



ACAPO

ASSOCIAÇÃO DOS CEGOS E AMBLÍOPES DE PORTUGAL

# ACAPO REPORT BRAILLE EMBOSSERS BENCHMARK

Tests and conclusions report

## Summary

Comparative and performance study of Braille embossers available in the domestic market.

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## 2 ANNEXES

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- Annex 2 - "Test Report No. 19.12.424.035", on EMC tests performed by ISQ
- Annex 3 - "RELATÓRIO REFª: DBW ERAP 0254/19", on noise tests performed by dBwave.i (an ISQ Group company)
- Annex 4 - " ACAPO BENCHMARK IMPRESSORAS BRAILLE", on measurement of the Braille dot on 4 different embossers, performed by JB & LT Metrology Solutions, Lda.
- Annex 5 - Comparison of technical and functional characteristics – file: "ACAPO\_Braille\_Benchmark.xlsx"

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## 3 INTRODUCTION

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### 3.1 MOTIVATION

ACAPO – Association of The Blind and Amblyopes of Portugal – is the Representative Association of the Visually Impaired in Portugal, being one of the main Portuguese Braille producers, having a strategic position in the implementation of Braille standards for all Portuguese-speaking countries, as well as one of the main associations of the blind in Europe.

Being the Braille the inescapable "Instrument" in the literacy of the blind, it is definitely an integral part of the inclusion of an entire community. But Braille is also one of the most exclusive media in the world (only less than 0.5% of the world's population can decipher it, by tact or visually), which causes some discomfort to most of those who intersect with their existence or need, and it is clear the difficulty in obtaining good documentation on such a differentiated and specific industry.

Because of the importance for all end-users, funding institutions, educational agents, potential clients and organizations that want to produce Braille in relatively small quantities, i.e. the majority of the acquisitions in this market, it is important to evaluate potential models available in the domestic market.

### 3.2 PURPOSE

Based on the motivation mentioned before, and due to ACAPO's experience, this work aims to carry out complete tests of comparison between the current embossers available on the market in order to systematize, measure and compare the potential models available in the domestic market.

In this first phase, only "common" Braille embossers at low price – up to 5000€ - with double side printing capability and reasonable speed for today's technology - minimum standard 100CPS - will be considered, as all suppliers have models in this range within the same price range.

### 3.3 REPORT STRUCTURE

This report is divided into four key parts:

1. Electrical and Mechanical Tests – focusing on Electromagnetic Compatibility tests, acoustic noise tests and mechanical tests for Braille dot characterization, in order to allow subsequent comparative analysis;
2. Technical and Functional Specifications, where the results of the tests of the previous points are compared, as well as the technical and functional specifications of the models under analysis;
3. Functional Tests in the User's Perspective – where, with an emphasis on the ease of use by the end user, all relevant specifications of the models under analysis, from the initial installation, equipment handling, connectivity, to achieving final results, and tactile quality of these, are compared. In this part, technical support is also analyzed, as well as ease of maintenance;

4. Conclusions, where the study is closed, and final considerations are discussed about the embosser models under analysis.



## 4 DEVICES UNDER TESTING

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For the present study, three models of Braille embossers currently available in the national market were considered, representing the category of low-priced embossers --up to 5000€ - with reasonable speed for current technology - minimum standard 100CPS:

1. ViewPlus Columbia;
2. IndexBraille Basic-D V5;
3. Enabling Technologies Juliet 120;

### 4.1 VIEWPLUS COLUMBIA + TIGER BOX



The ViewPlus Columbia is a desktop Braille embosser for Braille and tactile graphics production, using continuous paper.

Main features advertised by the manufacturer:

- Print speed: Up to 120 CPS;
- Up to 400 PPH;
- Printing Mode: Double-sided;
- USB e Ethernet connectivity;
- TSS software pack (Tiger Suite Software) for Braille translation and production of graphics;
- Tiger Box external module, adding wireless capabilities (Wi-Fi, Wi-Fi Direct and Bluetooth) as well as automatic Braille translation, and direct printing from PC / smartphone / tablet;
- Paper type: continuous (tractor-fed), 90g/m<sup>2</sup> to 200g/m<sup>2</sup>;
- Height/Width/Depth: 158mm x 557mm x 275mm;
- Weight: 9kg;
- Noise level: 70 dB(A);
- Price (December 2019): 3,262.00 € (including Tiger Box);
- Device model in analysis in this report: Columbia 131201;
- S/N of the device in analysis in this report: S/N CCL0001463;

## 4.2 INDEXBRAILLE BASIC-D V5



The IndexBraille Basic-D V5 is a lightweight, compact, low-cost desktop Braille embosser with advanced features.

Main features advertised by the manufacturer:

- Print speed: Up to 120 CPS;
- Up to 310 PPH;
- Windows/Mac/Linux/Unix support, as well as mobile devices (iOS e Android);
- Voice interface with built-in speaker (Acapela synthetic speech);
- Mobile Printing;
- Double-sided printing (interpoint);
- Horizontal and vertical printing;
- USB (*host port*), Ethernet, Wi-Fi and Bluetooth connectivity;
- Direct-printing from USB pen drive (*device port*);
- BrailleApp printing (webserver with integrated Braille editor, and direct printing capabilities from PC/smartphone/tablet);
- Paper type: continuous (tractor-fed), 120g/m<sup>2</sup> to 180g/m<sup>2</sup>;
- Height/Width/Depth: 130mm x 520mm x 260mm;
- Weight: 7,6kg;
- Noise level: 80 dB(A);
- Price (December 2019): 3,295.00 €;
- Device model in analysis in this report: Basic-D V5;
- S/N of the device in analysis in this report: S/N 69250;

### 4.3 ENABLING TECHNOLOGIES JULIET 120



The Enabling Technologies Juliet 120 is a lightweight, compact, low-cost desktop Braille embosser with advanced features.

Main features advertised by the manufacturer:

- Print speed: Up to 120 CPS;
- Up to 400 PPH;
- Voice interface with built-in speaker (Acapela synthetic speech);
- Horizontal and Booklet/Newspaper printing;
- Double-sided printing (interpoint);
- USB (*host port*), Ethernet, Wi-Fi and Bluetooth connectivity;
- Direct-printing from USB pen drive (device port);
- Embedded webserver;
- Free FireBird graphics software;
- Paper type: continuous (tractor-fed), 120g/m<sup>2</sup> a 180g/m<sup>2</sup>;
- Height/Width/Depth: 130mm x 520mm x 260mm;
- Weight: 7,6kg;
- Noise level: 80 dB(A);
- Price (December 2019): 4,028.00 €;
- Device model in analysis in this report: Juliet 120;
- S/N of the device in analysis in this report: S/N 21374;

## 5 ELECTRICAL AND MECHANICAL TESTS

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### 5.1 ELECTROMAGNETIC COMPATIBILITY TESTS (EMC)

Both devices manufactured in Europe have their Compliance Reports available for consultation, which does not happen with the equipment manufactured in the US (ViewPlus Columbia). Therefore, it was chosen to perform this type of testing only on the equipment manufactured in the US (ViewPlus Columbia).

The compliance of the ViewPlus Columbia embosser regarding the Electromagnetic Compatibility Directive 2014/30/EU was therefore assessed. A summary analysis of the main aspects relating to electrical safety was also carried out, under the Low Voltage Directive 2014/35/EU. EMC test reports are attached (annex 1 and annex 2).

Regarding Electromagnetic Compatibility, products bearing the CE Marking are presumed compliant with the requirements of the Electromagnetic Compatibility Directive, being an essential condition for placing this type of device on the domestic market.

The EU Community and Portuguese legislation that is directly encompassed in this context is as follows:

- Directive 2014/30/EU of the European Parliament and of the Council of 26 February;
- Decree-Law No. 31/2017 of March 22;
- Official Journal of the European Union on harmonized standards under the Electromagnetic Compatibility Directive.

For technical and logistical reasons, Electromagnetic Compatibility (EMC) tests carried out on the ViewPlus Columbia embosser were distributed among two national laboratories, the EMC Laboratory of the ISQ – Instituto da Soldadura e Qualidade – and ANACOM's EMC Laboratory – Autoridade Nacional de Comunicações.

The reports issued by these entities concerning immunity and emission tests are annexed to this report:

- Annex 1 - "EMC Test Report 0039742019.A", on EMC tests performed by ANACOM;
- Annex 2 - "Test Report No. 19.12.424.035", on EMC tests performed by ISQ;

#### 5.1.1 Applicable Product and Generic Standards

Harmonized Standards used for conformity assessment under the Electromagnetic Compatibility Directive applicable to this type of product are:

- EN 55032:2012 + AC:2013 – "*Electromagnetic compatibility of multimedia equipment – Emission Requirements*";
- EN 55024:2010 – "*Information technology equipment – Immunity characteristics – Limits and methods of measurement*";
- EN 61000-3-2:2014 – "*Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current  $\leq 16$  A per phase)*";

- EN 61000-3-3:2013 – " *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current  $\leq 16$  A per phase and not subject to conditional connection*";

EN 55032, which replaces EN 55022, sets emission limits under the Electromagnetic Compatibility Directive, applicable to multimedia equipment, which includes printers and other office and home appliance equipment, like embossers. EN 55024 defines the immunity test requirements for information technology equipment in relation to continuous and transient conducted and radiated disturbances under the Electromagnetic Compatibility Directive.

The standard EN 61000-3-2 sets the limits for harmonic current emissions (equipment input current  $\leq 16$  A per phase). The standard EN 61000-3-3 sets the limits for voltage changes, voltage fluctuations and flicker in public low-voltage energy supply systems, for equipment with rated current  $\leq 16$  A per phase and not subject to conditional connection.

## 5.1.2 Summary and results of EMC tests

### 5.1.2.1 Emission Tests

Port	Environmental Phenomena	Basic Standard	Test specification/units	Entity	Result
Enclosure	Radiated emission	EN 55032, Class B	30MHz – 1GHz	ANACOM	OK
Enclosure	Radiated emission	EN 55032, Class B	1GHz – 6GHz	ANACOM	OK
Power Supply	Conducted emission	EN 55032, Class B	0.15MHz – 30MHz	ANACOM	OK
Ethernet Communications	Conducted emission	EN 55032, Class B	0.15MHz – 30MHz	ISQ	OK
Power Supply	Current harmonics	EN 61000-3-2	Class A	ISQ	OK
Power Supply	Flicker	EN 61000-3-3	See standard	ISQ	OK

### 5.1.2.2 Immunity tests

Port	Environmental Phenomena	Basic Standard	Test specification/units	Entity	Criterion	Result
Enclosure	Electrostatic discharge immunity	EN 61000-4-2	±4 kV, contact discharge ±4 kV, indirect discharge ±8 kV, air discharge	ANACOM	B	OK
Enclosure	Radiated electromagnetic field immunity	EN 61000-4-3	3V/m, 1kHz, 80% AM	ANACOM	A	OK
Power Supply	Fast transient / burst immunity	EN 61000-4-4	±1 kV; 5/50ns, 5kHz	ANACOM	B	OK
Ethernet Communications	Fast transient / burst immunity	EN 61000-4-4	±0,5 kV; 5/50ns, 5kHz	ANACOM	B	OK
Power Supply	Surge immunity	EN 61000-4-5	±2 kV (MC); 1,2/50 µs ±1 kV (MD); 1,2/50 µs	ANACOM	B	OK
Power Supply	Conducted RF disturbance immunity	EN 61000-4-6	0,15 – 80MHz, 3Vr.m.s., 1kHz 80%	ANACOM	A	OK
Ethernet Communications	Conducted RF disturbance immunity	EN 61000-4-6	0,15 – 80MHz, 3Vef. 1kHz 80%	ANACOM	A(1)	OK(1)
Enclosure	Power frequency magnetic field immunity	EN 61000-4-8	1 A/m; 50Hz; 1 minute	ISQ	A	OK
Power Supply	Voltage dips and voltage interruptions	EN 61000-4-11	0% Un, 10ms 70% Un, 500ms 0% Un, 5s	ISQ	A C (A)(2) C	OK

- (1) The presence of 1kHz noise was detected at the output of the audio port during the test. The signal/noise ratio has been degraded, but not to the point of compromising its functionality.
- (2) The Acceptance Criterion defined by the Standard concerned is Criterion C, but the equipment complied with Criterion A (more demanding).

