

FREE+ 22

15.6" Touchmonitor with Intercom and Line Keys



Technical Overview

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A. GENERAL INFORMATION

The FREE+ 22 (FP22) is a member of the modular **FREE** (also referred to as FREE/FREE+/BeFREE) product family, integrating a 15.6" touchmonitor and an intercom device. Basically speaking it is a BeFREE22 without the computer. It is compatible and combinable with all existing **FREE** modules. It is meant for scenarios where a more powerful CPU is needed than the one integrated in the BeFREEs, or when a computer is already present.

The touchmonitor comprises a high-brightness, ultra-wide viewing angle TFT LCD and a touchscreen. It can be connected to any external computer with HDMI or DP and USB interface.

The Intercom section consists of a goose-neck microphone, illuminated PTT key, stereo loudspeakers, two volume control knobs, two VU-meters and 16 line keys with integrated three-color LED indicators. Its primary audio interface is USB via two independent Audio Codecs, but it is also connected to externally available connectors. The status of the PTT key is reported via HID Keyboard and/or HID Telephony interface. The same is applicable to the 16 line keys. Operation of the LED indicators inside line keys can be pre-programmed or controlled from the application software using HID API.

A.1 Highlights

FEATURES

- Space-saving integration of a touchmonitor and an intercom
- Wide-screen with integrated Line Keys
- Modular – combinable with other **FREE** modules into multifunctional terminals
- Low-profile horizontal design
- Extensive connectivity (USB, digital inputs)
- Analog audio connectivity (Intercom-In, Intercom-Out)
- Cable management – hidden and secured, but accessible
- Built-in Tipro controller enables:
 - o modularity and programmability
 - o touchscreen disable/enable control
 - o brightness adjustment
 - o 22 programmable keys
 - o two programmable digital inputs (e.g. for an external PTT switch/pedal)
- Stereo loudspeakers, each rated for 5W (8 W max), with two separate volume control encoders
- Amplifier with 2 x 8W rated output power
- Goose-neck microphone with illuminated PTT key
- 16 mechanical keys (Line Keys) with integrated three-color LED indicators
- Dual three-color bar-graph display
- Five mechanical keys for brightness control, volume adjustment and other functions
- Several LED indicators (power, USB, microphone, touchscreen ...)
- Optional Inclination Mechanism (VESA 75)

APPLICATIONS

- Operator/dispatcher terminals/consoles for command and control centres in:
 - o transport and traffic control (railways, air traffic ...)
 - o public safety (police, fire brigades, ambulance ...)
 - o utilities (electricity, gas ...)
 - o building/facility management systems (airports, banks, industrial plants ...)
- Trading and banking consoles
- Multifunctional control panels

A.2 Technical Characteristics

ELECTRICAL

- **Power supply:** 12V±5% (from an external AC/DC adapter)
- **Power consumption:**

Operating Mode	Typical	Maximal
OFF (no video and USB signal)	TBD	TBD
IDLE	TBD	TBD
ACTIVE	TBD	TBD

Note 1: Values in the table above are temporary approximations of typical consumption, obtained by measurements at the 12V power input of the FREE+ 22 (LCD at full brightness) without any additional Tipro modules and without any other peripherals connected.

- **Internal interface and power connectors** (to provide for modularity):
 - o left-hand side Tipro Bus connector: 6-pin Micro-MaTch header (male) at the end of a 6-wire ribbon cable
 - o right-hand side Tipro Bus connector: 6-pin Micro-MaTch header (male) at the end of a 6-wire ribbon cable
- **External interface and power connectors** (to provide for external expansions):
 - o standard computer interfaces: USB, Display ... (see Chapter B.4 for details)

MECHANICAL

- **Casing:** plastic ABS, black (C15) color with matte black (C25) top part
- **Gross dimensions** (with side-covers): 440x342x112 (WxDxH) [mm]
- **Goose-neck microphone length/height:** 350±50mm
- **Weight:** 5.9 kg (approximately)
- **Protection (sealing) grade:** IP20 (according to EN 60529)

