LM 128P
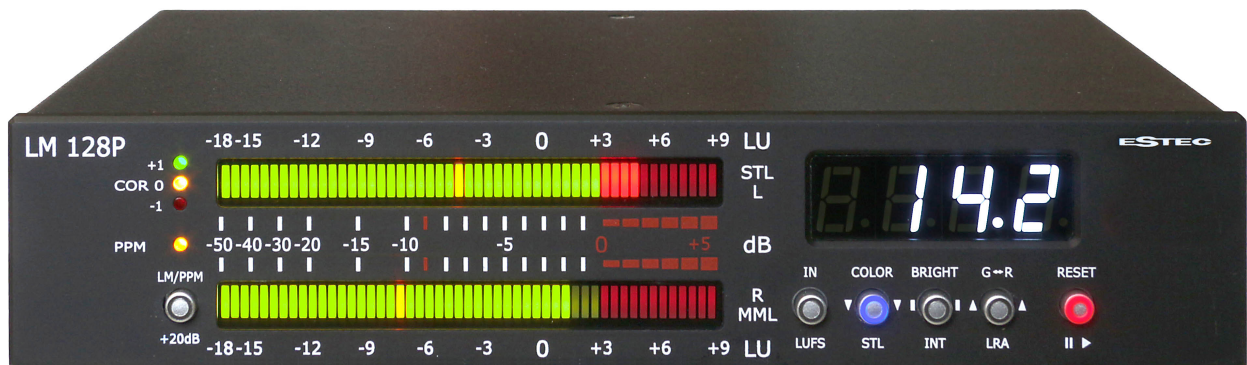
Loudness and Peak Program Meter according to EBU R 128

Firmware Version P4.0x

Installation

Operation

www.ssb-audio.com

SSB AUDIO GmbH * Sonnenweg 25 * 30827 Garbsen, Germany
Tel.: +49 5131 464272
www.ssb-audio.com * info@ssb-audio.com

Content

1 Safety guidelines – read before using!

The device meets protection class 2 and has left the factory in a technically faultless state.

In order to assure this state and to insure riskless operation the user must obey the notes and warnings which are part of this manual.

Safety, reliability and performance of this device are guaranteed only when:

- Installation, expansions, modifications and repairs are accomplished only by the manufacturer or by personal authorized by the manufacturer.
- The electrical installations of the relevant room meet the corresponding IEC (ANSI) requirements.
- The device is used in accordance with this user manual.

Power supply

The device is designed for continuous operation. The power supply's operating voltage must meet the local line voltage.

Avoid connections to the power supply system in junction boxes together with many other devices. The electrical outlet needs to be installed close to the device and easily accessible.

Use the supplied power supply unit. Other power supplies may cause malfunctions or even damage the device.

Installation site

The device should stand only on clean horizontal work surfaces or be installed in a suitable rack. During operation the device must not be exposed to vibration. Humidity, liquids of all kinds and dust must be kept away as far as possible. Sufficient ventilation needs to be provided. Avoid direct sunshine and the proximity of radiators and radiant heaters.
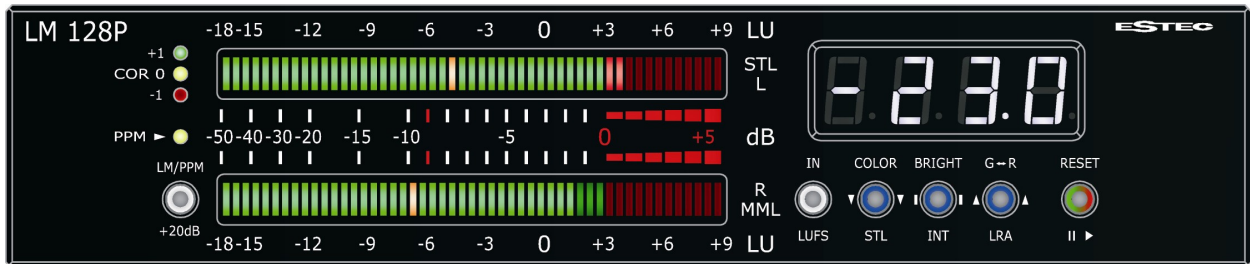
2 Properties

The Estec LM 128P is a Loudness and PPM Meter according to the EBU-recommendation R 128. It fulfills the demands for the 'EBU Mode' corresponding to the specifications

- EBU R 128 (September 2011),
- ITU-R BS.1770-2 (March 2011),
- EBU Tech Doc 3341 (August 2011)
- EBU Tech Doc 3342 (August 2011) and
- DIN IEC 60268-10

For more information please refer to http://tech.ebu.ch/loudness .