As can be concluded from the previous tables, the ViewPlus Columbia device complied with the requirements presented in the "Test specification/Units" and "Result" columns regarding the relevant harmonized Standards under the Electromagnetic Compatibility Directive.

### 5.1.3 Conclusions regarding EMC testing

As per the conclusions present in the ANACOM and ISQ test reports and taking into account the notes/comments made throughout this document, it can be concluded that the equipment concerned complies with the Electromagnetic Compatibility Directive, Directive 2014/30/EU of the European Parliament and of the Council.

## 5.2 BRIEF ANALYSIS ON ELECTRICAL SAFETY

In addition to Electromagnetic Compatibility, the CE Marking also requires the fulfilment of the essential requirements regarding the Low Voltage Directive, also representing an essential condition for placing this type of device on the EU market.

Although outside the scope of this report, a brief analysis regarding electrical safety was carried out under the scope of the Low Voltage Directive. The EU Community and Portuguese legislation that is directly encompassed in this context is as follows:

- Directive 2014/35/EU of the European Parliament and of the Council of February 2014;

This brief analysis, although not exhaustive, focused on critical aspects of electrical safety, based on EN 60950-1 standard, considered the most relevant standard whenever general user safety is concerned. Other situations involving risk of ignition and spread of fire, fault conditions in case of failure, or misuse, were not covered.

Regarding electrical safety, the following points were analyzed:

- Class I equipment, with provision for protective earthing through cable supplied with the equipment, which is of the type *pluggable Equipment Type A*;
- Power connector with integrated protective fuse and power switch;
- Internal switched-mode power supply, MeanWell brand, model SP-200-48, bearing CE Marking and Security Agency Safety Certificates (in this case, UL (USA));
- The rated output voltage of the power supply is 48V d.c., thus being considered a SELV level (*Safety-Extra Low Voltage*);
- All embosser electronics are powered by this voltage and therefore the voltage levels present are also considered SELV;
- Internal metal chassis (as well as other metal parts) properly bonded to protective ground conductor;
- User interfaces connected to internal ground/earth (and therefore to the protective ground conductor);
- Communication interfaces (USB port, transformer-insulated Ethernet port and audio output) electrically referenced to internal ground/earth (and therefore to the protective ground conductor);
- From the functional analysis performed, no surfaces that could reach high temperatures were detected, and which could be hazardous to the user;
- Moving mechanical parts that may present a hazard to the user are protected, so the risk to the user under normal operating conditions is low;
- In terms of mechanical robustness, design and construction, generically the equipment does not present a hazard to the user.

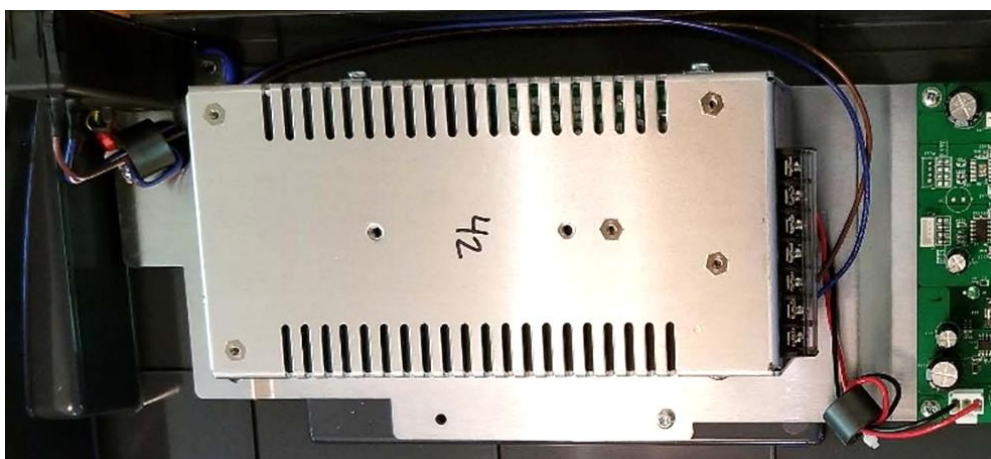
### 5.2.1 Power supply connection and communication ports

The following figures illustrate the embosser's power connection, which uses an IEC connector, with integrated fuse and switch, as well as its communication ports, namely USB, Ethernet network and audio output. The housings of these are properly connected to the metal internal chassis, which extends under the main printed circuit board and power supply and is properly bonded to the protective earth.



### 5.2.2 MeanWell SP-200-48 switched-mode power supply

The following figure illustrates the *closed frame* switched-mode power supply used by the ViewPlus Columbia embosser, namely a MeanWell SP-200-48 model, with an output voltage of 48V d.c. and rated 200W, bearing CE Marking, as well as Safety Regulatory Agency certificate (UL). Its casing is properly bonded to the embosser's internal metal chassis, and therefore to the protective earth.





### 5.3 ACOUSTIC NOISE LEVEL TESTS

Acoustic noise tests were carried out by the company dBwave.i, a company belonging to the ISQ group - Instituto da Soldadura e Qualidade. Measurements were taken inside the anechoic chamber of the ISQ Electromagnetic Compatibility Laboratory in Tagus Park, Oeiras.

The tests were carried out inside the anechoic chamber because the absorbent elements placed on the walls of the chamber ensured the reduction of sound reflections, which makes it appropriate for the evaluation of noise from the embossers under testing.

The tests are described in report DBW ERAP 0254/19, issued by dBwave.i, dated 2 September 2019. The equivalent continuous sound level  $L_{Aeq}$  (dB(A)) was measured, as it is the descriptor parameter best associated with the human perception of a noise.

Four noise measurement points were used, 1 m away from the embossers. The sonometers were placed with their measuring microphones at 1.2m from ground. The embossers were placed on a wooden table with an height of 0.75m:



The operating conditions used were identical for the 3 embossers:

- Double-sided printing - "interpoint";
- Printing on Braille paper 160g/m<sup>2</sup>, 11" x 12";
- Printing 27 lines per page and 40 characters per line.

#### 5.3.1 Summary and results of acoustic noise tests

The equivalent continuous sound level,  $L_{Aeq}$ , using A-weighting, of a noise and a Time Interval  $T$ , is defined from the instantaneous magnitude of the sound level, in dB(A), as:

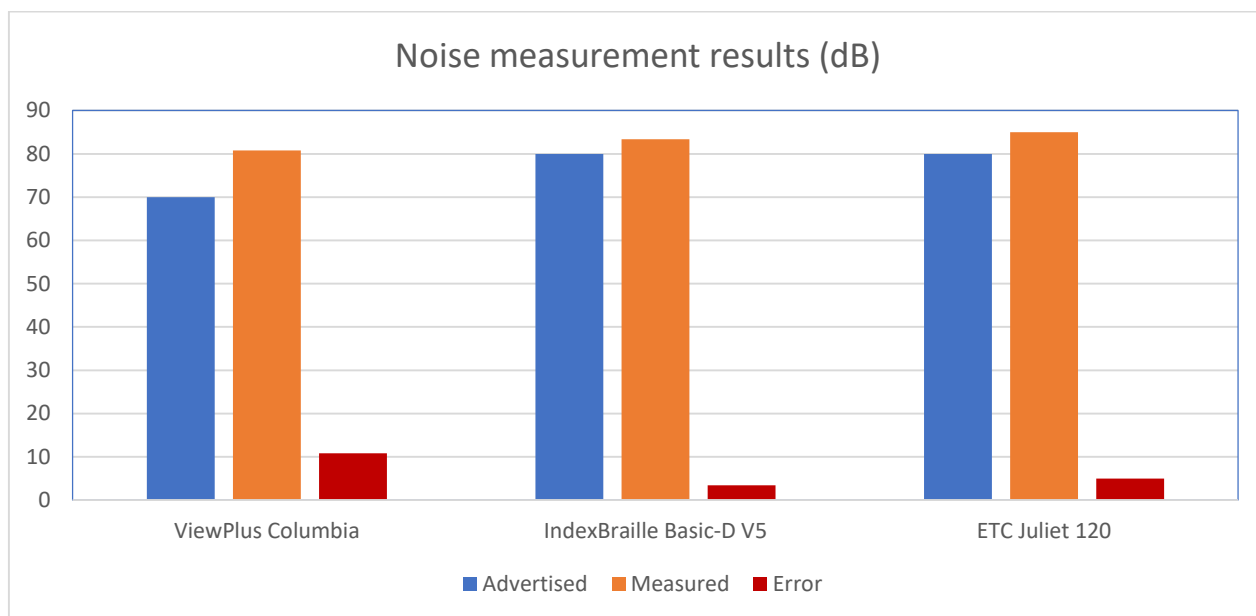
$$L_{Aeq} = 10 \log_{10} \left[ \frac{1}{T} \int_0^T 10^{\frac{L_A(t)}{10}} dt \right]$$

Where  $L_A(t)$  represents the instantaneous value of the sound level, in dB(A).

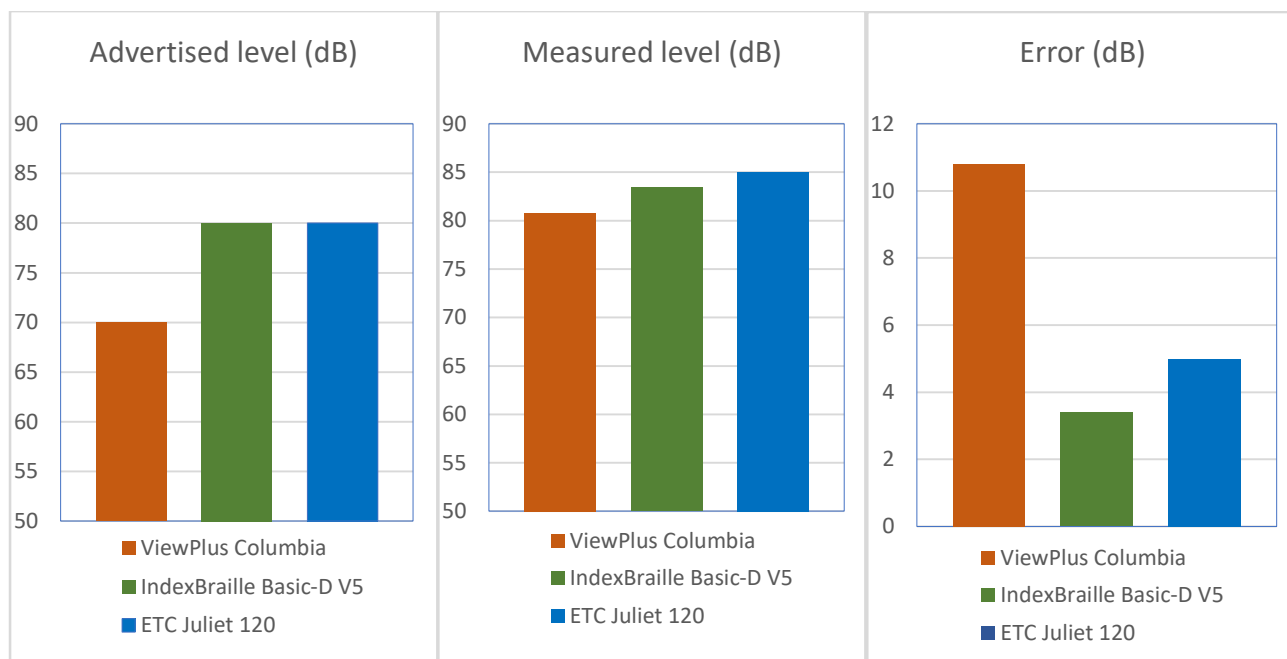
The following table and chart summarize the results, including the advertised noise levels, the average levels of the 4 measurement points, and the error (deviation) calculated for the 3 embossers:

Measuring point	L <sub>Aeq</sub> [(dB(A))]		
	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
P1 (Left)	77,8	79,7	82,4
P2 (Front)	81,3	83,7	84,7
P3 (Right)	78,8	80,6	83,2
P4 (Back)	83,3	86,3	87,6
<b>Average level</b>	<b>80,8</b>	<b>83,4</b>	<b>85,0</b>
<b>Advertised noise level</b>	<b>70,0</b>	<b>80,0</b>	<b>80,0</b>
<b>Error (dB) (Average level vs advertised level)</b>	<b>+10,8</b>	<b>+3,4</b>	<b>+5,0</b>

The following graph groups these results by embosser model:



The following graphs illustrate the aggregate values by category (Advertised level, Measured level, Error):



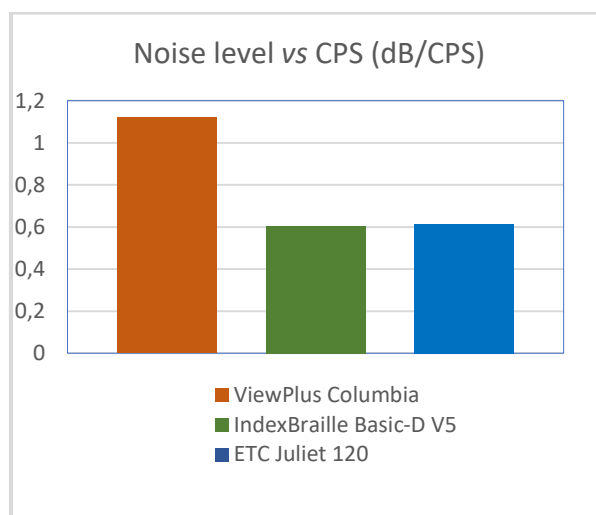
### 5.3.2 Conclusions on noise level tests

The test results reveal that although there are differences between the 3 embossers under similar conditions of use, the ViewPlus Columbia is the least noisy, and the ETC Juliet 120 the noisiest, with a difference between them of just over 4dB. This difference, although noticeable, is not extreme.

Although it was found that all three embossers exceeded the values advertised by their respective manufacturers, It should be noted that the ViewPlus Columbia is the one which deviates the most, by a margin of 10.8 dB (i.e., more than three times the noise level advertised by the manufacturer). IndexBraille Basic-D V5 and ETC Juliet 120 exceeded the stated values, respectively, by 3.4 dB and by 5 dB.

In any case, it was found that any noise reduction is very welcome, since the noise levels produced by any of the embossers under analysis are, at least, uncomfortable and stressful.

On the other hand, if taken into account the performance in terms of print speed of the embossers in question, considering the indicator noise *versus* CPS, (dB / CPS), we found that both IndexBraille Basic-D V5 and the ETC Juliet 120 are more efficient when it comes to this indicator, producing almost half of the noise by printed character per second (dB / CPS):



## 5.4 BRAILLE DOT MECHANICAL CHARACTERIZATION TESTS

For several decades, we have been speaking about the “Braille Dot Quality” of the various alternative communication devices that are introduced to the market, whether Braille embossers, Braille displays or others where the output is Braille.

Strictly speaking, perhaps because of the comfort of the specialized industry or the inadequacy of organizations to impose, this quality indicator was never quantified to end with the subjective assessment, conjuring or speculation. From now on, it may represent a technical figure of merit of each equipment. Braille Embossers, as well as other equipment have as last and final mission: The production of Braille.

So, it is important to define what it is:

1. A quality Braille dot;
2. How to measure it categorically and scientifically;
3. How to present it to the public for easy understanding and evaluation.

Today there are high precision optical tools available, capable of evaluating micro-infinitesimal measurements in a variety of ways. For this reason, it is possible to accurately characterize the degree of perfection of any form produced today, including the Braille dots of assistive technology equipment.

Based on these tools, the aim is to establish new market indicators to easily compare and evaluate the overall quality of the Braille dot printed by this type of embossers.

Accordingly, a quality Braille dot is understood to be similar to the standard dot of Perkins Braille.

Measurement in a categorical and scientific way is now possible thanks to the existence of high precision optical tools that allow the characterization and analysis of small structures such as the common Braille dot.

In order to easily evaluate and compare the overall quality of the Braille dot printed by a Braille embosser, a global Braille dot quality indicator - called *BDQ* - has been developed, that includes criteria for stability and Braille dot quality. It is calculated as the product of the various partial indicators,  $\alpha_D$  and  $\alpha_M$  relating to the dimensional stability of the Braille dot and Braille matrix, and  $Q_F$  and  $Q_V$  relating to the shape and volume quality of the Braille dot, as described in detail ahead.

### 5.4.1 Test

The method used, and described below, accurately and scientifically characterizes the results obtained by Braille embossers. It represents a mathematical, technical and practical approach to the quality assessment of the printed Braille dot using the latest technology for high precision measurements.

For the *BDQ* Braille Quality Measurement tests, the Metrology Laboratory of MetrologySolutions, a partner of the renowned manufacturer Zeiss (Zeiss Business partner) has been used.

### 5.4.2 Measured parameters

The mechanical tests of characterization of the Braille dot focused on four fundamental parameters for the embossers under analysis, and then a mathematical analysis was run to obtain the desired indicators. The measured parameters were:

- Braille dot diameter, measured at its base;
- Radius of curvature (this parameter has some limitations, as we shall see later);
- Braille dot height, measured from the base plane and the top thereof;

- Distance between dots in the Braille matrix (6 dot Braille);

The statistical analysis of the information collected includes:

- Absolute maximum value for all parameters in evaluation;
- Absolute minimum value for all parameters in evaluation;
- Average arithmetic value for all parameters in evaluation;
- Standard deviation calculated on 100% of the measurements for all evaluation parameters;

In terms of relevance to the present study, it is interesting to assess the information gathered during the metrological tests in order to make an analysis relevant to the user audience of Braille embossers. Thus, based on these results, the analysis focuses on:

- Braille dot Mechanical Characterization (diameter, height and radius of curvature);
- General homogeneity of the Braille dot (variation over several pages);
- Evaluation indicators for the creation of Braille dot:
  - Braille dot dimensional stability indicator,  $\alpha_D$ ;
  - Braille matrix stability indicator,  $\alpha_M$ ;
  - Braille dot shape quality indicator,  $Q_F$ ;
  - Braille dot volume quality indicator,  $Q_V$ ;
  - Global assessment indicator for Braille Dot Quality,  $BDQ$ ;
- Comparative analysis of the Braille dot printed by the target embossers in this study.

#### 5.4.3 Definition of indicators

##### 5.4.3.1 Braille dot dimensional stability Indicator, $\alpha_D$

The dimensional stability of the Braille dot was evaluated based on the variation of its height as well as the variation of the diameter at its base. The radius of curvature was not considered, given the difficult characterization in practice. Two partial indicators were defined, one for the stability of the height of the dot, and another for the stability of its diameter, as well as an overall indicator of dimensional stability:

- dimensional stability indicator of dot height,  $\alpha_{DA}$ ;
- dimensional stability indicator of dot diameter,  $\alpha_{DD}$ ;
- global indicator for dimensional stability of the Braille dot,  $\alpha_D = \sqrt{\alpha_{DA} \cdot \alpha_{DD}}$

Where:

$$\alpha_{DA} = 1 - \left( \frac{1}{\bar{A}/\sigma_A} \right)^2, [0 \leq \alpha_{DA} \leq 1]$$

and

$$\alpha_{DD} = 1 - \left( \frac{1}{\bar{D}/\sigma_D} \right)^2, [0 \leq \alpha_{DD} \leq 1]$$

And therefore:

$$\alpha_D = \sqrt{\alpha_{DA} \cdot \alpha_{DD}}, [0 \leq \alpha_D \leq 1]$$

Where  $\bar{A}$  represents the average height of the Braille dot,  $\bar{D}$  the average diameter of the Braille dot, and  $\sigma_A$  and  $\sigma_D$  the standard deviation of those measurements.

#### 5.4.3.2 Braille matrix stability indicator, $\alpha_M$

The stability of the Braille matrix was evaluated based on the variation of its pitch, being the nominal value in all cases 2.5mm. Thus, the Braille matrix stability indicator was defined,  $\alpha_M$ :

$$\alpha_M = 1 - \frac{1}{2 \cdot \bar{M} / \sigma_M}, [0 \leq \alpha_M \leq 1]$$

Where  $\bar{M}$  represents the average of the distances measured between dots 1 of adjacent Braille cells, and  $\sigma_M$  represents the standard dev. of that measurement.

#### 5.4.3.3 Braille dot shape quality indicator

The quality of the Braille dot shape was established based on the dev. of its shape from the considered ideal Braille dot, the Perkins Brailler dot. Thus, this indicator represents the quality in relation to height,  $A_P$  and diameter,  $D_P$  of the Perkins dot:

$$Q_F = 1 - \left( \left| \frac{\bar{D} - D_P}{D_P} \right|^2 + \left| \frac{\bar{A} - A_P}{A_P} \right|^2 \right)$$

#### 5.4.3.4 Braille dot volume quality indicator

The quality of the Braille dot volume was established based on its volume dev. from the ideal Braille dot, the Perkins Brailler dot. Thus, this indicator represents the quality relative to the volume of the Perkins Braille dot:

$$Q_V = 1 - \left| \frac{(\bar{D} \cdot \bar{A}) - (D_P \cdot A_P)}{D_P \cdot A_P} \right|^2$$

#### 5.4.3.5 Global Braille Dot Quality Assessment Indicator, $BDQ$

The global Braille Dot Quality assessment indicator,  $BDQ$ , was thus defined as the product of the various partial indicators,  $\alpha_D$  and  $\alpha_M$  concerning the dimensional stability of the Braille dot and matrix, and  $Q_F$  and  $Q_V$  concerning the shape and volume quality of the Braille dot:

$$BDQ = \alpha_D \cdot \alpha_M \cdot Q_F \cdot Q_V \cdot 100, [0 \leq BDQ \leq 100]$$

The maximum score of 100 points represents the volume and shape of the Perkins Braille dot consistently and uninterrupted embossed in the correct Braille matrix position.

#### 5.4.4 Method and test conditions

The mechanical tests for characterization of the Braille dot were performed based on flowing text embossing, using the alphabetical characters in sequence, on an 8.5 " x 12 " Braille paper of 160g / m<sup>2</sup>, with 27 lines per page and 26 characters per line ("abcdefghijklmnopqrstuvwxy"), two-sided, with the first page embossed on the front, the second on the back, and so on.

A total of 502 pages per embosser were embossed, corresponding to a total of 502 sheets, as each sheet has only one embossed page (odd front pages, even back pages). For analysis and measurement purposes, sheets 1 and 2, 101 and 102, 201 and 202, 301 and 302, 401 and 402, and 501 and 502 of each "run" were extracted for the ViewPlus Columbia and IndexBraille Basic- D V5.

For the ETC Juliet 120 embosser, only 4 sheets, A1, A2, B1 and B2 were evaluated. Sheets A1 and A2 refer to a standard Juliet 120 embosser, while sheets B1 and B2 refer to a modified Juliet 120 embosser with optimized pins and cups, kindly provided by the manufacturer for testing the new pre-production model to be presented to the market, with the former ETC – Juliet dot.

The sheets were then embossed without interruption and in the standard modes of each embosser (quality and speed) to represent real and identical situations for each embosser. In the case of the ViewPlus Columbia embosser, due to internal buffer limitations, 100-page sequences were embossed with a short interval between them (< 10s)<sup>1</sup>.

The prints were made at the ACAPO premises using the *Braille Facile* software, at the Chelas Braille Production Center, and the pages indicated above were numbered, stamped and signed. These pages were delivered to the metrology lab of JB & LT MetrologySolutions, Lda., for their analysis.