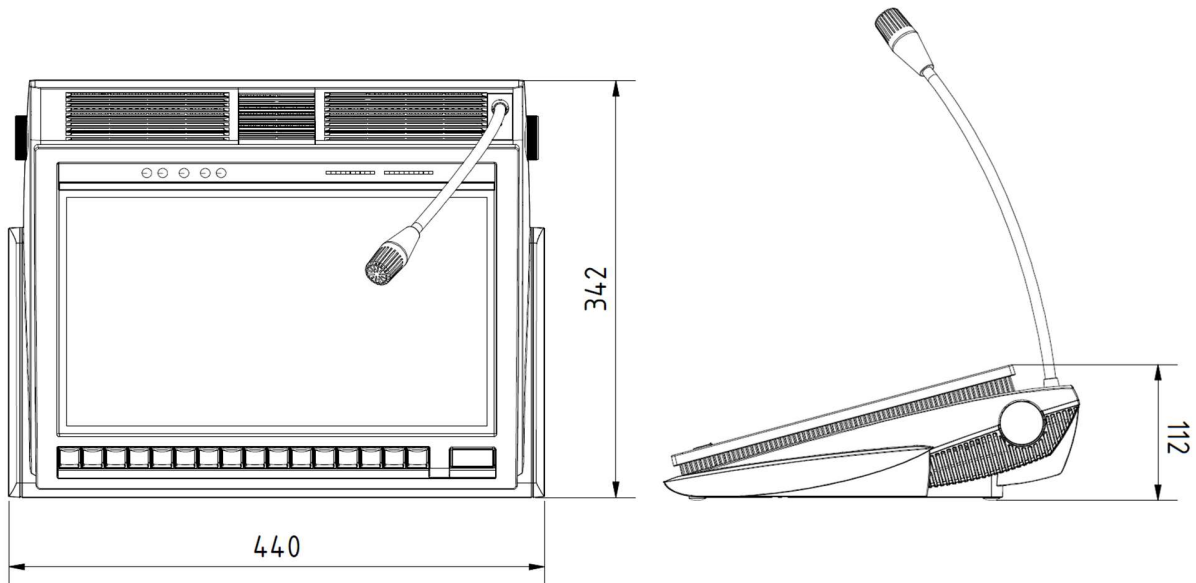


Figure 1 - Physical Dimensions

ENVIRONMENTAL

- Operating ambient temperature range: +5°C to +35°C
- Storage ambient temperature range: -10°C to +50°C
- Relative humidity range: 20% to 80% (non-condensing)

CONNECTIVITY TO COMPUTER

Video

- HDMI
- DP

USB:

- USB 2.0 B-connector for Touch, Audio, Tipro Controller (Key Events)

DISPLAY

- Type: TFT LCD
- Size: 15.6" diagonal
- Aspect ratio: 16:9
- Native resolution: 1920×1080 (HD)
- Luminance/brightness (typical): ≥400 cd/m²
- Contrast ratio (typical): ≥500:1
- Backlight lifetime (typical): ≥50,000 hours

TOUCHSCREEN

- **Technology: Projected Capacitive**
 - o Anti-Glare surface finishing
 - o Positional accuracy: $\pm 2\text{mm}$
 - o Multi-touch: 10 fingers
 - o Light transmission: min: 85% minimal
 - o Lifetime: $\geq 35 \times 10^6$ touches (with finger)

AUDIO SECTION (INTERCOM)

- **Loudspeakers (Left and Right)**
 - o Type: dynamic
 - o Rated power: 5W (8W max)
- **Goose-neck Microphone**
 - o Type: electret condenser, unidirectional
 - o Max input: 120dB SPL
- **Audio Amplifiers**
 - o Designed to meet wide-band IP telephony standards
 - o Frequency pass-band: (100Hz- 8kHz)TYP
 - o Output power: 2 x 8W
- **USB Audio Codecs**
 - o Model: Texas Instruments PCM2902C (Codec A) & PCM2900C (Codec B)
 - o USB Interface: full-speed, USB 2.0 compliant, certified by USB-IF
 - o Resolution: 16-bit Delta-Sigma ADC and DAC
 - o Sampling rates (ADC): 8, 11.025, 16, 22.05, 32, 44.1, 48 kHz
 - o Sampling rates (DAC): 32, 44.1, 48 kHz
 - o Recommended data format: **16-bit** (rather than 8-bit), **stereo** (rather than mono)

MECHANICAL KEYS

- **Push To Talk Key** (two key-switches in parallel) **and 16 Line Keys**
 - o Model: Cherry MX
 - o Key travel: 3.6mm to 4.0mm total, (2 $\pm$ 0.6)mm pretravel
 - o Actuating force: (60 $\pm$ 20)cN
 - o Reliability (Mean Cycles To Failure): MCTF=1 billion (10⁹) press/release cycles (50 million is guaranteed minimum)
- **Keycaps of Line Keys** (user replacable)
 - o Construction: separate body and cover
 - o Size: single (by default) or double (as an option)
 - o Keycap bodies (with cut-out for LED): CN15 black color
 - o Keycap covers: transparent
 - o Key legends: pictograms printed on a transparent paper, underneath keycap covers
- **Control Keys**
 - o Model: Diptronic DTS
 - o key travel (typical): 0.3mm
 - o Actuating force (typical): 255cN
 - o Lifetime (minimal): 0.5 million operations

B. INTEGRAL PARTS AND FUNCTIONALITY

FREE+ 22 represents an integration of a touchmonitor (display with touchscreen), an intercom and a controller.