Note: The LM 128P does not incorporate a true peak meter according to EBU R 128.

2.1 Inputs

- 1 AES/EBU digital input (XLR) for measurements of stereo signals
- Option: 3G-SDI input/output (BNC) carrying up to 4 stereo signals, each of which can be selected to be measured
- Option: 2 analog inputs (2 x XLR, stereo)

2.2 Display

2.2.1 LU Display Mode

- Short Term Level (average value over 3000 ms) with tricolor LED bar with 51 segments
- Momentary Loudness (average value over 400 ms) with tricolor LED bar with 51 segments

2.2.2 PPM Display Mode

- 2 tricolor LED bars with 51 segments displaying the left and the right channel's PPM values
- Scale range from -50 dB to +6 dB, linear from -10 dB to +6 dB with 2 LEDs per dB

2.2.3 Common in both Display Modes

- Numerical display of Short Term Loudness, Integrated Loudness or Loudness Range by a four-digit 7-segment display
- Numerical display of Momentary Loudness and Integrated Loudness selectable between LU and LUFS
- 3 LEDs +1, 0 and −1 to display L/R-correlation in 5 ranges
- Various options for individual display and operation settings

2.3 Keys

- Key **+20dB**: Adds 20 dB gain to the PPM display. Also: Selection between Loudness Meter (LM) Display Mode and Peak Program Meter (PPM) Display Mode.
- Key **LUFS**: Selection between LU (relative to a reference level) and LUFS (absolute to full scale level). Also: Selection between AES/EBU, SDI and analog inputs (if available).
- Keys **STL**, **INT** and **LRA**: Selection of the 7-segment display: Short Term Loudness, Integrated Loudness or Loudness Range. Also: Setup functions.
- Keys **RUN**/**PAUSE** resp. **RESET**: Start, Stop resp. Pause as well as resetting the Integrated Loudness and the Loudness Range measurement.

3 Technical Data

- 1 AES/EBU input, XLR, transformer coupled, for stereo signal measurements
- Optional 3G-SDI input/output, 2 x BNC
- Optional balanced analog inputs, input impedance approx. 34 kOhm, reference level for 0 LUFS adjustable from 0 dBu up to +24 dBu in steps of 1 dB
- 15 sample rates (8 kS/s up to 96 kS/s) are recognized automatically
- Automatic filter coefficients adjustment for 1 kHz reference frequency
- Sliding 400 ms and 3000 ms measuring windows with 25 ms resolution (i. e., the update rate is 40 Hz and the overlapping is 375 ms and 2975 ms resp.)
- PPM measurements with 10 ms/90% resp. 5 ms/80% attack and 1.5 s/-20 dB decay time
- Correlation Meter dynamic range > 130 dB
- 5 V low voltage supply, max. 2 A
- Size (W x H x D): 190 mm x 40 mm x 140 mm
- Weight: 850 g without / 900 g with optional SDI and analog inputs

4 Connections
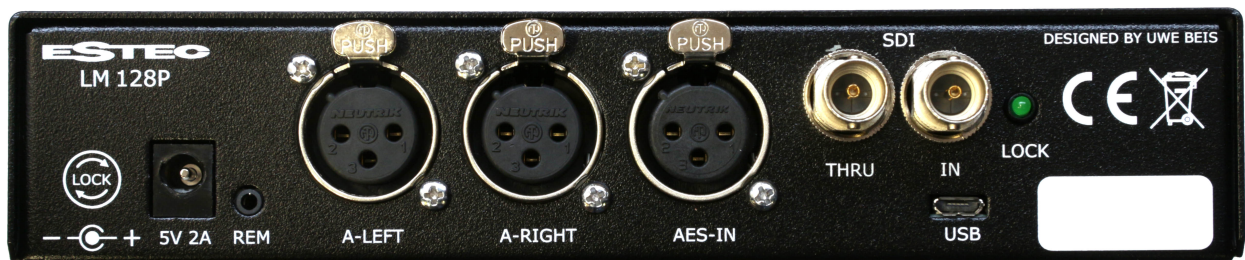
4.1 Power Supply

5 V DC: Please use the supplied power supply unit. Other power supplies may cause malfunctions or even damage the device.