Each sheet was scanned using high-resolution Zeiss optical equipment. 28 STL files were generated and then analyzed by specific software. This software generated Excel files (Annex 4), which were then subjected to mathematical analysis, the results of which are presented in the following section.

Regarding the evaluation of the "radius of curvature" parameter, and as will be seen from the results shown below, a significant variation will be observed. There are two main reasons for this.:

- Technically, paper imperfection limits the fixed definition of a general plan to all dots on a line. For this reason, a plane was defined for each analyzed dot, so that the value of the radius of curvature may vary with some frequency.
- The imperfection of the dot shape resulting from the "springback" effect on a layer of paper fiber creates different dot shapes on an amorphous structure, which can maintain its expected diameter and height, but generate different radii of curvature. Although hammers apply a constant force, different dot shapes were often scanned. In more extreme cases, small cracks or paper tear were detected.

From these results the differences between the three (four, considering both versions of Juliet 120) embossers under test were evaluated, as well as the homogeneity and repeatability of the Braille dot printed by each of them. Also, the Braille Dot Quality indicators previously defined were calculated and compared.

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<sup>1</sup> Continuous operation problems described in 7.4 - Emboss Speed.

## 5.4.5 Results - Embosser 1 – ViewPlus Columbia

### 5.4.5.1 Measurement results tables

VP Columbia, Sheet 1, Line 1 (odd)					VP Columbia, Sheet 2, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	1,8901	1,4551	1,5730	0,0818	Diameter	1,8247	1,1768	1,5323	0,1218
Radius	1,6262	0,8736	1,1533	0,1711	Radius	2,1585	1,0318	1,6179	0,2526
Height	0,3943	0,1980	0,3085	0,0430	Height	0,2633	0,1285	0,2011	0,0319
Distance	2,6793	2,3052	2,4945	0,0705	Distance	2,9174	2,3084	2,5319	0,1391

VP Columbia, Sheet 101, Line 1 (odd)					VP Columbia, Sheet 102, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	2,0684	1,2310	1,5932	0,1622	Diameter	1,8020	1,1923	1,4850	0,1026
Radius	1,7968	0,8374	1,2141	0,2532	Radius	2,1700	0,9787	1,6537	0,2473
Height	0,3957	0,1942	0,2948	0,0479	Height	0,2304	0,1248	0,1797	0,0197
Distance	2,8396	2,2365	2,4947	0,1378	Distance	2,8380	2,3372	2,5341	0,1419

VP Columbia, Sheet 201, Line 1 (odd)					VP Columbia, Sheet 202, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	2,0292	1,2061	1,5494	0,1427	Diameter	1,9078	1,2440	1,4950	0,1035
Radius	1,8415	0,8044	1,1935	0,2615	Radius	2,1858	1,0678	1,6937	0,2559
Height	0,3646	0,1370	0,2858	0,0487	Height	0,2449	0,1325	0,1779	0,0206
Distance	2,8331	2,0737	2,4784	0,1540	Distance	2,8380	2,3471	2,5263	0,1448

VP Columbia, Sheet 301, Line 1 (odd)					VP Columbia, Sheet 302, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	1,9808	1,2659	1,5876	0,1391	Diameter	1,7545	1,3004	1,4940	0,1002
Radius	1,8691	0,8200	1,2107	0,2511	Radius	2,0555	1,0938	1,6395	0,2271
Height	0,3655	0,2080	0,2942	0,0352	Height	0,2319	0,1333	0,1820	0,0205
Distance	2,7712	2,0620	2,4802	0,1426	Distance	2,8475	2,3486	2,5403	0,1484

VP Columbia, Sheet 401, Line 1 (odd)					VP Columbia, Sheet 402, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	2,1201	1,3759	1,6414	0,1413	Diameter	1,8633	1,2143	1,4550	0,1161
Radius	1,9229	0,8070	1,3045	0,2699	Radius	1,9956	0,9427	1,3759	0,2403
Height	0,3984	0,1865	0,2908	0,0461	Height	0,2566	0,1507	0,2083	0,0202
Distance	2,7340	2,0813	2,4631	0,1499	Distance	2,8380	2,3552	2,5357	0,0915

VP Columbia, Sheet 501, Line 1 (odd)					VP Columbia, Sheet 502, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	1,9218	1,2758	1,5666	0,1241	Diameter	1,6697	1,2372	1,4510	0,0987
Radius	2,1341	0,8312	1,1501	0,2213	Radius	2,0634	0,9420	1,3731	0,2419
Height	0,3909	0,1998	0,3038	0,0447	Height	0,2702	0,1304	0,2089	0,0239
Distance	2,7544	2,1088	2,4726	0,1388	Distance	2,6436	2,4804	2,5450	0,0452



### 5.4.5.2 Results analysis

The following table illustrates the aggregate values of the odd (front) and even (back) pages.

VP Columbia, odd pages (front)					VP Columbia, even pages (back)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	2,1201	1,2061	1,5852	0,1373	Diameter	1,9078	1,1768	1,4854	0,1109
Radius	2,1341	0,8044	1,2044	0,2458	Radius	2,1858	0,9420	1,5590	0,2779
Height	0,3984	0,1370	0,2963	0,0452	Height	0,2702	0,1248	0,1930	0,0268
Distance	2,8396	2,0620	2,4806	0,1357	Distance	2,9174	2,3084	2,5356	0,1246

Although there is no significant variation across the various embossed pages, there is a reasonable dispersion of the analyzed parameters on the same page and between pages. What is most noticeable is the difference in height between the odd (front) and even (back) pages in standard mode. The dot on odd pages is always "fuller", with a height in average 50% higher than the height on even pages.

Also noteworthy is the dispersion in the Braille matrix, observable in the distance between homologous dots between Braille cells. Although the average is around 2.5mm, dispersion is measurable, although in practice the effect is not very noticeable. Noticeable is a gap between the maximums and minimums values of the radius of curvature between the beginning and end pages.

Overall, the dot is somewhat inconsistent, inhomogeneous, and "low," which translates into less readability.

In terms of objective analysis, based on the Braille Dot Quality indicators, we obtain:

ViewPlus Columbia		
Indicator	Description	Value
$\alpha_D$	Braille dot dimensional stability indicator	0,962
$\alpha_M$	Braille matrix stability indicator	0,973
$Q_F$	Braille dot shape quality indicator	0,756
$Q_V$	Braille dot volume quality indicator	0,788
<b>BDQ</b>	Global Braille Dot Quality Assessment Indicator	<b>56</b>

Although both the Braille dot dimensional stability indicator,  $\alpha_D$ , and the Braille matrix stability indicator,  $\alpha_M$ , are relatively good, the Braille dot shape quality and Braille dot volume quality indicators leave a great deal to be desired, far from the Braille dot considered ideal, the Braille dot printed by the Perkins Braille, used as a reference. The ViewPlus Columbia achieves a score of 56 points for the overall Braille quality indicator, **BDQ**.

## 5.4.6 Results - Embosser 2 – IndexBraille Basic-D V5

### 5.4.6.1 Measurement results tables

IndexBraille Basic-D V5, Sheet 1, Line 1 (odd)					IndexBraille Basic-D V5, Sheet 2, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	2,0993	1,5518	1,7479	0,0952	Diameter	1,9678	1,2524	1,7584	0,1256
Radius	1,5360	0,9755	1,1536	0,1390	Radius	1,6584	0,9914	1,2516	0,1544
Height	0,4757	0,2827	0,4070	0,0341	Height	0,8695	0,1943	0,3687	0,0743
Distance	2,6848	2,2344	2,4229	0,1319	Distance	2,7940	2,2745	2,5136	0,1160

IndexBraille Basic-D V5, Sheet 101, Line 1 (odd)					IndexBraille Basic-D V5, Sheet 102, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	2,0232	1,3791	1,6927	0,1296	Diameter	2,0475	1,3564	1,7391	0,1304
Radius	1,5623	0,9363	1,2133	0,1471	Radius	2,4899	0,9558	1,3046	0,3039
Height	0,4339	0,2095	0,3457	0,0503	Height	0,4144	0,1998	0,3421	0,0495
Distance	2,8185	2,0624	2,4631	0,1532	Distance	2,6946	2,2691	2,4682	0,1207

IndexBraille Basic-D V5, Sheet 201, Line 1 (odd)					IndexBraille Basic-D V5, Sheet 202, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	1,8947	1,2428	1,6512	0,1117	Diameter	2,0922	1,4566	1,7284	0,1062
Radius	1,5432	0,9055	1,1515	0,1234	Radius	1,6570	0,9333	1,2056	0,1393
Height	0,4585	0,1502	0,3465	0,0539	Height	0,4635	0,1972	0,3700	0,0393
Distance	2,8371	2,0951	2,4700	0,1449	Distance	2,6313	2,3375	2,4834	0,0860

IndexBraille Basic-D V5, Sheet 301, Line 1 (odd)					IndexBraille Basic-D V5, Sheet 302, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	1,8707	1,2431	1,6346	0,1227	Diameter	2,0006	1,4923	1,7253	0,1161
Radius	1,5158	0,9571	1,1480	0,1320	Radius	1,9853	0,9708	1,2328	0,2090
Height	0,4399	0,1591	0,3406	0,0607	Height	0,4425	0,2595	0,3550	0,0417
Distance	2,8784	2,1260	2,4968	0,1431	Distance	2,6670	2,2542	2,4633	0,0919

IndexBraille Basic-D V5, Sheet 401, Line 1 (odd)					IndexBraille Basic-D V5, Sheet 402, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	2,0556	1,2684	1,6582	0,1271	Diameter	1,9938	1,5120	1,7103	0,0973
Radius	1,6609	0,9680	1,1935	0,1396	Radius	2,0577	0,9910	1,1975	0,1830
Height	0,4075	0,1752	0,3338	0,0562	Height	0,4354	0,2387	0,3634	0,0406
Distance	2,8221	2,1198	2,4886	0,1346	Distance	2,6407	2,2893	2,4765	0,0898

IndexBraille Basic-D V5, Sheet 501, Line 1 (odd)					IndexBraille Basic-D V5, Sheet 502, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	1,9636	1,4402	1,6947	0,0974	Diameter	1,9277	1,4557	1,6770	0,1020
Radius	1,5540	0,9824	1,1394	0,1076	Radius	1,9705	0,9683	1,1495	0,1500
Height	0,4654	0,2587	0,3827	0,0439	Height	0,4385	0,2146	0,3582	0,0421
Distance	2,6795	2,2808	2,4981	0,0937	Distance	2,8567	2,1143	2,5467	0,1400

#### 5.4.6.2 Results analysis

The following table illustrates the aggregate values of the odd (front) and even (back) pages.

IndexBraille Basic-D V5, odd pages (front)					IndexBraille Basic-D V5, even pages (back)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	2,0993	1,2428	1,6799	0,1207	Diameter	2,0922	1,2524	1,7231	0,1163
Radius	1,6609	0,9055	1,1665	0,1349	Radius	2,4899	0,9333	1,2236	0,2038
Height	0,4757	0,1502	0,3594	0,0571	Height	0,8695	0,1943	0,3596	0,0503
Distance	2,8784	2,0624	2,4732	0,1374	Distance	2,8567	2,1143	2,4919	0,1131

The dot is consistent, and there is no significant variation in parameters across the various embossed pages. What is most noticeable is the similarity of diameter and height of the Braille dot between the odd (front) and even (back) pages. The overall dot is always fuller, rounder, and more readable.

There is no offset between maximum and minimum values of the radius of curvature between beginning and end pages, unlike the ViewPlus Columbia.

Overall, the dot is "fuller", both in diameter and height, which translates into greater readability and ease of reading. Although the dispersion values of the analyzed parameters in absolute value are not far from those obtained by the ViewPlus Columbia, this translates into a lower percentage change, making the dot more homogeneous.

