HANDSET

FREE Handset Module

TECHNICAL OVERVIEW

Description and Application

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TIPRO

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A. GENERAL INFORMATION

The **Handset** module is a member of the modular **FREE** (also referred to as FREE / FREE+ / BeFREE) product family. It is a USB audio device for digital bidirectional voice communication, which can be combined with other family members into multifunctional consoles for various applications.

Integrated PushToTalk / PushToMute key and Hook switch operate as USB programmable keys (i.e. emulating user definable input from a standard computer keyboard) what enables seamless integration of these features into existing application software without any intervention in the code. Two RGB LEDs within the cradle visually indicate the status of the switches (Talk / Mute and On Hook / Off Hook).

Once configured (using ChangeMe programming utility), the module does not require any proprietary software to operate, but rather generic USB HID keyboard (for PTT key and Hook switch) and USB audio (for voice) drivers of the operating system in use.

As all other **FREE** add-on modules, the handset module requires a Tipro USB controller to operate. The controller is normally integrated into another module (e.g. a touchcomputer, a touchmonitor or a Speakerbox module) within the same modular configuration. Alternatively, for a stand-alone application, a special variant of the module with integrated controller (TM-HxM) is also available (see Chapter B.3).

A.1. Highlights

APPLICATIONS

- dispatcher terminals
- banking & trading consoles
- multifunctional control panels
- digital telephony (e.g. Voice over IP) devices

CONCEPT AND MODULARITY

- handset with integrated PushToTalk / Mute key and Hook switch
- combination of a USB audio device and an HID keyboard
- plug & play operation with generic USB audio and USB HID keyboard drivers
- optional emulation of HID Telephony device
- side-tone generated internally by the hardware
- software - adjustable volume (loudspeaker and microphone) and side-tone level
- integrated acoustic shock protection circuitry

- combinable with other **FREE** add-on modules (e.g. Speakerbox, touchcomputers, touchmonitors, keyboard modules …) into multifunctional terminals
- stand-alone operation as a **FREE** module with integrated Tipro USB controller
- optional Dial-Pad in the cradle for ergonomic dialling
- optional analogue interface (direct connection to the loudspeaker and the microphone)

PROGRAMMABILITY

- configurable properties of the microphone amplifier (gain, noise gate threshold and compression ratio) and the loudspeaker amplifier (gain)
- programmable PushToTalk / PushToMute key (also referred to as switch)
- programmable magnetic Hook switch (also referred to as key)
- two RGB LEDs indicating status (Talk / Mute and On Hook / Off Hook)
  - various operating modes
  - 5 different colours: Red / Green / Blue / Orange / Violet
- programmable Dial-Pad keys (TM-Hxx-5KW only)

VERSATILITY

- user configurable predefined operating mode ("Off-Line")
- dynamically controlled operation by the application software ("On-Line")
- keys with dedicated hardware function and/or programmable keys
- LED indicators with dedicated hardware function and/or programmable indicators

A.2. Technical Characteristics

ELECTRICAL

- **power supply (audio circuitry)**: 5V ± 5% (from USB)
- **power supply (control circuitry)**: 5V ± 5% (from Tipro controller via Tipro bus)
- **current consumption (audio circuitry)**: 85 mA$_{TYP}$ (100 mA$_{MAX}$)
- **current consumption (control circuitry)**: 40 mA$_{TYP}$ (75 mA$_{MAX}$)
- **additional consumption of TM-HUM & TM-HTx**: 25 mA$_{TYP}$ (45 mA$_{MAX}$)
- **audio interface**: USB (except for TM-HHA-6AW – see Chapter D.3)
- **control interface (TM-HxA)**: TIPRO bus
- **control interface (TM-HxM-5xW)**: USB
- **interface connectors**:
  - **left-hand side Tipro bus connector**: 6-pin Micro-MaTch header (male) at the end of a 100 mm long ribbon cable
  - **right-hand side Tipro bus connector**: 6-pin Micro-MaTch receptacle (female) on the PCB