4.2 Digital Audio Inputs

4.2.1 AES Input

This is an AES/EBU resp. AES3 input. With a matching adapter also AES3id (BNC) or S/P-DIF (RCA) signals can be applied.

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4.2.2   3G-SDI Input/Output (optional)

The optional 3G-SDI input/output provides a 4 stereo channel audio de-embedder for data stream 1. These 4 stereo signal pairs can be selected to be measured. The green LED "LOCK" will be on when a valid SDI signal is detected.

4.2.3   Sample Rates

The LM 128P operates with the following 15 sample rates where the filter coefficients are automatically chosen correctly for 1 kHz reference frequency:

8, 11.025, 12, 16, 22.05, 24, 32, 44.1, 48, 64, 88.2 and 96 kHz

For all other sample rates the filter coefficients of the closest known frequencies are chosen.

4.3 Analog Inputs (optional)

An optional analog stereo input is available on two XLR jacks.

4.4 Remote Control

The LM 128P is equipped with a remote control input with a 3-pin TRS (Tip, Ring, Sleeve) jack. With external keys it is possible to

-   start, stop and reset the INT and LRA measurement,

-   select between STL, INT and LRA for the numerical display and

-   clear the clipping indication.

Attention: The plug needs to be plugged <u>strongly</u> as far as it will go into the jack!

4.4.1   Connection

Two keys switching to ground can be connected.

T (Tip):   Start, stop and reset the INT and LRA measurement

**R** (Ring):   Select between STL, INT and LRA for the numerical display and clear clipping indication

S (Sleeve):   Ground

4.4.2   Function

A key at pin T operates identically to the **RUN**/**PAUSE** resp. **RESET** key at the LM 128P.

With a key at pin R the numerical display is cyclically switched between STL, INT and LRA. The blue LEDs in the corresponding keys display the current selection.

Pressing the key at pin R for a longer time will clear the clipping indication.
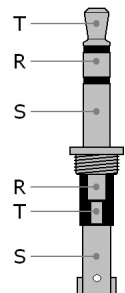
4.5 USB Connector

The LM 128P is equipped with a USB connector in order to read out the measured loudness values and to control the most important functions. Refer to Chapter 7 "USB Functions".

5 Operation

5.1 LED Bars

Depending on the display mode the LED bars either show LM (Loudness Meter) values or PPM (Peak Program Meter) values.

Selection between both modes is done by pressing the **LM/PPM** key a long time (longer than 800 ms). The display mode is indicated by the yellow LED **PPM** above the key, beside the PPM scale.

5.1.1   LM Display Mode

After power-on in LM display mode the upper LED bar **SHORT TERM LEVEL** (**STL**) shows the input's signal average power integrated over the recent 3000 ms. The lower LED bar **MOMENTARY LEVEL** (**MML**) shows the input's signal average power integrated over the recent 400 ms.

The marker 0 LU refers to the target loudness level which should be set to -23 LUFS in order to comply with the EBU R 128 'EBU Mode' specifications. It can be adjusted. In case the LU reference level is not set to -23 LUFS the LM 128P does not operate in the 'EBU Mode'.

5.1.2   PPM Display Mode

In PPM display mode the LED bars display the measured PPM values for the left resp. the right channel. The reference level for the PPM display is -9 dBFS, i.e., with a digital signal of -9 dBFS a PPM value of 0 dB is displayed.

In the PPM display mode 20 dB gain can be added to the displayed PPM value so that signals down to even -70 dB can be detected. The additional gain is selected by the key **+20dB** and indicated by the illuminated key.

5.2 Correlation Display

The left/right channel correlation factor is displayed from -1 to +1 with 3 LEDs.

With these 3 LEDs 5 ranges of correlation can be discriminated:

+1.0 to +0.6	+0.6 to +0.2	+0.2 to -0.2	-0.2 to -0.6	-0.6 to -1.0

5.2.1   Missing Audio Signal Indication

The correlation display is also used to indicate when the digital audio signal is missing. In this case all three LEDs are flashing synchronously.

5.3 Numerical 7-Segment Display

The numerical display indicates measured loudness values during normal operation and settings in Setup Mode.