In terms of objective analysis, based on the Braille Dot Quality indicators, we obtain:

IndexBraille Basic-D V5		
Indicator	Description	Value
$\alpha_D$	Braille dot dimensional stability indicator	0,986
$\alpha_M$	Braille matrix stability indicator	0,975
$Q_F$	Braille dot shape quality indicator	0,907
$Q_V$	Braille dot volume quality indicator	0,985
<b>BDQ</b>	Global Braille Dot Quality Assessment Indicator	<b>86</b>

The IndexBraille Basic-D V5 prints a very good quality Braille dot with slightly higher dimensional dot stability than ViewPlus Columbia. The stability of the Braille matrix is marginally higher. However, the quality of the shape and volume of the Braille dot is remarkable and far superior to ViewPlus Columbia, achieving the IndexBraille Basic-D V5 a very good score of 86 points.

In fact, this confirms the subjective tactile results previously noted. The difference from ViewPlus Columbia is especially evident in the values of the partial indicators of quality of Braille dot shape  $Q_F$  and volume quality of Braille dot  $Q_V$ .

## 5.4.7 Results - Embosser 3A – ETC Juliet 120 standard (A)

### 5.4.7.1 Measurement result tables

ETC Juliet 120 A, Sheet A1, Line 1 (odd)					ETC Juliet 120 A, Sheet A2, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	1,9653	1,5759	1,7031	0,0818	Diameter	1,9009	1,5939	1,7071	0,0616
Radius	1,6883	0,9413	1,1320	0,1466	Radius	1,3766	0,9522	1,0971	0,0938
Height	0,4583	0,2553	0,3849	0,0318	Height	0,4504	0,3492	0,4024	0,0228
Distance	2,7311	2,3168	2,4976	0,1111	Distance	2,6789	2,2729	2,4346	0,1094

### 5.4.7.2 Results analysis

Given the reduced number of embossed pages, it was not possible to analyze the variation of the parameters over several embossed pages. However, the similarity of diameter and height of the Braille dot between the odd (front) and even (back) pages is noticeable. In general, the dot is "full-bodied" in both diameter and height, which translates into greater readability and ease of reading, as in the case of IndexBraille Basic-D V5.

In terms of objective analysis, based on the Braille Dot Quality indicators, we obtain:

Enabling Technologies Juliet 120 (standard)		
Indicator	Description	Value
$\alpha_D$	Braille dot dimensional stability indicator	0,996
$\alpha_M$	Braille matrix stability indicator	0,977
$Q_F$	Braille dot shape quality indicator	0,937
$Q_V$	Braille dot volume quality indicator	0,999
<b>BDQ</b>	Global Braille Dot Quality Assessment Indicator	<b>91</b>

The standard ETC Juliet 120 produces a very good quality Braille dot, similar to the dot printed by the IndexBraille Basic-D V5, achieving an excellent score of 91 points. In fact, this confirms the subjective tactile results previously noted. The difference from the IndexBraille Basic-D V5 is mainly due to the slight difference in shape and volume of the dot, most likely due to the reduced number of pages analyzed.

## 5.4.8 Results - Embosser 3B – ETC Juliet 120 modified (B)

### 5.4.8.1 Measurement result tables

ETC Juliet 120 B, Sheet B1, Line 1 (odd)					ETC Juliet 120 B, Sheet B2, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	1,9684	1,4806	1,6598	0,1347	Diameter	1,9512	1,4750	1,6520	0,1289
Radius	1,6306	0,8409	1,0377	0,1686	Radius	1,4334	0,8225	1,0151	0,1632
Height	0,4688	0,3198	0,4179	0,0284	Height	0,4853	0,3385	0,4332	0,0317
Distance	2,6698	2,0828	2,4129	0,1356	Distance	2,7356	1,9233	2,3907	0,1686

### 5.4.8.2 Results analysis

Given the small number of embossed pages, it was not possible to analyze the variation of the parameters over several embossed pages. It is, however, noticeable the increase of the height of the Braille dot in relation to the standard ETC Juliet 120 (about 10%), as well as the slight decrease of its diameter (about 5%). The dot is usually higher and narrower, which makes it better defined, approaching the dot considered ideal, the dot printed by the Perkins Brailleurs. This dot also approximates the dot volume traditionally known as the "American Braille Dot", popularized in the 1980s and 1990s by the famous Enabling Technologies Romeo and Juliet.

Once again, the dispersion of the Braille matrix, observable by the varying distance between homologous dots between Braille cells, is similar to the other embossers under analysis.

In terms of objective analysis, based on the Braille Dot Quality indicators, we obtain:

Enabling Technologies Juliet 120 (modified)		
Indicator	Description	Value
$\alpha_D$	Braille dot dimensional stability indicator	0,994
$\alpha_M$	Braille matrix stability indicator	0,968
$Q_F$	Braille dot shape quality indicator	0,967
$Q_V$	Braille dot volume quality indicator	0,999
<b>BDQ</b>	Global Braille Dot Quality Assessment Indicator	<b>93</b>

This shows the high quality of the pre-production Braille dot printed by the modified ETC Juliet 120, courtesy of Enabling Technologies/Humanware, which achieves an excellent score of 93 points, the closest to the "ideal Braille dot". We look forward to its relaunch in the Braille market!

#### 5.4.9 Comparison of measurement results

VP Columbia, odd pages (front)					VP Columbia, even pages (back)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	2,1201	1,2061	1,5852	0,1373	Diameter	1,9078	1,1768	1,4854	0,1109
Radius	2,1341	0,8044	1,2044	0,2458	Radius	2,1858	0,9420	1,5590	0,2779
Height	0,3984	0,1370	0,2963	0,0452	Height	0,2702	0,1248	0,1930	0,0268
Distance	2,8396	2,0620	2,4806	0,1357	Distance	2,9174	2,3084	2,5356	0,1246

IndexBraille Basic-D V5, odd pages (front)					IndexBraille Basic-D V5, even pages (back)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	2,0993	1,2428	1,6799	0,1207	Diameter	2,0922	1,2524	1,7231	0,1163
Radius	1,6609	0,9055	1,1665	0,1349	Radius	2,4899	0,9333	1,2236	0,2038
Height	0,4757	0,1502	0,3594	0,0571	Height	0,8695	0,1943	0,3596	0,0503
Distance	2,8784	2,0624	2,4732	0,1374	Distance	2,8567	2,1143	2,4919	0,1131

ETC Juliet 120 A, Sheet A1, Line 1 (odd)					ETC Juliet 120 A, Sheet A2, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	1,9653	1,5759	1,7031	0,0818	Diameter	1,9009	1,5939	1,7071	0,0616
Radius	1,6883	0,9413	1,1320	0,1466	Radius	1,3766	0,9522	1,0971	0,0938
Height	0,4583	0,2553	0,3849	0,0318	Height	0,4504	0,3492	0,4024	0,0228
Distance	2,7311	2,3168	2,4976	0,1111	Distance	2,6789	2,2729	2,4346	0,1094

ETC Juliet 120 B, Sheet B1, Line 1 (odd)					ETC Juliet 120 B, Sheet B2, Line 1 (even)				
	Maximum	Minimum	Average	Std. dev.		Maximum	Minimum	Average	Std. dev.
Diameter	1,9684	1,4806	1,6598	0,1347	Diameter	1,9512	1,4750	1,6520	0,1289
Radius	1,6306	0,8409	1,0377	0,1686	Radius	1,4334	0,8225	1,0151	0,1632
Height	0,4688	0,3198	0,4179	0,0284	Height	0,4853	0,3385	0,4332	0,0317
Distance	2,6698	2,0828	2,4129	0,1356	Distance	2,7356	1,9233	2,3907	0,1686

Taking into account the results obtained between the ViewPlus Columbia and the IndexBraille Basic-D V5, it is concluded that both the diameter of the dot at its base and its height are higher in IndexBraille Basic-D V5, resulting in a more "full-bodied" dot, with more volume, and better defined. These differences are significant, reaching about more 7% and 21% of the diameter and height at the front, and 15% and 80% at the back. In the ViewPlus Columbia, the height of the Braille dot on the back is always lower. Dot measurements were made with the factory setting, but even changing these, the changes were minor.

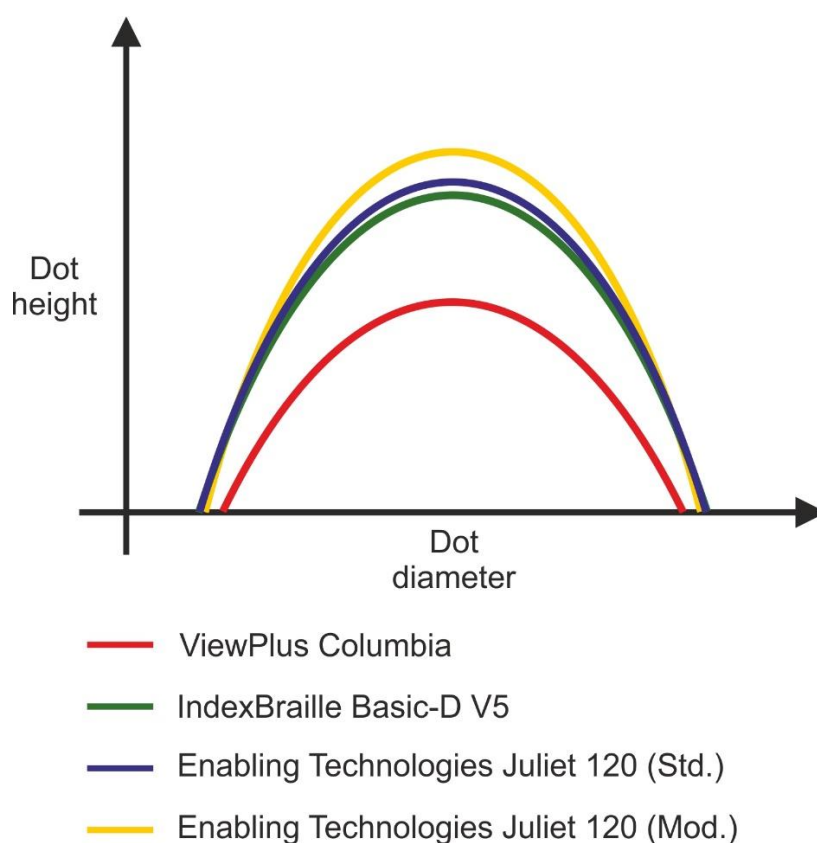
Considering the results obtained between the IndexBraille Basic-D V5 and the Juliet 120 A (standard), it is concluded that the Braille dot obtained has a similar diameter, but its height is in average about 5% higher, which, although not being very expressive, results in a better definition of the dot.

It should be noted that in the case of the modified ETC Juliet 120 B, the Braille dot has a base diameter about 5% lower than the standard ETC Juliet 120, but the dot height is on average almost 10% higher, resulting in a better-defined dot. However, there is also a slight increase in the dispersion of these results, observing the calculated value for the standard deviation.

#### 5.4.10 Comparison of Braille dot Shape

The following figure illustrates the comparison of the shape of Braille dot printed by the embossers under analysis, from the average values of measurements for height, diameter (at the base) and radius of curvature (the vertical scale is different from the horizontal scale, allowing for a more obvious comparison of the differences):

Measured average values (mm)				
Measurement	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120 (standard)	ETC Juliet 120 (modified)
Height	0.2446	0.3595	0.3937	0.4256
Diameter	1.5353	1.7015	1.7051	1.6559
Radius of curvature	1.3817	1.1951	1.1145	1.0264



#### 5.4.11 Braille Dot Quality Indicator results comparison

Comparing now to the Braille Dot quality indicators, it is clear that the stability parameters do not differ much between the four models, although there are slight variations. These variations turn out to be insignificant in the overall result as well as in practice.

However, regarding the shape and volume of the Braille dot produced, the differences are noticeable. The ViewPlus Columbia deviates considerably from the ideal Braille dot, the Perkins Braille dot, used as a reference, and achieves a *BDQ* = 56 points, in line with the subjective analysis already performed.