Figure 2 - Operator Interface of FREE+ 22

B.1 Operator Interface

The **Stripe** (see Figure 3 below) is an ergonomically designed horizontal area along the top side of the display. It comprises a number of visual indicators and mechanical keys (short-travel) to provide the operator with a quick insight and immediate access to important controls.

The **Line Keys** (see Figure 4) are mechanical keys (long-travel) aligned below the display. Each of 16 Line Keys incorporates a three-color (red, green and orange) LED indicator which can be controlled from the application software via the HID API. Key contents are programmable. Using double keycaps (8 of them are supplied with the product, along with the associated instructions on how to replace them) the Line Keys can be reconfigured into 8 double keys or a combination of single and double keys as per user preferences. Key legends (F1-F16) are printed on a transparent paper to allow the LED light to get through. Users can make their own paper legends and apply them instead.

The most prominent position is assigned to the **PTT Key**, which consists of two long-travel mechanical key-switches and a large actuator with dimmable background illumination.

	Power	Blue	Blink: OFF (power present, no video signal) Continuous: ACTIVE (operating)
	USB	Blue	Continuous: USB connected
	Touchscreen	Red	Illuminated when touchscreen is disabled
	Warning	Red	Illuminated when an error has been detected
	Brightness DOWN Key		Press to decrease brightness of the display and all visual indicators.
	Brightness UP Key		Press to increase brightness of the display and all visual indicators.
	Home / Touch Disable Key		Long press disables touchscreen. Short press (re)enables touchscreen.
	Volume DOWN Key		Press to decrease volume of left and right speakers.
	Volume UP Key		Press to increase volume of left and right speakers.
		Bar-Graph Displays	Green: loudspeakers volume level Red: VU-meter (actual signal level at the loudspeakers and the microphone) Orange: display brightness level
	Microphone LED		Illuminated (red) while the microphone is active (enabled).

Figure 3 - Top Stripe (Keys & Indicators)

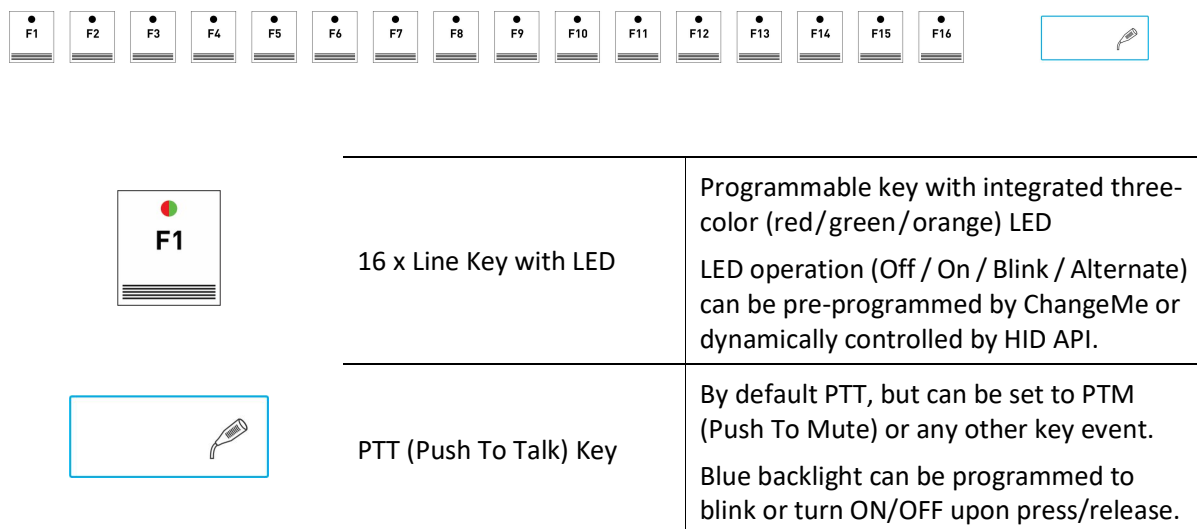


Figure 4 - Line Keys and PTT Key

B.2 Touchmonitor

The touchmonitor comprises a high-brightness, ultra-wide viewing angle TFT LCD and a touchscreen. The display is connected to a video board via LVDS interface. The video board offers HDMI and DisplayPort connectivity for the external computer. The touchscreen is operated by the respective controller with USB interface.