During normal operation the display may optionally display:

- The **Short Term Level** value **STL**,
- the **Loudness Integrated** value **INT** and
- the **Loudness Range** value **LRA**.

Selection is done by keys **STL**, **INT** and **LRA**. After power-up the 7-segment display shows the Short Term Level.

For the values STL and INT, the readout can be selected between LU/LUFS:

- For LUFS (Loudness Units Full Scale) the key **LUFS** is pressed so that it is lit.
- For LU (Loudness Units relative) the key **LUFS** is pressed so that it is not lit. The displayed value is referenced to the LU reference level mentioned above.

5.3.1   Switching the Numerical Display On or Off

- In LM display mode the numerical display and the LEDs in the keys below are always on.
- In PPM display mode it can be selected whether the numerical display and the LEDs shall be on or off.

In order to select between display on and off in PPM mode, select PPM mode first.

- To turn the display off, press the key with the blue LED on. The display will be switched off.

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- To turn the display on, press any key under the display. The display will be switched on.

5.3.2   Clip Indication

The numerical display is also used to indicate when the audio signal is clipped, even in PPM display mode when it is off.

Clipping is defined as three sequential samples with their 16 MSBits to be either = 7FFF (hex) or <= 8001 (hex). Clipping is indicated by the word 'CLIP'. Refer to chapter 'Clip Indication Time' for display options.

5.4 Input Selection AES, SDI and Analog

Selection between the inputs is done by pressing the key **IN** for a longer time:

- After pressing the **IN** key for a minimum time of 800 ms the selected input is displayed as soon as the key is released but it cannot be changed. The middle blue key starts flashing in order to indicate that it now works as 'Exit' (❙) key.

- After pressing the **IN** key for a minimum time of 5 s the selected input is displayed and can be changed. All three blue keys start flashing. This indicates that the three keys now work as 'Up' (▲), 'Down' (▼) and 'Exit' (❙) keys.

The selected input is indicated in the numerical display. **0** corresponds to the AES input, **1**, **2**, **3** and **4** are the SDI stereo signal pairs and **A** is the analog input.

AES: Press the key **IN** a long time (longer than 5 s), then press key 'Up' (▲) or 'Down' (▼) until '**In 0**' is visible in the numerical display and then 'Exit' (❙).

ADC: When an ADC is installed it is selected by pressing the key **IN** a long time (longer than 5 s) and afterwards pressing key 'Down' (▼) until '**In A**' is visible in the numerical display.

SDI: When a 3G-SDI module is installed each of its four outputs is selected by pressing the key **IN** a long time (longer than 5 s) and afterwards pressing keys 'Up' (▲) or 'Down' (▼) until the desired input '**In 1**' to '**In 4**' is selected.

5.5 Start, Stop, Pause INT and LRA

Pressing the **Pause/Run** key shortly starts the INT (Loudness Integrated) and the LRA (Loudness Range) measurement. Another short push lets them pause, then continue again and so on.

During running measurements the **Pause/Run** key is lit green. It is lit red when the measurements are paused. It is lit yellow when the measurements are running but the STL resp. the MOM value is ignored because its level is below the 'Absolute Gating Threshold' of -70 LUFS as defined by the EBU.

After power-up both measurements are reset and stopped (the key is lit red). As long as no valid measured value is present, '————' is displayed when the INT or LRA value is selected for display. As soon as the measurements have been started and the level is above -70 LUFS the display shows the corresponding INT or LRA value which has been evaluated since the start of the measurements.

The measurements can be reset as well while they are running (key is lit green or yellow) as during pause (key is lit red) by pressing the **RESET** key for a longer time (minimum 800 ms).

5.6 Display Options

The LM 128P offers display options for

- **COLOR** Scheme,
- Brightness (**BRIGHT**) and
- LED bar yellow (**G◄►R**)

These three settings are initiated by pressing the desired blue key for a longer time:

- After pressing the key for a minimum time of 800 ms the selected setting is displayed as soon as the key is released but it cannot be changed. The middle blue key starts flashing in order to indicate that it now works as 'Exit' (❙) key.

- After pressing the key for a minimum time of 5 s the selected setting is displayed and can be changed. All three blue keys start flashing with the selected key flashing inversely. This indicates that the three keys now work as 'Up' (▲), 'Down' (▼) and 'Exit' (❙) keys.

LM 128P

Loudness and Peak Program Meter according to EBU R 128

A numerical equivalent of the corresponding setting is indicated by the 7-segment display.