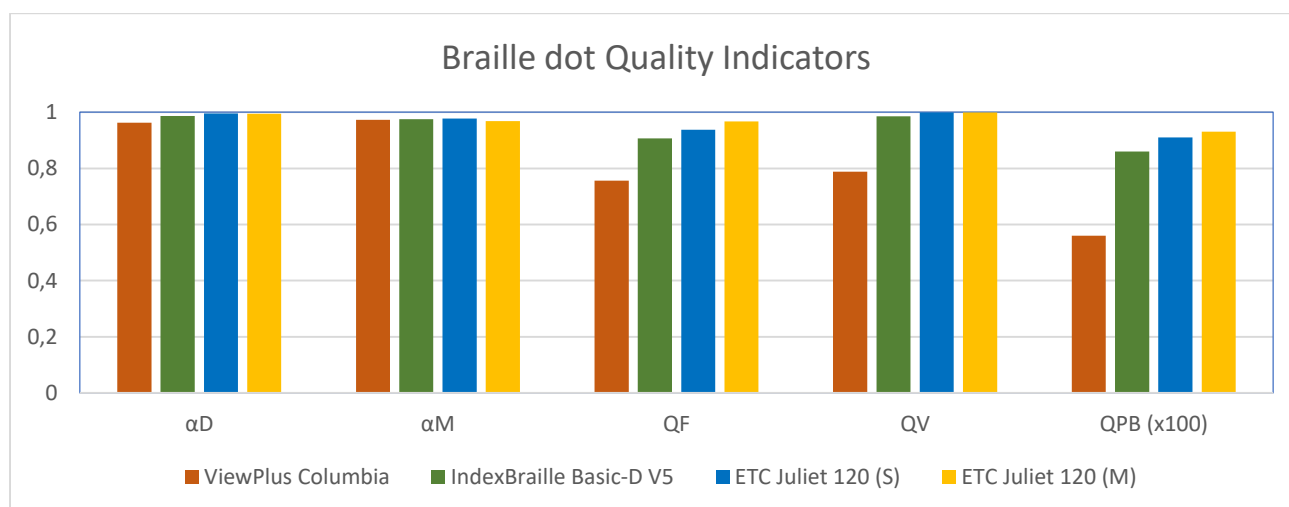
The IndexBraille Basic-D V5 prints an excellent dot, with very good quality. The quality of the shape and volume of the Braille dot is remarkable, being vastly superior to the ViewPlus Columbia, thus achieving a *BDQ* score of 86 points, also in line with the subjective analysis already performed.

The standard Juliet 120 ETC produces a very good quality Braille dot, similar to the dot produced by the IndexBraille Basic-D V5, achieving an excellent *BDQ* score of 91 points. In fact, this confirms the subjective tactile results previously noted. The differences from the IndexBraille Basic-D V5 are small, but nonetheless measurable, most likely due to the small number of pages embossed.

It is noteworthy the high quality of the pre-production Braille dot printed by the modified ETC Juliet 120, kindly provided by Enabling Technologies/Humanware, which is under development, reproduces the traditional US American dot of the 1980's and 1990's, made famous by Enabling Technologies. This achieves an excellent *BDQ* score of 93 points, which is the closest to the "ideal Braille dot".

Braille Dot Quality Indicator Comparison				
Indicator	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120 (standard)	ETC Juliet 120 (modified)
$\alpha_D$	0,962	0,986	0,996	0,994
$\alpha_M$	0,973	0,975	0,977	0,968
$Q_F$	0,756	0,907	0,937	0,967
$Q_V$	0,788	0,985	0,999	0,999
<b><i>BDQ</i></b>	<b>56</b>	<b>86</b>	<b>91</b>	<b>93</b>

The following graph illustrates the calculated partial indicators, as well as the overall quality indicator, *BDQ*:



From the global Braille Dot Quality indicator *BDQ* developed in this study, it is clear that the Braille dot of the IndexBraille Basic-D V5, reaching 86 points, is about 50% better than the dot printed by the ViewPlus Columbia, which scores 56 points. This is mainly due to the quality of dot shape and volume. It should also be noted that the stability indicators differ slightly, with a slight advantage of the IndexBraille Basic-D V5.

It follows that the quality of the pre-production Braille dot from Enabling Technologies has the potential to score almost 10% better than the IndexBraille dot, and about 60% better than the Braille dot from ViewPlus. This pre-production Braille dot, which is under development, reproduces the traditional US American dot of Enabling Technologies and Juliet 120.



## 6 FUNCTIONAL TECHNICAL SPECIFICATIONS

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Please refer to Annex 5 - Comparison of technical and functional characteristics – file:  
"ACAPO\_Braille\_Benchmark.xlsx"

## 7 FUNCTIONAL TESTING FROM THE USER'S PERSPECTIVE

### 7.1 DRIVERS, LICENSING AND CONNECTIVITY

#### 7.1.1 Drivers and Licensing

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"><li>• Easy-to-install Windows drivers, from the flash drive drivers supplied with the equipment, as well as from the manufacturer's website.</li><li>• Drivers are also available for Mac OS, but not for Linux.</li><li>• Installation of the easy Tiger Software Suite in Windows 10, as well as the add-in for MS Word and Excel.</li><li>• With the purchase of a new embosser is provided a perpetual license to use the Tiger Software Suite, however upgrades are paid. There is also the annual subscription mode.</li></ul>	<ul style="list-style-type: none"><li>• Easy-to-install Windows drivers, either from the flash drive supplied with the embosser, or even using the Windows 10 library. The manual refers to driver download from the IndexBraille website.</li><li>• For installation on Mac OS, as well as for Linux (Debian/Ubuntu), a link with instructions is provided.</li><li>• For this embosser and features described, licensing is not required.</li></ul>	<ul style="list-style-type: none"><li>• Easy-to-install Windows drivers, either from the flash drive that came with the embosser, or even using the Windows 10 library. The manual refers to driver download from the IndexBraille (IndexBraille-ETC Printer Driver) website.</li><li>• Drivers for Mac OS and Linux (Debian/Ubuntu) are also available.</li><li>• For this embosser and features described, licensing is not required.</li></ul>

#### 7.1.2 Connectivity

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
Native connectivity ( <i>onboard</i> ): <ul style="list-style-type: none"><li>• USB <i>device</i></li><li>• Ethernet</li></ul> Requires <i>TigerBox</i> for <i>wireless</i> connectivity and USB <i>host</i> : <ul style="list-style-type: none"><li>• Wi-Fi;</li><li>• Bluetooth;</li><li>• USB (<i>host</i>);</li></ul>	Native connectivity ( <i>onboard</i> ): <ul style="list-style-type: none"><li>• USB (<i>device</i>);</li><li>• USB (<i>host</i>);</li><li>• Ethernet</li><li>• Wi-Fi;</li><li>• Bluetooth;</li></ul>	Native connectivity ( <i>onboard</i> ): <ul style="list-style-type: none"><li>• USB (<i>device</i>);</li><li>• USB (<i>host</i>);</li><li>• Ethernet</li><li>• Wi-Fi;</li><li>• Bluetooth;</li></ul>

### 7.1.3 USB Interface (USB connection and printing from USB *pen*)

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>• Easy printing via USB using Windows.</li> <li>• The USB interface allows direct access to the embosser configuration (properties), without the need to use the webserver.</li> <li>• Printing from mobile devices only via TigerBox (print server).</li> <li>• Printing via USB pen only via TigerBox (print server).</li> </ul>	<ul style="list-style-type: none"> <li>• Easy printing via USB using Windows.</li> <li>• Printing from mobile devices via native print server (BrailleApp).</li> <li>• Direct printing via USB flash drive also works well, using internal conversion idB (IndexBraille direct-Braille). It is also possible to print braille files (.brf and .brl) from the USB flash drive.</li> </ul>	<ul style="list-style-type: none"> <li>• Easy printing via USB using Windows.</li> <li>• Printing from mobile devices via native print server (webserver).</li> <li>• Direct printing via USB flash drive also works well, using internal conversion (direct-Braille). It is also possible to print braille files (.brf and .brl) from the USB flash drive.</li> </ul>

### 7.1.4 Ethernet interface

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>• Easy configuration via utility, however, presents some failures or inconsistencies when saving parameters.</li> <li>• You can use DHCP, or set up a static IP address with ease, after the USB connection is first established.</li> <li>• The installation process takes place easily, and automatically.</li> </ul>	<ul style="list-style-type: none"> <li>• You must connect the embosser over an Ethernet network with active DHCP, so that the embosser obtains IP address, and then use HELP+10 or HELP+1 to get the assigned IP address. It is also possible to send a network setup file.</li> <li>• You can also configure the network manually from the local interface. It is easy to set up the Wi-Fi network as well.</li> <li>• Part of the installation process is manual, making it more difficult for less experienced users (the printing port is not immediately available).</li> </ul>	<ul style="list-style-type: none"> <li>• You must connect the embosser over an Ethernet network with active DHCP, so that the embosser obtains IP address, and then use HELP+10 or HELP+1 to get the assigned IP address. It is also possible to send a network setup file.</li> <li>• You can also configure the network manually from the local interface. It is easy to set up the Wi-Fi network as well.</li> <li>• Part of the installation process is manual, making it more difficult for less experienced users (the printing port is not immediately available).</li> </ul>

### 7.1.5 Wireless network interface (Wi-Fi)

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>• Not available autonomously (only with TigerBox).</li> <li>• Easy configuration with both DHCP and static IP, via USB or print server (TigerBox).</li> <li>• Direct printing via Windows PC and mobile devices via print server ran smoothly (TigerBox).</li> <li>• TigerBox supports infrastructure network modes (connected to an existing Wi-Fi network) and <i>Wi-Fi Direct</i> (TigerBox creates a network named "TigerBox").</li> </ul>	<ul style="list-style-type: none"> <li>• Available autonomously.</li> <li>• Easy configuration with both DHCP and static IP.</li> <li>• The configuration can be done via control panel or via <i>webserver</i> (BrailleApp).</li> <li>• Direct printing via Windows PC and mobile devices via print server ran smoothly.</li> <li>• The manual only mentions the use of WPS on the router, as well as the configuration via BrailleApp.</li> </ul>	<ul style="list-style-type: none"> <li>• Available autonomously.</li> <li>• Easy configuration with both DHCP and static IP.</li> <li>• The configuration can be done via control panel or via <i>webserver</i>.</li> <li>• Direct printing via Windows PC and mobile devices via print server ran smoothly.</li> <li>• The manual only mentions the use of WPS on the router, as well as the configuration via <i>webserver</i>.</li> </ul>

### 7.1.6 Bluetooth connection

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>• Not available autonomously (only with TigerBox).</li> <li>• With the ViewPlus Columbia embosser, Bluetooth printing is possible from <i>iOS</i> and Android mobile devices using TigerBox.</li> <li>• With <i>iOS</i> it was not visible to the mobile device. Through <i>airprint</i>, however, it was possible to print directly from <i>iOS</i> (<i>iPrint</i>).</li> </ul>	<ul style="list-style-type: none"> <li>• Available autonomously.</li> <li>• With the IndexBraille Basic-D V5 embosser, Bluetooth printing from <i>Android</i> devices is possible. You can also connect from a PC via <i>Bluetooth</i>.</li> <li>• Successfully printing from <i>Android</i> devices by sharing a file through <i>Bluetooth</i>.</li> <li>• Apple <i>iOS</i> devices are not currently supported due to apparent incompatibility regarding the Bluetooth connection. From <i>iOS</i> it is visible to the device, allows you to pair, but then does not appear as a printer and therefore does not allow printing.</li> </ul>	<ul style="list-style-type: none"> <li>• Available autonomously.</li> <li>• With the ETC Juliet 120 embosser, Bluetooth printing from <i>Android</i> devices is possible. You can also connect from a PC via <i>Bluetooth</i>.</li> <li>• Successfully printing from <i>Android</i> devices by sharing a file through <i>Bluetooth</i>.</li> <li>• Apple <i>iOS</i> devices are not currently supported due to apparent incompatibility regarding the Bluetooth connection. From <i>iOS</i> it is visible to the device, allows you to pair, but then does not appear as a printer and therefore does not allow printing.</li> </ul>