The brightness of the LCD and all visual indicators on the Stripe (Bar-Graph Displays, LED Indicators and PTT Key backlight) is adjustable by Brightness UP and DOWN keys. The Home/TouchDisable key can be used to temporarily disable touchscreen for cleaning purposes.

B.3 Intercom (Audio Section)

The functional block diagram of the audio section is shown in Figure 5 below.

Internal signal processing includes analog-to-digital and digital-to-analog conversion (block “USB AUDIO CODEC” which comprises two USB Codec chips), conditioning (amplification, attenuation, filtering ...), sensing and switching. The complete processing is programmable via ChangeMe software and can be dynamically modified during the operation in so-called On-Line operating mode (using the HID API). USB and analog signals can be mixed, resulting in up to six listening/output audio channels (3 stereo signals) and three parallel recording/input channels (USB and analog). The Echo-Cancellation circuitry is optional (see Chapter D.4 for more details).

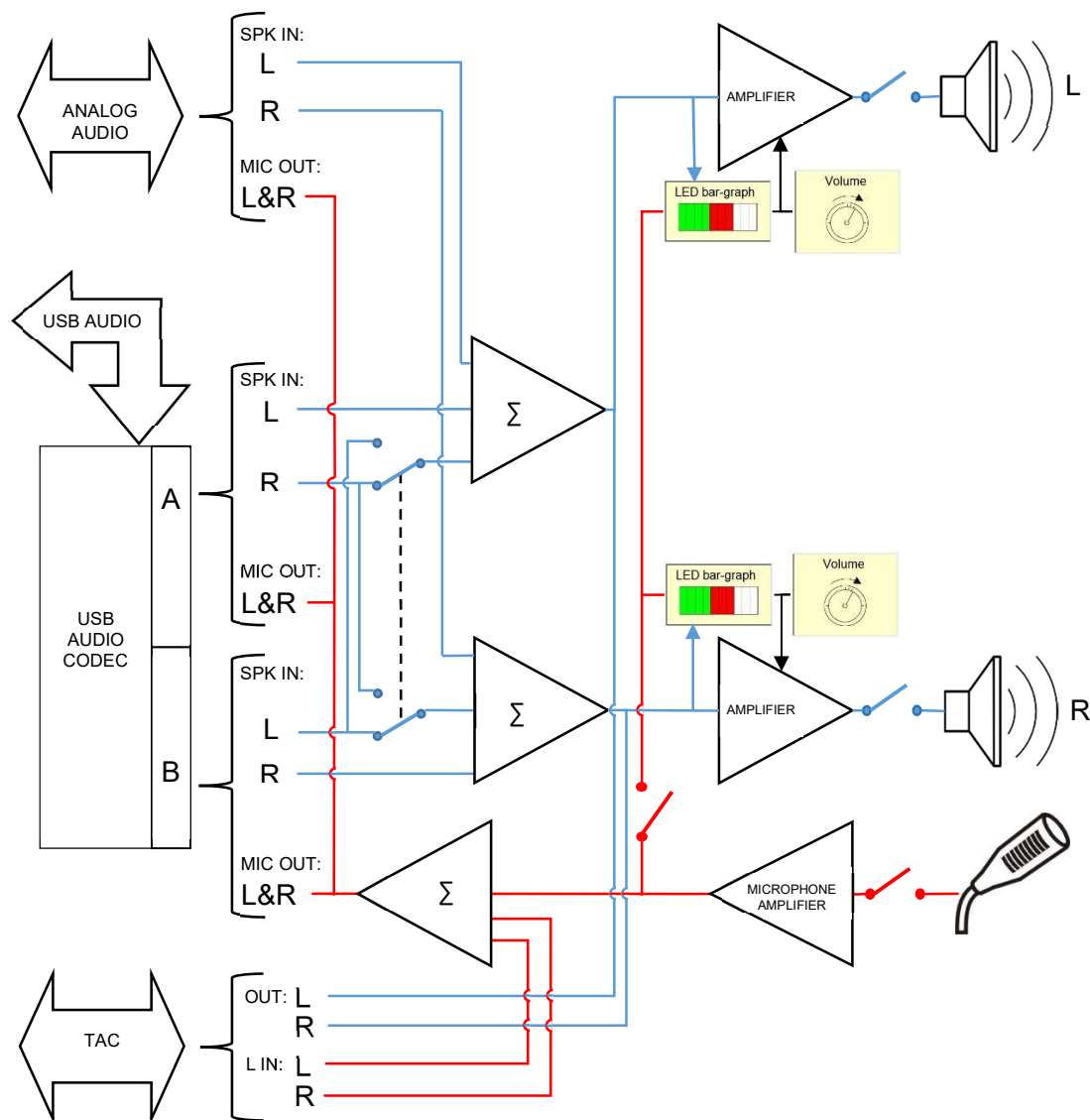


Figure 5 - Audio Section (intercom)

Analog Audio

Analog audio signals to and from the Intercom can be connected to the output and input of an external audio device, e.g. the sound card of the connecting computer via the externally accessible connectors (see Chapter B.4 for more details).