COLOR The user may choose his preferred color pattern for the LED bars and also between bar display and dot display by selecting color schemes.

- With a bar display all LEDs up to the measured value are lit, all others are adjustable weakly lit or off.

- With a dot display all LEDs are adjustably weakly lit or off while the measured value is indicated by a bright yellow LED.
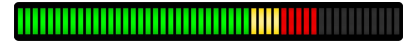
Color schemes are different for LU and PPM bars. When the LU display mode is selected, the user can choose between color schemes provided for the LU Display Mode and when the PPM Display Mode is selected, the user can choose between color schemes provided for the PPM Display Mode.

Positive numerical values indicate bar display settings while negative values indicate the same color scheme but as dot display.

These color patterns are available for LU bars:

1
2
3
4
5
6
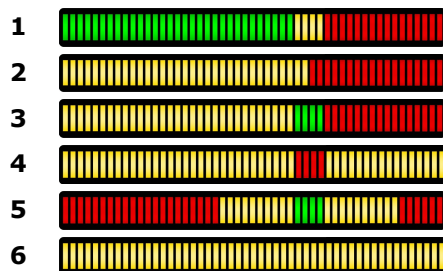
In the LU display mode the color schemes (color patterns and bar/dot display) of both LED bars can be chosen individually: At first the color pattern of the upper LED bar is selected for setup. Each time the **COLOR** key is pressed again for a minimum time of 800 ms the other LED bar is selected.

These color patterns are available for PPM bars:

0   Combined bar and dot display, read below

1   Red starts at 0 dB

2   Yellow starts at 0 dB

3   Red starts at 0 dB

4   Yellow covers -9 dB to 0 dB

5   Yellow covers -10 dB to 0 dB

6   Yellow/green segments, borders at
7   -50, -40, -30, -20, -10, -5 and 0 dB

With pattern 0 both, the peak program value and the digital peak value are displayed:

Value	Peak Program Value	Digital Peak Value
EBU aka	QPPM	SPPM or Fast PPM
Attack Time	10 ms to 90%	Zero (one sample)
Decay time	20 dB/1.5s	
Displayed by	Bar	Yellow dot
100% Full scale at	+9 dB (out of scale)	0 dB (green/red segment border)
20 dB Gain added optionally	Yes	No

BRIGHT With this setting the operator can suit the brightness of all displays (LEDs) according to his preferences.

The background brightness can be adjusted by pressing the **BRIGHT** key a second time again for a minimum time of 800 ms.

G◄►R With this setting the tint of the LEDs set as yellow can be changed between red and green resulting in further variations for the color schemes. Particularly for color pattern 6, where all LEDs are yellow, the user may select his preferred monochrome tint for the LED bar between green, different variations of yellow up to red.

5.7 Reference Level Settings and Clip Indication Time

Attention: *For correct measurements the Reference Level Settings must be set correctly. Wrong settings, e.g. accidentally misadjusted settings, lead to hardly noticeable false measurements!*

These three settings are initiated by pressing the **LM/PPM** key together with the **IN** key for a longer time (minimum 800 ms). All three blue keys start flashing. Now the desired setting is selected by pressing the corresponding blue key for a short time whereby the selected key starts to flash inversely. The three keys now work as 'Up' (▲), 'Down' (▼) and 'Exit' (▐) keys.

5.7.1 LU Reference Level

The LU reference level for the measured LU (Loudness Unit) value can be set between -30 LUFS and 0 LUFS in steps of 1 LU. According to the EBU R 128 this setting shall be -23 LUFS for the EBU Mode. With a setting other than -23 LUFS the LM 128P will no longer work in the EBU Mode.

The LU reference level can be changed after pressing the **LM/PPM** key together with the **IN** key for a longer time (minimum 800 ms) followed by pressing the **STL**/**COLOR** key shortly. During setup the numerical display shows the LU reference level as LUFS.

5.7.2 ADC Full-Scale dBu-Level

When the LM 128P is equipped with an ADC the analog input's gain can be adjusted in 25 steps of 1 dB each so that the digital full-scale value is between 0 dBu and +24 dBu.

Example: A setting of 18 means that an analog signal of +18 dBu is converted to 100% FS. In other words, a sine signal of +18 dBu and 1 kHz applied to both inputs L and R results a measured value of 0 LUFS and a sine signal of +9 dBu is displayed as a peak program value of 0 dB. (This setting corresponds to the standard reference level of the ITU-R BS.645-2).