- **USB connector**: USB type B
- **Handset connector**: RJ 6P/6C

MECHANICAL

- **casing**: plastic ABS, black (C15) colour with matte black (C25) top part
- **net dimensions**: 70 x 222 x 66 (W x D x H) [mm]
- **gross dimensions** (with side-covers): 90 x 222 x 66 (W x D x H) [mm]
- **weight**: 400 g (approximately)
- **protection (sealing) grade**: IP 40 (according to EN 60529)

ENVIRONMENTAL

- **operating ambient temperature range**: 0°C to +40°C
- **storage ambient temperature range**: -10° C to +50°C
- **relative humidity range**: 20% to 80% (non-condensing)

AUDIO

- **Analogue front-end**
  - designed to meet wide-band IP telephony standards
  - frequency pass-band: (100 Hz - 8 kHz) TYP
- **USB Audio Codec**
  - model: Texas Instruments PCM 2912x
  - USB Interface: full-speed, USB 2.0 compliant, certified by USB-IF
  - resolution: 16-bit Delta-Sigma ADC and DAC
  - sampling rates (ADC & DAC): 8, 11.025, 16, 22.05, 32, 44.1, 48 kHz

MECHANICAL KEYS AND REED SWITCHES

- **PTT/ PTM key (two keyswitches in parallel)**
  - model: Cherry ML
  - key travel: 2.5 mm to 3.0 mm total
  - actuating force: (45 ± 20) cN
  - reliability (Mean Cycles To Failure): MCTF = 1 billion (10^9) press/release cycles (20 million is guaranteed minimum)
- **Hook switch (reed switch)**
  - reliability (Mean Cycles To Failure): MCTF = 500 million (5×10^8) switching cycles (20 million is guaranteed minimum)

B. INTEGRAL PARTS AND FUNCTIONALITY

Two major parts – a handset and a cradle – constitute the module. The handset is connected to the cradle by a handset cord.

Figure B.1 USB Handset Module – Integral Parts

B.1. Handset

The handset itself is a combination of a dynamic loudspeaker, an electret microphone and a PushToTalk/ Mute key. It is connected to the cradle by a spiral cable. The cable (also referred to as handset cord) is detachable at the cradle side (see **Figure B.2**).

B.2. Cradle (Base)

The cradle contains an electronic board with a hook switch, analogue conditioning circuitry, a USB audio Codec, LED indicators and a microcontroller. The USB audio Codec converts analogue signals into a digital USB data stream and vice versa, while the microcontroller supervises the operation and enables modularity/ programmability via Tipro bus. The hook switch is a reed contact activated by a magnet inside the handset.

B.2.1. Microphone Preamplifier

The microphone preamplifier is a linear Programmable Gain Amplifier (PGA) provided for a fine adjustment of the microphone sensitivity when the handset is used further away from the mouth. Differential inputs of the PGA further improve immunity to external electromagnetic noise.

B.2.2. Microphone Amplifier

The microphone amplifier is a logarithmic audio amplifier with programmable gain, noise gate threshold and compression ratio. The noise gating feature enables ambient noise to be suppressed. All sounds below the threshold are removed inside the amplifier, so with a 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). The output of the amplifier connects to the Analogue-to-Digital Converter (ADC) inside the USB Codec chip.

Default logarithmic mode of the amplifier ensures highest voice dynamics and best signal clarity. Its linear regime is a software selectable option available for those who prefer naturalness over clarity.

B.2.3. Loudspeaker Amplifier

The loudspeaker amplifier is a linear audio amplifier with differential output, programmable gain and limiting circuitry to prevent an acoustic shock. It drives the loudspeaker inside the handset with a signal which is a composition of the output signal (USB audio data stream received from the computer and converted by Digital-to-Analogue Converter inside the USB Codec chip) and a part of the microphone signal (so-called side-tone). The left and right channel of the Codec's stereo output and internally summed prior to the amplification.

B.2.4. USB Audio Codec

The audio Codec with USB interface is the Texas Instruments' PCM2912x integrated circuit (refer to respective data sheet for details).