Microphone Amplifier

This is a logarithmic audio amplifier with programmable gain, noise gating threshold and compression ratio. Noise gating feature enables ambient noise to be suppressed. All sounds below the threshold are

removed inside the amplifier, so with higher threshold the microphone needs to be used closer to the mouth and speech needs to be louder to get through the amplifier. The compression feature enables compression of the output signal dynamics in order to minimize the difference between soft/low and loud speech. The amplifier is also capable of limiting extremely loud speech thus preventing distortion and popping. The overall gain can be even lower than one (i.e. attenuation) as well as equal to zero (i.e. totally muted input). Also the range of the goose-neck microphone can be adjusted.

A linear regime of the amplifier is a special option which might be activated in full-duplex operation where acoustic echo is to be cancelled using application software (rather than optionally integrated hardware echo-canceller – see Chapter D.4).

Left and Right Speaker Amplifier

A stereo D-class amplifier is driving both speakers (Left and Right Speaker in Figure 5). The gain of each speaker (i.e. volume level of the respective speaker) can be adjusted by the user in normal operation via the respective incremental encoder at the respective side of the module (Left and Right Encoder in Figure 2). The selected level is immediately displayed at the respective bar-graph display in green color (20 volume levels + mute). The amplifier can deliver up to 8W of electric power to each speaker.

By default, the left speaker is driven by the sum of left output of USB Codec A and left output of USB Codec B, while the right speaker is driven by the sum of right output of Codec A and right output of Codec B (so-called **Stereo Mode**). Alternatively, each Codec can drive its own speaker, i.e. Codec A to left speaker, Codec B to right speaker (so-called **Mono Mode**). In either of the modes the analog Line Out signals from the computer's sound card can be optionally added to the summing amplifiers, Speaker In Left to the left amplifier, Speaker In Right to the right amplifier.

Bar-Graph Displays

Each of the two bar-graph displays comprises 10 three-color (red, green and orange) LEDs. By default they constantly operate as VU meters in red color, showing actual levels of the respective speaker signals and the level of the microphone signal. Optionally, the microphone signal can be disconnected from the VU meters.

If a rotation of an incremental encoder has been detected the respective bar-graph automatically displays the gain of the respective amplifier in green color. Volume UP and DOWN keys can also be used to adjust the current volume settings, but simultaneously for both speakers.

If a press of Brightness UP or DOWN key has been detected both bar-graphs simultaneously display the current brightness setting of the LCD and all visual indicators in orange color.

Incremental Encoders

These (Left and Right Encoder in Figure 2) are endless digital potentiometers used for immediate volume control of the Left and the Right Speaker respectively. Each has 24 detents per revolution. Every single detent changes the volume for one step up or down, but only every second one is represented by one LED in the corresponding Bar-Graph display in green color.

Optionally, any of the encoders can change the volume for both speakers (programmable by ChangeMe software)

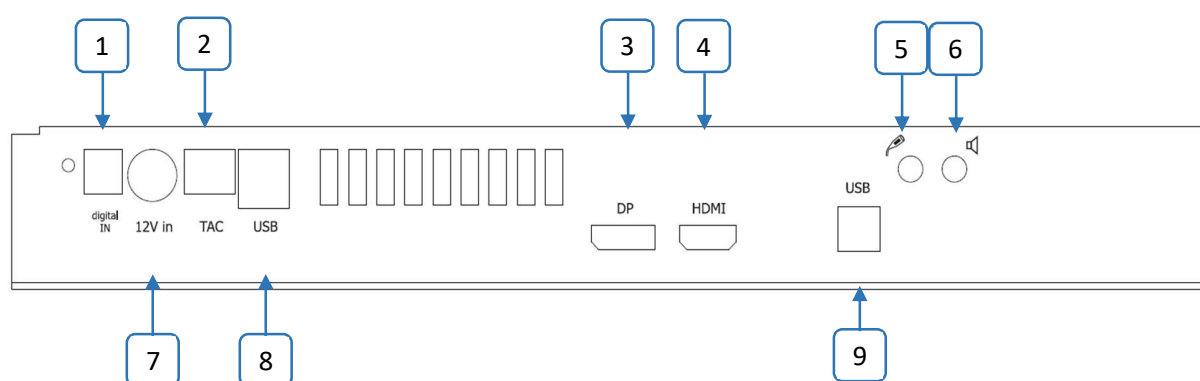
It is possible to program events for encoder operation (e.g. synchronisation with software).