## 7.2 BRAILLE TABLE VALIDATION (PORTUGUESE)

The Braille tables for the Portuguese language were validated by printing a file containing seven lines of characters, containing each of them the characters corresponding to each of the seven Braille character series. This test was performed on the three embossers. All characters, prefixes and accentuation were validated by ACAPO after printing the texts. The characters considered for this validation were thus:

Series	Characters	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
1st	⠁ ⠃ ⠉ ⠑ ⠙ ⠛ ⠝ ⠞ ⠠ ⠡ <b>a b c d e f g h i j</b>	O.K.	O.K.	O.K.
2nd	⠋ ⠌ ⠍ ⠎ ⠏ ⠒ ⠔ ⠖ ⠘ ⠚ <b>k l m n o p q r s t</b>	O.K.	O.K.	O.K.
3rd	⠠ ⠡ ⠢ ⠣ ⠤ ⠥ ⠦ ⠧ ⠨ ⠩ <b>u v x y z ç é á è ú</b>	O.K.	O.K.	O.K.
4th	⠠ ⠡ ⠢ ⠣ ⠤ ⠥ ⠦ ⠧ ⠨ ⠩ <b>â ê î ô ù à ñ û õ w</b>	O.K.	O.K.	O.K.
5th	⠠ ⠡ ⠢ ⠣ ⠤ ⠥ ⠦ ⠧ ⠨ ⠩ <b>, ; : ÷ ? ! = × * °</b>	O.K.	O.K.	O.K.
6th	⠠ ⠡ ⠢ ⠣ ⠤ ⠥ ⠦ ⠧ ⠨ ⠩ <b>í ã ó # . -</b>	O.K.	O.K.	O.K.
7th	⠠ ⠡ ⠢ ⠣ ⠤ ⠥ ⠦ ⠧ ⠨ ⠩ <b>^ º   ~ _ \$ /</b>	O.K.	O.K.	O.K.

## 7.3 PAPER TYPE AND SIZE, PRINT FORMATS

### 7.3.1 Paper type and size

The paper used during the tests was Braille paper of 140g/m<sup>2</sup> and 160g/m<sup>2</sup>. All tests performed with the embossers were carried out with 8.5" x 11" and 11" x 12" paper.

In the case of the ViewPlus Columbia embosser, however, some failures or inconsistencies were found when storing the parameters relating to paper size and margins used. Even when forcing the settings and restarting the embosser, the inconsistencies sometimes remained.

The following table contains the conclusions regarding paper type and size for each of the embossers:

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"><li>• The manual refers the use of Braille paper from 90g/m<sup>2</sup> to 200g/m<sup>2</sup>.</li><li>• With regard to paper size, discounting the perforated strips, a maximum useful width of 11.5" remains for printing. Values between 7" and 11.5" can be used without problem.</li><li>• A maximum of 43CPL was achieved.</li><li>• Settings for user-defined paper are supported.</li></ul>	<ul style="list-style-type: none"><li>• The manual refers the use of Braille paper from 120g/m<sup>2</sup> to 180g/m<sup>2</sup>.</li><li>• With regard to paper size, discounting the perforated strips, a maximum useful width of 11.8" remains for printing. Values between 4" and 11.8" can be used without problem.</li><li>• A maximum of 46CPL was achieved.</li><li>• Settings for user-defined paper are supported.</li></ul>	<ul style="list-style-type: none"><li>• The manual refers the use of Braille paper from 120g/m<sup>2</sup> to 180g/m<sup>2</sup>.</li><li>• With regard to paper size, discounting the perforated strips, a maximum useful width of 11.8" remains for printing. Values between 4" and 11.8" can be used without problem.</li><li>• A maximum of 46CPL was achieved.</li><li>• Settings for user-defined paper are supported.</li></ul>

### 7.3.2 Printing formats

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"><li>• Horizontal (Landscape) vertical (Portrait), Inverted Landscape and Inverted Portrait, as well as single or double-sided (interpoint) print formats are supported.</li></ul>	<ul style="list-style-type: none"><li>• Horizontal (normal) and vertical (sideways), <i>Z-folding</i>, as well as single or double-sided (interpoint) print formats are supported.</li><li>• The <i>Booklet / Newspaper</i> format is also supported.</li></ul>	<ul style="list-style-type: none"><li>• Horizontal (normal) and vertical (sideways), <i>Z-folding</i>, as well as single or double-sided (interpoint) print formats are supported.</li><li>• The <i>Booklet / Newspaper</i> format is also supported.</li></ul>

## 7.4 PRINT SPEED (CPS/PPH)

Three different tests were performed to evaluate the printing speed of the Braille embossers under analysis in this study. The first test (Test 1) aimed to determine the maximum possible print speed, in characters per second (CPS), for each of the embossers. These were printed in *"draft"* mode.

The second test (Test 2) aimed to determine the maximum and average values of pages per hour (PPH) printed by each embosser, using several time intervals, as well as a more realistic estimate for the number of characters per second, using a real text (standard text, prepared by ACAPO). These were also printed in *"draft"* mode.

The third test (Test 3) aimed to determine the maximum and average values of pages per hour (PPH) printed by each embosser, using three time intervals: 5, 10 and 15 minutes, in *standard* print mode, or *"high"*, using the same text as Test 2, but limited to 15 minutes of printing.

### 7.4.1 Test 1 – Maximum speed (CPS)

Continuous text files were created, without spaces, with two pages (double-sided), using all the lowercase letters of the Portuguese alphabet in sequence, by line, and restarting in the letter "a" until making up as many characters as possible per line ("abcdefg... xyzabcdefg...").

The number of lines per page used was the maximum allowed by the parameterization of each embosser, with all margins reduced to zero (or equal to the minimum allowed). The text was converted to Braille and printed from the *Braille Fácil* application at ACAPO's premises.

For this test, 15 sheets / 30 pages were printed, having been excluded from the speed calculations the first 2 sheets / 4 first pages, in order to ensure that the embossers were already printing at constant speed (initially the print speed is lower). The Character Per Second (CPS) value was calculated by multiplying the Values of CPL and LPP (total characters per page) by the number of pages (total printed characters), then dividing this result by the print time of the 26 pages.

All tests were repeated three times, so the values presented in the results tables represent the average values of three distinct measurements. The remaining test conditions for each of the embossers are described in the following table:

Condition	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
Paper size	11" x 12"	11" x 12"	11" x 12"
Characters per line	43 CPL	46 CPL	46 CPL
Lines per page	28 LPP	29 LPP	29 LPP
Number of pages	26	26	26
Total characters	31304	34684	34684
Print modes	<i>Draft and Standard</i>	<i>Draft and High</i>	<i>Draft and High</i>

#### 7.4.1.1 Results - ViewPlus Columbia

ViewPlus Columbia		
Print modes	Standard	Draft
Characters per page	43 * 28 = 1204	43 * 28 = 1204
Number of pages	26	26
Total characters	31304	31304
Total time (26 pages)	8' 25" (505")	7' 14" (434")
Average PPH	185 PPH	216 PPH
Calculated CPS	62 CPS	72,1 CPS
Advertised CPS	120 CPS	120 CPS

During the above tests, it became clear that the first 14 pages were typically printed at a regular speed, while the following were printed at an irregular, slower rate with a clearly distinct print noise. Therefore, the tests were repeated twice, the first accounting only 10 pages at a higher initial rate (new 12-page printing excluding the first two pages), and the second accounting for 10 pages already at the slowest rate. The results obtained are found in the following table:

ViewPlus Columbia				
Print modes	Standard		Draft	
Printing rate	"Normal"	"Slow"	"Normal"	"Slow"
Characters per page	43 * 28 = 1204	43 * 28 = 1204	43 * 28 = 1204	43 * 28 = 1204
Number of pages	10	10	10	10
Total characters	12040	12040	12040	12040
Total time (10 pages)	2' 08" (128")	3' 29" (209")	1' 58" (118")	3' 24" (204")
Calculated CPS	94CPS	57,6 CPS	102 CPS	59 CPS

Observing these results, it is obvious that the print speed values obtained deviate considerably from the 120 CPS advertised by the manufacturer, considering that this will be the best possible situation in terms of Characters Per Second, and it is not in fact representative of a "normal" text.

This situation is further aggravated by the fact that the ViewPlus Columbia embosser does not keep the print rate constant, slowing down to a slower and irregular pace.

Even this situation was found to be irregular, typically occurring between about 14 pages and several dozen pages, without being able to set a right pattern. It should be noted that this situation always occurs, and once this occurs, the print speed slows down and becomes irregular.



#### 7.4.1.2 Results - IndexBraille Basic-D V5

IndexBraille Basic-D V5		
Print modes	<i>High</i>	<i>Draft</i>
Characters per page	46 * 29 = 1334	46 * 29 = 1334
Number of pages	26	26
Total characters	34684	34684
Total time (26 pages)	4' 41" (281")	4' 12" (252")
Average PPH	333 PPH	371 PPH
Calculated CPS	123,4 CPS	137,6 CPS
Advertised CPS	120 CPS	

Unlike the ViewPlus Columbia, the IndexBraille Basic-D V5, even in "*high*" mode, manages to exceed 120 CPS, reaching a maximum value of 123.4 CPS. This value increases significantly in "*draft*" mode, reaching in this mode a maximum of 137.6 CPS, which exceeds the maximum values declared by the manufacturer, for both printing modes.

#### 7.4.1.3 Results - ETC Juliet 120

ETC Juliet 120		
Print modes	<i>High</i>	<i>Draft</i>
Characters per page	46 * 29 = 1334	46 * 29 = 1334
Number of pages	26	26
Total characters	34684	34684
Total time (26 pages)	4' 39" (279")	4' 11" (251")
Average PPH	335 PPH	373 PPH
Calculated CPS	124,3 CPS	138,2 CPS
Advertised CPS	120 CPS	

Like the IndexBraille Basic-D V5, the ETC Juliet 120, even in "*high*" mode, manages to exceed the 120 CPS, reaching a maximum value of 124.3 CPS. This value increases significantly in "*draft*" mode, reaching in this mode a maximum of 138.2 CPS, which exceeds the maximum values declared by the manufacturer, for both printing modes.

#### 7.4.2 Test 2 – Continuous printing, 500 pages

For this test, a standard text prepared by ACAPO was used. The text comprises an excerpt from the Holly Bible, having been converted to Braille and printed using the TSS Tiger Software Suite (TSS) *plug-in* for *Microsoft Word* in the case of the ViewPlus Columbia embosser, and using the *Braille Facile* application in the case of IndexBraille Basic-D V5 and ETC Juliet 120 embossers. The use of different applications was due to an incompatibility between the *Braille Facile* application and the ViewPlus Columbia embosser.

The text was formatted taking into account each of the embossers:

Test 2 – Continuous printing "standard text" <i>draft</i> mode 500 pages			
Embosser	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
Print mode	<i>Draft</i>	<i>Draft</i>	<i>Draft</i>
Paper size	11" x 12"	11" x 12"	11" x 12"
Characters per line	42 CPL	46 CPL	46 CPL
Lines per page	28 LPP	29 LPP	29 LPP

The first 500 pages of the document were printed, and the time moments of 5, 10, 15 and 30 minutes, 1 hour, and the end of printing were recorded (marked) in the printings. For each of these moments, the corresponding average CPS and PPH values were calculated, taking into account the marks made during the printing.