Standard settings are:

Recommendation	Full-Scale dBu-Level Setting	Analog Level resulting in Digital 100% FS	Nominal Level resp. Permitted Maximum Level 0 dB	Alignment Level −9 dB
ITU-R BS.645-2	18	+18 dBu	+9 dBu	0 dBu
ARD HFBL-K	15	+15 dBu	+6 dBu	-3 dBu

The ADC full-scale dBu-level can be changed after pressing the **LM/PPM** key together with the **IN** key for a longer time (minimum 800 ms) followed by pressing the **INT**/**BRIGHT** key shortly. During setup the numerical display shows the ADC full-scale dBu-level in dBu.

5.7.3 PPM Reference Level

The PPM reference level is fixed according to IEC 268-10/1 so that an input signal of -9 dB FS is displayed at 0 dB on the PPM scale.

5.7.4 Clip Indication Time

The clip indication time is the time during which the word '**CLIP**' is displayed in the numerical display after clipping of a digital audio signal has been detected. It can be set to 0.2 – 0.3 – 0.5 – 0.7 – 1.0 – 1.4 – 2.0 – 3.5 – 7.0 - 10 seconds. It also can be set to '**OFF**' which indicates that no clipping is displayed. Additionally it can be set to infinite ('**On**'). In this case the display must be cleared manually by either of the three blue keys (**STL**, **INT** or **LRA**).

The clip indication time can be changed after pressing the **LM/PPM** key together with the **IN** key for a longer time (minimum 800 ms) followed by pressing the **LRA/G◄►R** key shortly. During setup the numerical display shows the clip display time in seconds resp. the settings '**On**' or '**OFF**'.

5.8 More Displays

5.8.1 Version Number

The firmware version and revision number, e.g. '`P4.00`' (version 4, revision 0), is displayed temporarily after the LM 128P is powered up and visible for a few seconds until the device is operational.

5.8.2 Sample Rate

The sample rate of the selected digital audio input signal is displayed after the **LM/PPM** key together with the **IN** key is pressed for a longer time. In case no signal is present, '`----`' is displayed. In case the analog inputs are selected, '` -A-`' is displayed. Pressing **LM/PPM** temporarily resumes the normal display state.

5.9 Factory Defaults

All settings can be reset to the factory default settings. There are two sets of factory defaults available. One is primarily for using the LM128P as a loudness meter (LM) and the other one is primarily for using the LM 128P as a peak program meter (PPM).

Items marked with an asterisk (*) differ between both defaults.

5.9.1 Factory Defaults for Loudness Meter (LM)

Press and hold the **LM/PPM** key together with the **RUN**/**PAUSE** key for at least 5 s.

Item		Setting	Comment
LED-Bar Display Mode	*	LM	Loudness Meter
20 dB Gain in PPM Mode		Off	None
Numerical Display in PPM Mode		On	
LU/LUFS Display		LU	Referenced to LU Reference Level
Input Selection	*	0	AES3: Digital XLR input
Color Scheme in LM Mode		-1: Dot display	
Color Scheme in PPM Mode	*	0: Combined bar and dot display	
Brightness	*	4	Medium
Background Brightness	*	3	Medium
Yellow LED Tint		Yellow	50% red, 50% green
LU Reference Level		-23 LUFS	EBU R 128 "EBU Mode" requirement
ADC Full-Scale dBu-Level		+18 dBu	According to ITU-R BS.645-2
Clip Indication Time		0.5 s	

5.9.2 Factory Defaults for Peak Program Meter (PPM)

Press and hold the **LM/PPM** key together with the **IN/LUFS** key for at least 5 s.