TAC

The Tipro Audio Connection is an analog audio connection meant to connect a Tipro analog switching Handset. This connection makes it possible to switch between Handsfree audio (the built-in Intercom) and the attached Handset.

B.4 External Connectors

Numerous connections for external devices are available at the Connector Plate (see Figure 6) from underneath the module. Most of them are standard interfaces (USB, LAN, COM, Display ...) intended for users to apply freely.



#	Designator	Type	Note
1	Digital Input	RJ 4P/4C socket	see External Digital Inputs below
2	TAC	RJ 8P/8C (RJ 45)	Connection to Tipro Analog Handset
3	DP	DP1.4a	Display connection from external computer – option 1
4	HDMI	HDMI 2.0	Display connection from external computer – option 2
5	Intercom Line-Out	Stereo jack 3.5 mm	microphone amplifier output
6	Intercom Line-In	Stereo jack 3.5 mm	loudspeaker amplifier input
7	12V Input	Mini Power DIN	reserved
8	Dual USB	2 x USB type – A	full-speed, 500 mA (Tipro USB devices)
9	USB	USB type - B	USB connection to computer (touch, audio, Tipro controller)

Figure 6 - Connector Plate

External Digital Inputs

Two inputs (refer to Figure 7 for the connector and signal description) are provided for detection of external digital (ON/OFF) signals to be transformed into programmable key events, equivalent to, for instance, PushToTalk key on the Stripe. Typical device to be connected to is an external PushToTalk switch/pedal.

One of the inputs (A) is galvanically isolated (via opto-coupler) and is therefore intended for an external ground-referenced signal, such as a digital output of another electronic device. The other input (B) is to be used for an external “floating” signal, such as contacts of a mechanical/magnetic key/switch (see Figure 8).

