortcuts> button in the Help menu. This opens a HTML document that can be easily printed if necessary. In addition, the keyboard shortcuts are visible in the tooltips of the respective elements in the main window of the application.

Allgemein	Tastaturkürzel
Beenden	Strg + Q
Vorherige Seite	Bild aufwärts
Nächste Seite	Bild abwärts
Setze alle Spektren auf den Standard Frequenzbereich	F7
Setze alle Spektren auf den vollen Frequenzbereich	F8
Alle Y-Achsen autom. einstellen	F9
Alle aktiven Tracks anhören	0
Nur Track 1 anhören	1
Fokus auf Track 1	Strg + 1
Nur Track 2 anhören	2
Fokus auf Track 2	Strg + 2
Nur Track 3 anhören	3
Fokus auf Track 3	Strg + 3
Nur Track 4 anhören	4
Fokus auf Track 4	Strg + 4
Nächstes Segment	Strg + Rechts
Vorheriges Segment	Strg + Links
Öffnen	Strg + O
Wiedergabe/Pause	Leertaste
Squelch-Restlautstärke erhöhen	Strg + Umschalt + Hoch
Squelch-Restlautstärke verringern	Strg + Umschalt + Herunter
Zum Anfang springen	Pos1
Zum Ende springen	Ende
Zurück springen	Links
Vorwärts springen	Rechts

Allgemein	Tastaturkürzel
Zurückspulen um die zehnfache Sprungweite	Umschalt + Links
Vorspulen um die zehnfache Sprungweite	Umschalt + Rechts
Automatisches Vorspulen	A
Abspielintervall ein-/ausschalten	I
Wiederholungsmodus ein-/ausschalten	L
Abspielgeschwindigkeit erhöhen	Umschalt + Hoch
Abspielgeschwindigkeit verringern	Umschalt + Herunter
Stummschalten	Strg + M
Lautstärke erhöhen	Umschalt + +
Lautstärke verringern	Umschalt + -
Hineinzoomen an Wiedergabeposition	Strg + +
Hineinzoomen an Wiedergabeposition	Strg + -
Timestamp to Clipboard	T
Seek to Timestamp from Clipboard	Umschalt + T
Handbuch	F1
Tastaturkürzel	F2

Table 1: Voreingestellte Tastaturkürzel für Gruppe Allgemein

Track	Tastaturkürzel
Lautstärke erhöhen	+
Lautstärke verringern	-
Stummschalten	M
Ausgabekanal wechseln	C
Squelch umschalten	Q
Zurücksetzen	Strg + R
Squelchlevel automatisch	S
Squelchlevel erhöhen	Strg + Hoch
Squelchlevel verringern	Strg + Herunter
AGC umschalten	G
Verstärkung erhöhen	Alt + +
Verstärkung verringern	Alt + -
Frequenz um 10 Hz erhöhen	Alt + Rechts
Frequenz um 10 Hz verringern	Alt + Links
Frequenz um 100 Hz erhöhen	Alt + Umschalt + Rechts

Track	Tastaturkürzel
Frequenz um 100 Hz verringern	Alt + Umschalt + Links
Bandbreite um 10 Hz erhöhen	Alt + Hoch
Bandbreite um 10 Hz verringern	Alt + Herunter
Bandbreite um 100 Hz erhöhen	Alt + Umschalt + Hoch
Bandbreite um 100 Hz verringern	Alt + Umschalt + Herunter
Auto-range y-axis	R
USB	Strg + U
LSB	Strg + L
AM	Strg + A
FM	Strg + F
DIG	Strg + D
CW	Strg + C
Kontextmenü	Menü

Table 2: Voreingestellte Tastaturkürzel für Gruppe Track

Track- und Seitenübersicht	Tastaturkürzel
Abbrechen	Esc
Öffnen/Schließen der Tack-/Seitenübersicht	Strg + T
Markiere vorherige Seite	Links
Markiere nächste Seite	Rechts
Vorherigen Eintrag selektieren	Hoch
Nächsten Eintrag selektieren	Herunter

Table 3: Voreingestellte Tastaturkürzel für Gruppe Track- und Seitenübersicht



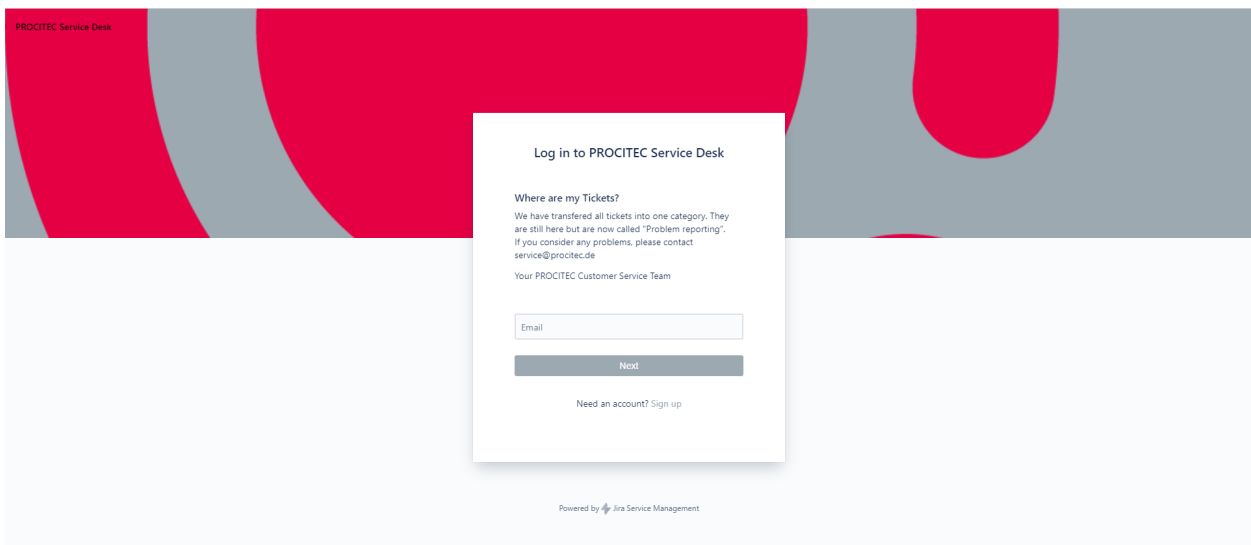
## B. Support

### Requests and suggestions?

All requests or suggestions regarding our go2signals product-range are very much appreciated; we would be delighted to hear from you.

### Any questions? We are happy to assist you!

If you have any further questions, please do not hesitate to contact our Support Team for rapid assistance – just raise a service request at: <http://servicedesk.procitec.com>.



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