B.2.5. USB Interface

Audio interface of the module is full-speed USB, compliant to the USB 2.0 specification. It is accessible from the bottom of the cradle (see **Figure B.2**) at the USB upstream (type B) connector to be connected to a USB downstream port of the Tipro USB controller inside some other (typically a touchcomputer or a touchmonitor) module within the same **FREE** configuration.

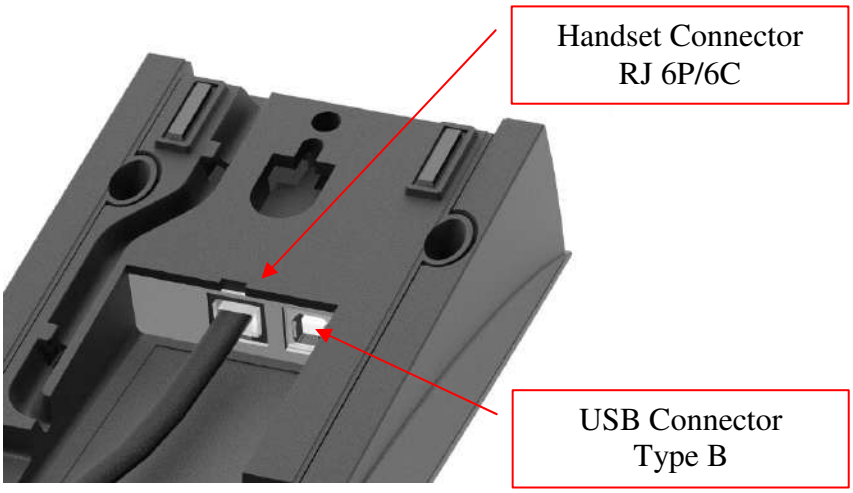


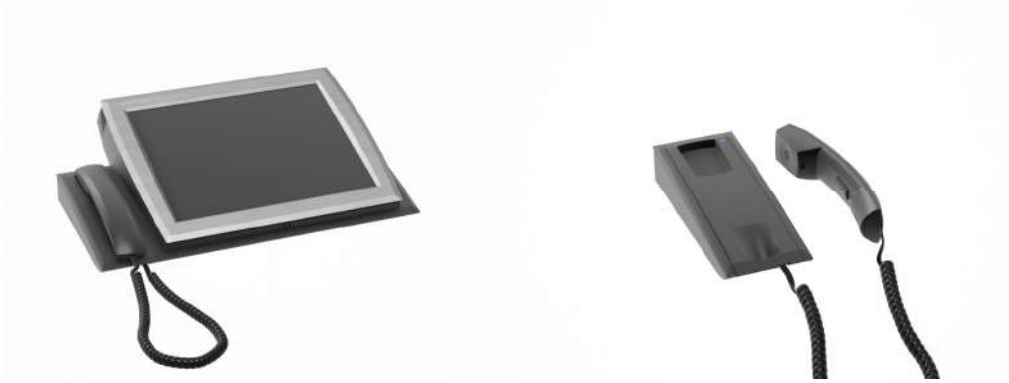
Figure B.2 USB Handset Module – External Connections

In case of Stand-Alone handsets (i.e. TM-HxM-5AW) or handsets with HID Telephony Interface (i.e. TM-HTx-5AW) the USB is also the control interface and must be connected to a self-powered or a root hub, because the module itself comprises a bus-powered USB hub.

B.3. Differences between Stand-Alone and Add-On Versions

The TM-HUM-5AW is a stand-alone version and a functional superset of the TM-HUA-5AW Add-On version of the module. It additionally incorporates a Tipro USB controller with built-in bus-powered hub (one downstream port is occupied by the Tipro controller, another one with the USB Audio Codec).

Figure B.3 presents a block diagram of the Stand-Alone Handset, as well as a block diagram of the Add-On Handset in a representative **Terminal/Console** configuration (i.e. a configuration comprising a touchcomputer module).