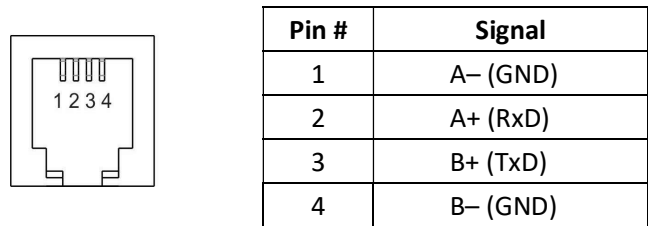


Figure 7 - Digital Inputs Connector

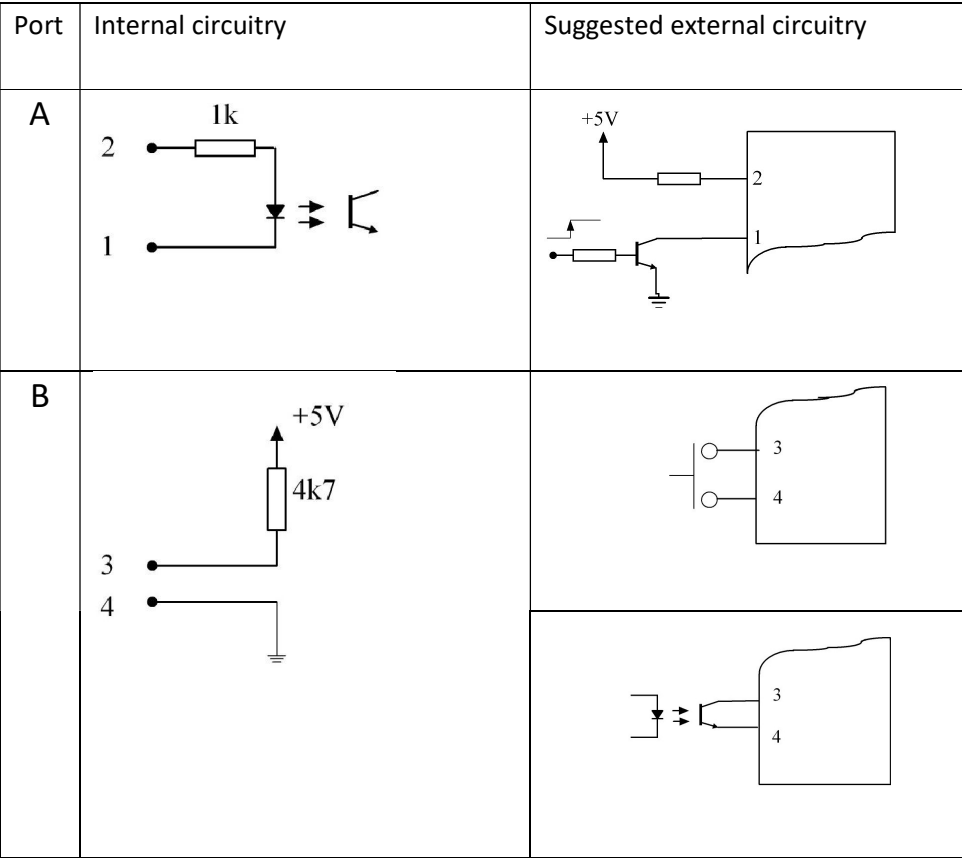


Figure 8 - Applying Digital Inputs

External Analog Inputs and Outputs

The Microphone Out signal is actually the output of the internal microphone amplifier at standard line level (0dBu) which can be connected to a computer or external recording device, for instance. Its output impedance is $10\text{k}\Omega$ in series with $1\mu\text{F}$.

The Speaker In signal is an auxiliary stereo analog input to the internal speaker amplifiers. Expected signal level is 0dBu. Its input impedance is $100\text{k}\Omega$ in series with $0.1\mu\text{F}$.

C. OPERATION

C.1 Configuring FREE+ 22

The FREE+ 22 is a rather complex device with a number of programmable settings/parameters provided for users to configure in accordance to the particular application. To enable that feature Tipro supplies the respective programming utility (ChangeMe) which operates only under Windows operating systems. (for Linux an updating software tool is available – see reference [9]) It assists users to define own set of parameters, save them into a file (for possible replication in the future) and program into non-volatile memory of the Tipro controller for permanent storage.

It is also possible to dynamically modify certain settings (e.g. display brightness, LED indicators, touchscreen disable/enable for cleaning purposes ...) from the application software. For that purpose Tipro provides the respective Application Programming Interface (API); **Tipro HID API** for Windows and **Tipro Linux API** for Linux and the associated documentation (reference [5]).

C.2 Applying FREE+ 22

The FREE+ 22 is typically used together with other FREE add-on modules, combined in various compositions/configurations. An example with Handset modules is shown in Figure 9 below, along with its schematic representation in Figure 10.

In this case, two Handsets are connected; one “analog switching” and one USB version.

The analog switching Handset on the left uses the Audio Codec inside the FREE+. The user can switch between the Handsfree (gooseneck microphone and built-in speakers) and the Handset while using the same audio device for the software. By default this switching is done by lifting the Handset.

The USB Handset on the right offers an extra Audio Codec, independent of the FREE+ internal codecs. This Handset can be used in parallel with the gooseneck microphone and speakers.



Figure 9 - Example FREE+ 22 Configuration

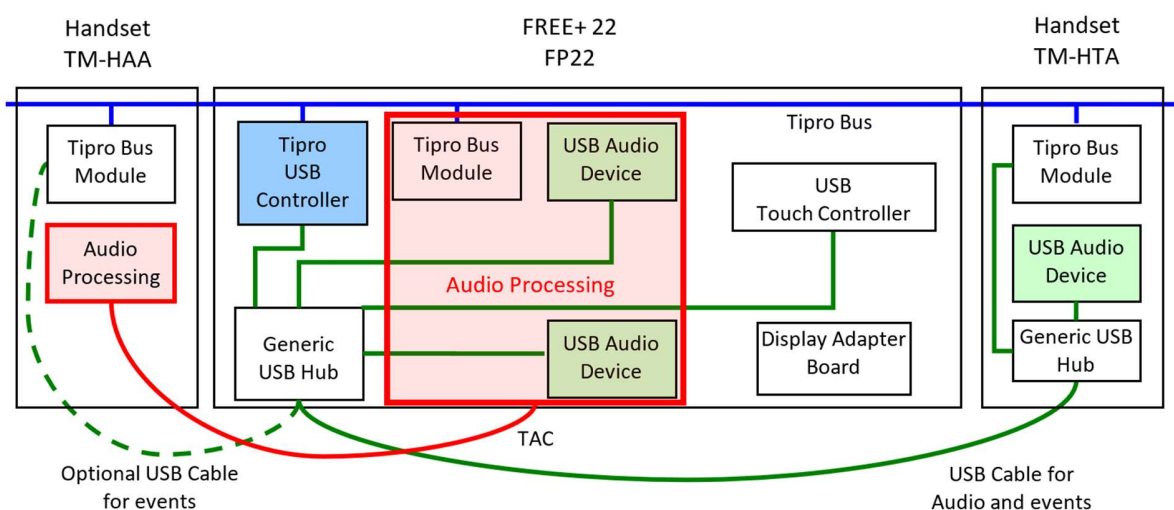


Figure 10 - Example FREE+ 22 Configuration – Schematic Representation

D. OPTIONS

D.1 Inclination Mechanism

The FREE+ 22 can be fitted with an Inclination Mechanism (also referred to as Angle Adjustment Mechanism). Normally, the display surface of FREE+ 22 is inclined for 15° against the horizontal plane. The mechanism enables gradual adjustment of the angle from approximately 30° to 70° .