Item		Setting	Comment
LED-Bar Display Mode	∗	PPM	Peak Program Meter
20 dB Gain in PPM Mode		Off	None
Numerical Display in PPM Mode		On	
LU/LUFS Display		LU	Referenced to LU Reference Level
Input Selection	∗	1	SDI input 1 (audio signal pair 1/2)
Color Scheme in LM Mode		-1: Dot display	
Color Scheme in PPM Mode	∗	1: Bar display	
Brightness	∗	3	Medium
Background Brightness	∗	0	Off
Yellow LED Tint		Yellow	50% red, 50% green
LU Reference Level		-23 LUFS	EBU R 128 "EBU Mode" requirement
ADC Full-Scale dBu-Level		+18 dBu	According to ITU-R BS.645-2
Clip Indication Time		0.5 s	

6 Control Functions Overview

6.1 Short Keystroke

Add or remove 20 dB gain to the measured PPM value:

Change numerical display LU/LUFS:

Display STL (Short Term Level) numerically:

Display INT (Loudness Integrated) numerically:

Display LRA (Loudness Range) numerically:

Start and stop (or pause, resp.) the INT and LRA measurement:

6.2 Long Keystroke

Reset the INT and LRA measurement:

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6.3 Settings

Press key > 0.8 s to display the corresponding setting, > 5 s to change it.

6.3.1 Inputs

Select between different inputs (if available):
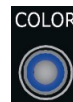
6.3.2 Color Scheme

1. Long keystroke
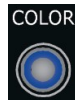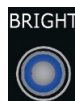
2. Selection with ▲◯▲ or ▼◯▼

3. Finish with ▮◯▮

In LU display mode toggle between both LED bars with long keystrokes

6.3.3 Brightness

1. Long keystroke

2. Increase with ▲◯▲ or decrease with ▼◯▼

3. Finish with ▮◯▮

Toggle between brightness and background brightness with long keystrokes

6.3.4 LED bar Yellow Tint (G↔R)

1. Long keystroke

2. Change to green with ▲◯▲ or to red with ▼◯▼

3. Finish with ▮◯▮

Loudness and Peak Program Meter according to EBU R 128

6.4 Reference Level Settings and Clip Indication Time

6.4.1 LU Reference Level

Note: According to the EBU R 128 this setting shall be -23 LUFS to meet the EBU Mode requirements.

1. Long keystroke [+20dB] and [LUFS]

2. Short keystroke [STL]

2. Selection with ▲[ ]▲ or ▼[ ]▼

3. Finish with [ ]

6.4.2 ADC Full-Scale dBu-Level (if analog inputs are available)

Note: To comply with the standard reference level of the ITU-R BS.645-2 this setting needs to be -18 dBu.

1. Long keystroke [+20dB] and [LUFS]

2. Short keystroke [INT]

2. Selection with ▲[ ]▲ or ▼[ ]▼

3. Finish with [ ]

6.4.3 Clip Indication Time

1. Long keystroke [+20dB] and [LUFS]

2. Short keystroke [LRA]

2. Selection with ▲[ ]▲ or ▼[ ]▼

3. Finish with [ ]

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7 USB Functions

The loudness meter is equipped with a USB port in order to read out the measured loudness values as well as to enable the control of the most important functions of the LM 128P.

When connected to a PC it logs on with a virtual COM port. This virtual COM port requires a driver originating from the company FTDI. The download can be found on the website of FTDI (ftdichip.com) under Drivers → VCP Drivers for different operating systems. At the time of writing this manual the driver for Windows has the version no. 2.12.28 and can be reached via this link:

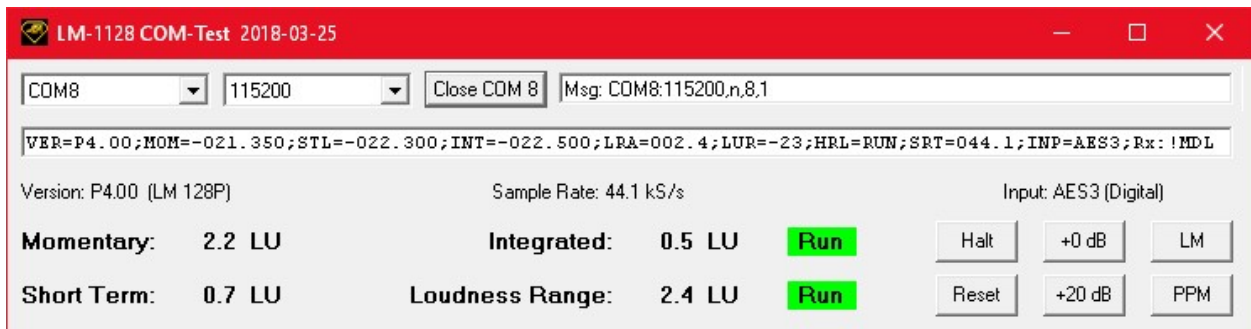http://www.ftdichip.com/Drivers/CDM/CDM%20v2.12.28%20WHQL%20Certified.zip