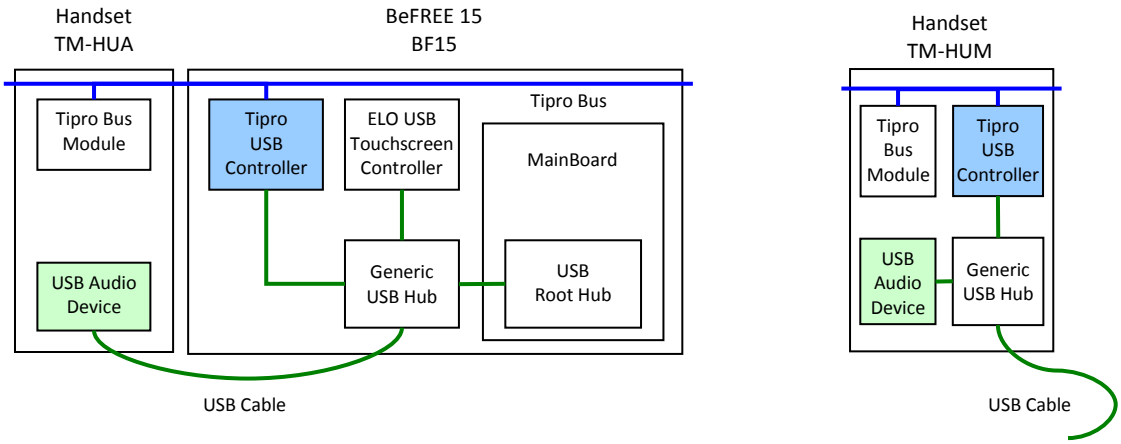


Figure B.3 Add-On and Stand-Alone Handset Modules

C. OPERATION

C.1. Configuring Handset

The Handset is a relatively complex device with a number of programmable settings/parameters provided for users to configure in accordance to the particular application. To enable this feature Tipro supplies the respective programming utility (**ChangeMe**) which operates only under Windows operating systems. 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 device.

The USB Handset module implements a standard USB audio Codec. Therefore no device specific driver is needed for the module to operate under Windows operating systems. However, it may or may not be the case with other operating systems, such as Linux, where it depends on the actual distribution, kernel version, etc.

C.2. Operating Modes

Off-Line is the default mode where the operation is controlled by the module itself, which applies the parameters/settings previously defined by ChangeMe programming utility.

In the **On-Line** operating mode the host computer controls the complete operation of the module. This mode is intended for advanced users who have control over the application software design. The respective Windows API (**HID API**) is available, as well as the associated technical documentation.

C.3. Using Tipro USB Audio Modules

Besides the USB Handset Tipro also offers other USB audio modules (e.g. Speakerbox, Touchmonitor with integrated loudspeakers) that can be joined into a single **FREE** configuration. On the other side, Windows operating systems present each of them as a **USB Audio Device**. In order to enable independent addressing and differentiation, each type of **FREE** audio module (Handset, Speakerbox, Touchmonitor) has a different USB product ID.

However, Tipro can not guarantee that the actual Product ID of the USB Handset module (or any other individual **FREE** USB audio module) will not change in future, as it depends on the USB Codec IC vendor(s) who reserve the right to change it.

D. OPTIONS

D.1. HID Telephony Interface

The actual status of the Hook switch (inside the cradle) and PushToTalk/PushToMute (PTT) key/switch is normally reported to the host computer 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 [8] ("Hook and PTT in Software").

Since nearly all operating systems are capable of accepting standard USB keyboard input and nearly every application software expect the operator to use it, this concept typically enables Tipro Modular Dispatcher Terminals to be integrated into the existing software environment without any intervention in the code.

However, certain software applications are designed to enquire on the status of the keys rather than capturing the respective keyboard events. In such cases the HID Telephony Interface is applicable. It is supported by the special Handset variants (TM-HTx) that send status reports only when specifically addressed to, what is different to HID Keyboard devices that report automatically to the respective driver whenever a change in status occurs. TM-HTx Handsets represent supersets of the standard TM-HUx counterparts, being capable to emulate HID Telephony and HID Keyboard device concurrently.