Figure 11 – FREE+ 22 with Inclination Mechanism (VESA 75)

D.2 HID Telephony Interface

The actual status (pressed/released) of the PTT key and Line Keys is normally reported as a programmable sequence of keystrokes generated by a standard USB keyboard, this way emulating a generic HID Keyboard Device. An example of the application can be found in the Reference [7] (“Hook and PTT in Software”).

Additionally or alternatively, the PTT and Line Keys status can be reported via HID Telephony Interface, which is an integral part of the FREE+ 22. See reference [8] (“HID Telephony Interface”) for more details.

D.3 HID Gamepad Interface

An alternative firmware is available, offering HID Gamepad event reporting in stead of the HID Telephony events.

Please contact Tipro support for more information.

D.4 Echo-Cancellation Circuitry

Acoustic echo is a physical phenomenon inherent to hands-free devices (such as Intercom) in full-duplex mode, so it needs to be suppressed and/or cancelled. This is normally implemented in the application software through the specific signal processing routines. Alternatively, it can be achieved in the hardware using a digital signal processor. Basic properties of the optional (see Chapter E.1 for details on the respective Ordering Code) Echo-Cancellation circuitry are listed below.

- Performance: full-duplex
- Sampling rate: 16kHz
- Acoustic echo-cancellation: up to 40dB
- Acoustic echo suppression
- Background noise reduction

The reference signal for the echo-canceller is the sum of signals at the left and the right speaker. Optionally, the reference might be taken from either of the speakers.

D.5 Goose-Neck Microphone

By default, the goose-neck microphone is an integral part of the FREE+ 22, but it can be optionally omitted. See Chapter E.1 for details on the respective Ordering Code.

D.6 Without Line_keys

By default, 16 programmable Line-Keys or shortcut keys are integrated under the display. As an option, these can be removed.



E. ORDERING CODES

E.1 FREE+ 22

1	2	3	4	5	6	7	8	8	9				
FP	22	-	0	P	0	-	A	U	0	-	C15C25	-	xxx

1 – Module Type

FP – FREE+ (touchmonitor with audio) module

2 – Model

22 : Integrated Intercom, 15.6" LCD

3 – reserved

0 :

4 – Video Board

P : DP / HDMI

5 – Video Cables

0 : No Video Cable included

D : Display Port Cable, 2.5m included

H : HDMI cable, 2.5m included

7 – Integrated Intercom Option

U : USB Intercom functionality

C : USB Intercom functionality with Echo-Cancellation Circuitry

V : USB Intercom functionality without goose-neck microphone

8 – Integrated Options II

0 : none

B : without Line-Keys

G : Gamepad Interface

C : without Line-Keys, with HID Gamepad Interface

9 – Housing Color (optional)

C15 : or when left out, standard C15-C25 combination
(black housing with black matte top frame)

10 – Custom Version

Three-digit number reserved for product modifications. It is omitted in case of standard version.

Note 1:

FREE+ 22 requires 12V_{DC} power supply to operate (see Chapter A.2). The respective AC/DC adapter is included in the packaging, along with the EU power cord.

E.2 Inclination Mechanism

1 2 3 4 5
T M - S U A - C 1 5 - x x x

1 – Accessory Type

S – Mechanical Support mechanism (Inclination Mechanism)

2 – Mechanism Type

U : Universal

3 – Adapter Type

A : All BeFREEs and FREE+

4 – Color

C15 : black

This part of the code is not mandatory if the color is C15, what is a default.

5 – Custom Version

Three-digit number reserved for product customizations. It is omitted in case of standard version.

F. REFERENCES

1. "BeFREE22" – Technical Overview
2. "HANDSET" – Technical Overview
3. "SPEAKERBOX" – Technical Overview
4. "ChangeMe" – User's Manual
5. "HID API" - Reference Manual
6. "Modularity Demystified" – "Dispatching Hints & Tips" White Paper – Issue No. 001
7. "Hook & PTT in Software" – "Dispatching Hints & Tips" White Paper – Issue No. 004
8. "HID Telephony Interface" – "Dispatching Hints & Tips" White Paper – Issue No. 005
9. ["Tiprowrite - Program settings and key contents into Tipro devices on Linux OS"](#)
10. "Cleaning / Disinfecting guidance"

G. NOTICES

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