On request, SSB AUDIO GmbH provides a Windows software for test and demonstration purposes only. A screenshot illustrates the USB functions:

As soon as the COM-port is opened, the LM continuously sends 40 cr/lf-terminated strings per second as visible on the screenshot above, in this case:

`VER=P4.00;MOM=-021.350;STL=-022.300;INT=-022.500;LRA=002.4;LUR=-23;HRL=RUN;SRT=044.1;INP=AES3;Rx: !MDL`

`VER=P4.00`	the firmware version
`MOM=-021.350`	the Momentary Level (MOM) in LUFS (can also be MOD=, see below)
`STL=-022.300`	the Short Term Level (STL) in LUFS (can also be STD=, see below)
`INT=-022.500`	the Integrated Loudness in (INT) LUFS
`LRA=002.4`	the Loudness Range (LRA) in LU
`LUR=-23`	the relative numeric LU/LUFS setting
`HRL=RUN`	the state of the Integrated and the Range measurement
`SRT=044.1`	the current sample rate
`INP=AES3`	the input state and selection
`RX: !MDL`	the last received command

Note: All transmitted values are always absolute LUFS-values and not relative LU values.

Remarks on the transmitted values:

`MOD=` instead of `MOM=` resp. `STD=` instead of `STL=`	indicates that this value is also displayed on the numerical display of the LM so that inconsistencies between numerical PC- and numerical LM-display can be avoided (the LM's numerical display is only updated a couple of times per second while these values are sent 40 times per second).

`????.???` resp. `????.?` for a measured values indicates that there is currently no valid value available

`LUR=`	`LUR=+00:`	Numeric LM display in LUFS,
	`LUR=+23:`	Numeric LM display in LU with 23 LUs added to the LUFS value (transmitted values are always LUFS values).
`HRL=`	`HRL=RUN:`	Normal measurement,
	`HRL=HLT:`	Halted (paused),
	`HRL=LOW:`	The 400 ms (STL) as well as the 3000 ms (MOM) value is momentarily too low to contribute to the Loudness Integrated resp. Loudness Range value,
	`HRL=LO4:`	The 400 ms (STL) is momentarily too low to contribute to the Loudness Integrated (INT) value,
	`HRL=LO3:`	The 3000 ms (MOM) value is momentarily too low to contribute to the Loudness Range (LRA) value.
`INP=`	`INP=AES3:`	The AES input is selected
	`INP=ADC :`	The analog input is selected (if available)
	`INP=SDI1` to `SDI4`:	The SDI channel pairs 1 to 4 are selected (if available)

The following commands, terminated by CR/LF, can be sent to the LM:

- **!RUN**   Starts or resumes the integrated and range measurement
- **!HLT**   Halts (pause) the integrated and range measurement
- **!RES**   Resets the integrated and range measurement
- **!G00**   No additional gain for PPM scale
- **!G20**   20 dB additional gain for PPM scale
- **!MDL**   Operation Mode Loudness Meter
- **!MDP**   Operation Mode Peak Program Meter

8 Appendix

Table: Relations between dB values, gain and level in dBu

dB	Voltage and Current Gain	Power Gain		dBu	Voltage (RMS)
0	1	1		0	0.77459667
1	1.12201846	1.25892542		1	0.86911176
2	1.25892542	1.5848932		2	0.97515943
3	1.41253756	1.99526237		3	1.09414689
4	1.5848932	2.51188647		4	1.227653
5	1.77827941	3.16227766		5	1.37744931
6	1.99526237	3.98107192		6	1.54552359
7	2.23872111	5.0118722		7	1.73410591
8	2.51188647	6.30957362		8	1.94569889
9	2.81838285	7.94328191		9	2.18310997
10	3.16227766	10		10	2.44948974
11	3.54813399	12.5892548		11	2.74837277
12	3.98107192	15.8489337		12	3.08372505
13	4.46683568	19.952621		13	3.45999604
14	5.0118722	25.1188629		14	3.88217951
15	5.62341325	31.6227766		15	4.35587717
16	6.30957362	39.8107192		16	4.88737471
17	7.07945823	50.1187289		17	5.48372477
18	7.94328191	63.0957275		18	6.15283971
19	8.91250914	79.4328191		19	6.90359989
20	10	100		20	7.74596669