All Handset variants with HID Telephony support (TM-HTx) as well as the variants with integrated Tipro controller (TM-HxM) comprise a bus-powered USB hub and therefore have to be connected to the root hub of the host computer (e.g. BeFREE 20)

D.2. Integrated Dial-Pad

The USB handset, either as a module (TM-HUA-5KW) or the module with integrated Tipro USB controller (TM-HUM-5KW), can optionally incorporate the Dial-Pad with 12 mechanical keys to provide for more ergonomic dialling. The keys are programmable in the same way as the PTT key and the Hook switch.

Figure D.1 USB Handset Module with Integrated Dial-Pad (TM-Hxx-5KW)

MECHANICAL KEYS

- **keyswitch**
  - model: Cherry ML
  - key travel: 2.5 mm to 3.0 mm total
  - actuating force: (45 ± 20) cN
  - reliability (Mean Cycles To Failure): MCTF = 1 billion (10^9) press/release cycles (20 million is guaranteed minimum)
- **keycaps**
  - construction: separate body and cover
  - size: single
  - keycap bodies: CN15 black colour
  - key legends: printed on the keycap bodies
  - keycap covers: transparent
  - user-customizable key legends/pictograms (to be printed on a thin paper and put underneath the keycap covers)

D.3. Analogue Interface

The TM-HHA-6AW is an analogue derivative of the handset module. It lacks audio processing circuitry (both analogue and digital), providing a direct connection to the loudspeaker and the microphone via RJ4P/4C jack/socket. The connector is placed in the cradle instead of the USB Type B connector (refer to **Figure B.2**). The external audio cable is a 4-wire straight-through cable 2.5m long (TM-CH1). The loudspeaker is connected between pins 2 and 3, electrically "floating" (no ground connection). The microphone is also "floating" between pins 4 (positive) and 1 (negative).

LOUDSPEAKER

- type: dynamic
- impedance: 150 Ω TYP @ 1 kHz @ 1 V
- Sound Pressure Level (SPL): 93dB ± 3 dB @ 1 kHz (with IEC318 coupler @ 60 mV)
- frequency range: (200 Hz - 7 kHz) TYP
- rated power: 10 mW

MICROPHONE

- type: electret condenser, omni-directional
- impedance: 2.2 kΩ MAX @ 1 kHz
- sensitivity: - 36 dB ± 3 dB (0 dB = 1 V/Pa @ 1 kHz)
- frequency range: (100 Hz - 7 kHz) TYP
- operating voltage: 1.0 VDC - 5.0 VDC

All other (non-audio) functions are the same as of the TM-HUA-5AW. The module (TM-HHA-6AW) is intended for direct connection to the Speakerbox module (see Reference [4]) as well as to a third-party analogue audio processing hardware.

E. ORDERING CODES

	1	2	3		4		5		6
T M -	**H**	**U**	**A**	**-**	**5**	**A W -**	**C15C25**	**-**	**xxx**

1 – Module Type

H – **H**andset module

2 – Audio Interface

U : **U**SB

T : USB with HID **T**elephony Device

3 – Configuration

A : Standard **FREE** add-on module

M : Stand-alone **FREE** module with Tipro USB controller

4 – Integrated Options

A : none

K : Dial-Pad

5 – Housing Colour

C15C25 : black (C15) with black matte (C25) top part (see Note 3. below)

6 – Custom Version

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

Note 1:

USB interface cable is considered to be an integral part of the module and shall not be ordered separately.

Note 2:

Stand-Alone handsets (TM-HxM-5AW) are supplied with the side covers.

Note 3:

The upper part of the handset housing is protected with a special coating in order to improve its abrasion resistance. The coating modifies the shade of the original black (C15) colour, what is referred to as C25 colour.

F. REFERENCES

1. “BeFREE 20” - Technical Overview
2. “BeFREE 10” - Technical Overview
3. “BeFREE 15” - Technical Overview
4. “SPEAKERBOX” – Technical Overview
5. “ChangeMe” – User’s Manual
6. “HID API” – Reference Manual
7. “Modularity Demystified” – “Dispatching Hints & Tips” White Paper – Issue No. 001
8. “Hook & PTT in Software” – “Dispatching Hints & Tips” White Paper – Issue No. 004
9. “HID Telephony Interface” – “Dispatching Hints & Tips” White Paper – Issue No. 005

G. NOTICES

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