The following table contains the results obtained (rounded to the page and to the line of characters) by the three embossers, for the temporal moments of 5', 10', 15', 30', 60' and final printing:

Test 2 – Continuous printing "standard text" <i>draft</i> mode 500 pages			
Embosser	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
Moment 1: 5'	25 pages / 300 PPH	32 pages / 384 PPH	32 pages / 384 PPH
	20974 chars / 69,9 CPS	33049 chars / 110,16 CPS	33044 chars / 110,15 CPS
Moment 2: 10'	49 pages / 294 PPH	62 pages / 372 PPH	61 pages / 366 PPH
	42760 chars / 71,26 CPS	65667 chars / 109,45 CPS	66937 chars / 111,56 CPS
Moment 3: 15'	70 pages / 280 PPH	92 pages / 368 PPH	92 pages / 368 PPH
	63796 chars / 70,88 CPS	99087 chars / 110,10	100421 chars / 111,59 CPS
Moment 4: 30'	141 pages / 282 PPH	188 pages / 376 PPH	188 pages / 376 PPH
	124378 chars / 69,1 CPS	196691 chars / 109,27	196699 chars / 109,28 CPS
Moment 5: 60'	260 pages / 260 PPH	378 pages / 378 PPH	378 pages / 378 PPH
	226176 chars / 62,83 CPS	396271 chars / 110,08 CPS	396120 chars / 110,03 CPS
Final (500 Pages)	1: 58' 18" (*)	1:19' 27"	1:19' 29"
	500 pages / 254 PPH	500 pages / 378 PPH	500 pages / 377 PPH
	436454 chars / 61,49 CPS	521513 chars / 109,40 CPS	521513 chars / 109,35 CPS

(\*) After the *firmware* update to version 11.11.25, the buffer limitation has apparently ceased to manifest. However, the ViewPlus Columbia embosser stopped when printing page 380 after 1:31' 30" of printing time, with the error "10005 – Coprocessor error". Printing could only be resumed after restarting the embosser. The remaining printing time (page 381 – page 500) was 26' 48", so the total printing time, minus the time required to restart the embosser, was 1:58' 18". Moreover, on three separate occasions it did not conveniently pull the paper, which caused some Braille character lines to overlap.

#### 7.4.3 Teste 3 – Continuous printing 15 minutes

For this test, the standard text prepared by ACAPO was again used, but now using the "Standard" (ViewPlus Columbia) or "High" print speed (IndexBraille Basic-D V5 and ETC Juliet 120). The following table contains the operating conditions for each embosser:

Test 3 - Continuous printing, "standard text" <i>standard/high</i> mode, 15 minutes			
Embosser	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
Print mode	Standard	High	High
Paper size	11" x 12"	11" x 12"	11" x 12"
Characters per line	42 CPL	46 CPL	46 CPL
Lines per page	28 LPP	29 LPP	29 LPP

The first 500 pages of the document were printed, but the printing time was limited to a total of 15 minutes, and the points relating to the time intervals (not temporal moments) of 0' – 5', 5' and 10' – 15' were recorded (marked) in the printings. The final value for the total print interval of 0' – 15' was also recorded in order to obtain an overall final average value for PPH. For each of these intervals, the corresponding average CPS and PPH values were calculated, taking into account the marks made during the printings.

The following table contains the results obtained (rounded to the page) by the three embossers, for Test 3:

Test 3 - Continuous printing, "standard text" <i>standard/high</i> mode, 15 minutes			
Embosser	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
Interval 1: 0' - 5'	21 pages / 252 PPH	28 pages / 336 PPH	28 pages / 336 PPH
	18381 chars / 61,27 CPS	29020 chars / 96,73 CPS	29261 chars / 97,54 CPS
Interval 2: 5' – 10'	23 pages / 276 PPH	28 pages / 336 PPH	28 pages / 336 PPH
	20581 chars / 68,60 CPS	30263 chars / 100,88 CPS	30127 chars / 100,42 CPS
Interval 3: 10' – 15'	19 pages / 228 PPH	28 pages / 336 PPH	28 pages / 336 PPH
	16290 chars / 54,3 CPS	31118 chars / 103,73 CPS	31009 chars / 103,36 CPS
Final 0' - 15' (PPH/CPS)	252 PPH	336 PPH	336 PPH
	61,39 CPS	100,45 CPS	100,44 CPS

#### 7.4.4 Printing speed comparison

The following tables summarize the results for printing speed tests, for the three embossers:

Test 1 (Max. speed)	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
Print mode: "Draft"	102 / 72,1 CPS (*)	137,6 CPS	138,2 CPS
	216 PPH (*)	371 PPH	373 PPH
Print mode: "Standard" / "High"	94 / 62 CPS (*)	123,4 CPS	124,3 CPS
	185 PPH (*)	333 PPH	335 PPH

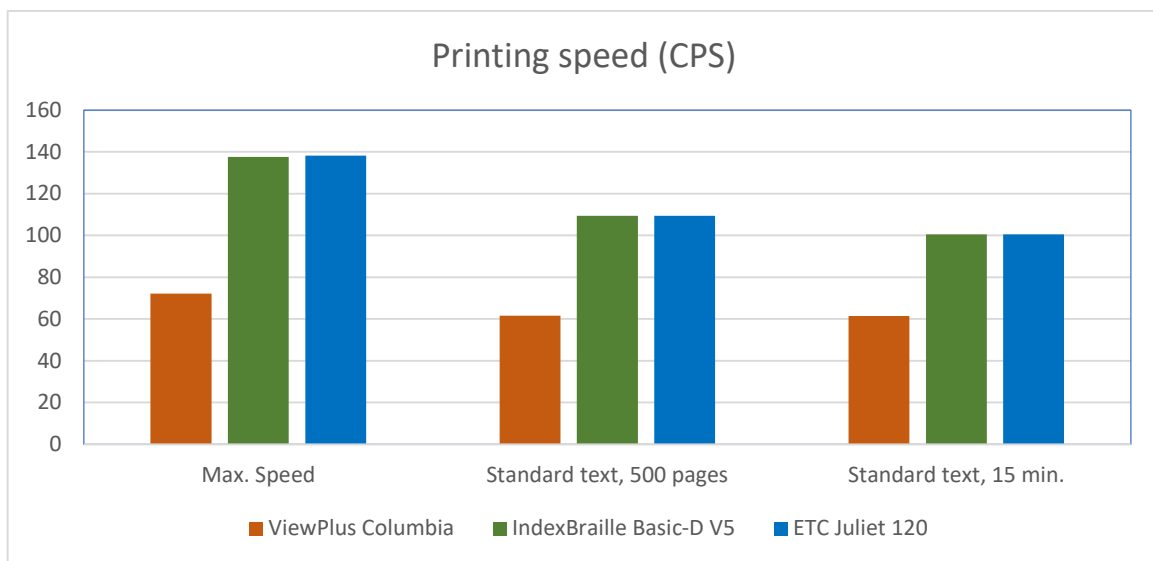
(\*) Irregular printing speed, results may vary greatly, depending on the number of times it crashes. Maximum / average values obtained.

Test 2 (standard text)	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
Total time (500 pages)	1: 58' 18" (**)	1:19' 27"	1:19' 29"
Pages per hour	254 PPH	378 PPH	377 PPH
Characters per second	61,49 CPS	109,40 CPS	109,35 CPS

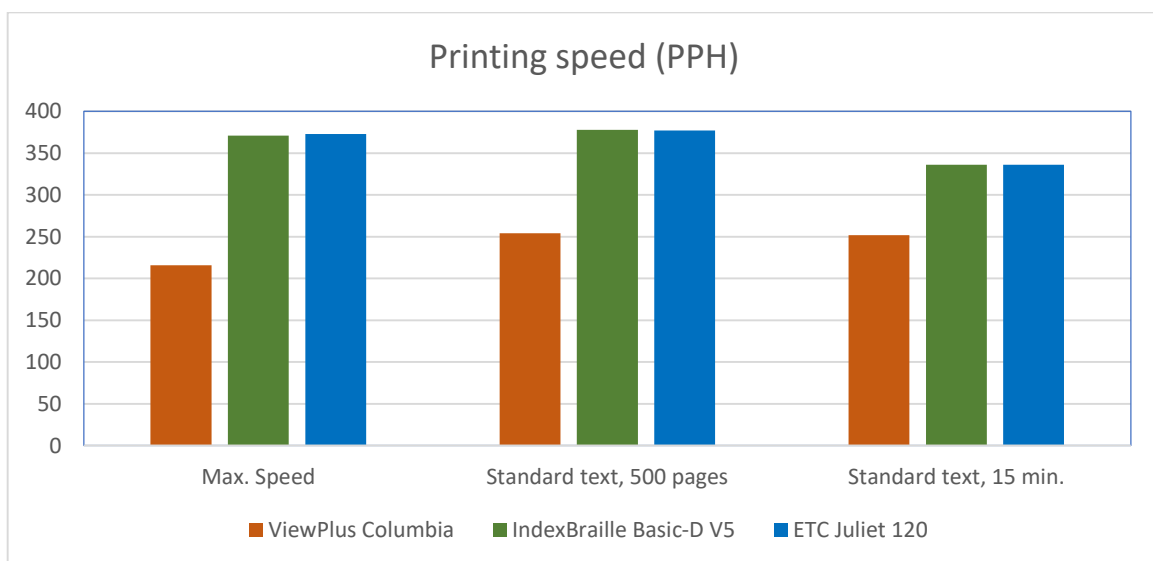
(\*\*) Embosser stopped on page 380 indicating "10005 – Coprocessor error " and had to be restarted, and printing resumed.

Test 3 (15 minutes)	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
Interval 1: 0' - 5'	61,27 CPS / 252 PPH	96,73 CPS / 336 PPH	97,54 CPS / 336 PPH
Interval 2: 5' – 10'	68,60 CPS / 276 PPH	100,88 CPS / 336 PPH	100,42 CPS / 336 PPH
Interval 3: 10' – 15'	54,30 CPS / 228 PPH	103,73 CPS / 336 PPH	103,36 CPS / 336 PPH
Final 0' - 15' (PPH/CPS)	61,39 CPS / 252 PPH	100,45 CPS / 336 PPH	100,44 CPS / 336 PPH

Printing speed results, showing average CPS speed:



Printing speed results, showing average PPH speed:



In the three speed tests carried out, it is worth noting the similarity between the printing speeds of the IndexBraille Basic-D V5 and the ETC Juliet 120 embossers, being, in practical terms, identical, taking into account the test scenarios used. In terms of absolute CPS, for the best case, both embossers exceed the values advertised by their manufacturers. Maximum PPH values depend largely on the nature of the text to be printed, approaching 400 pages per hour in both cases.

Regarding the ViewPlus Columbia, besides the base printing speed being always reasonably lower than the other two embossers as well as significantly below the advertised, it is still hampered by its printing rate, which from a certain moment - and the exact moment can vary greatly - becomes slower and irregular.

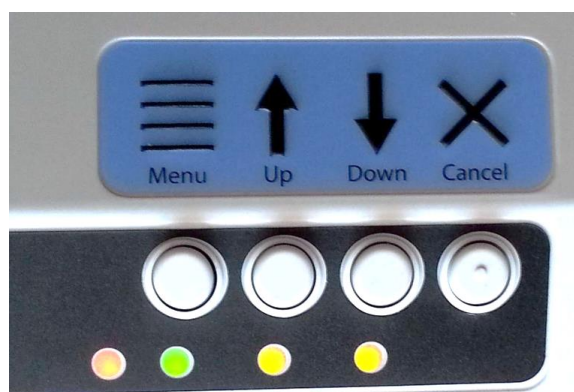
## 7.5 USABILITY (USER EXPERIENCE)

### 7.5.1 User Interface

#### 7.5.1.1 ViewPlus Columbia

The user interface of the ViewPlus Columbia embosser is somewhat minimalist, consisting only of 4 keys and 4 LEDs. The keys allow more than one function, depending on the duration with which key is pressed, making it somewhat difficult to navigate the menus, therefore making menu navigation less fluid. It would be preferable to have more keys to directly access the functions than few keys with various functions.

Because the embosser does not feature a built-in speaker, external amplified speakers must be used for this purpose. The following figure illustrates the local interface (front panel) of the ViewPlus Columbia embosser:



#### 7.5.1.2 IndexBraille Basic-D V5

The user interface of the IndexBraille Basic-D V5 embosser is much more complete, including 13 keys, some of which are illuminated, as well as 12 descriptions that will lit, in order to signal connection status (Bluetooth, cable network, Wi-Fi) as well as other states, including error situations. The control panel is text and Braille labeled, which allows for easy use of the interface. It features a built-in speaker, and therefore does not require the use of external speakers.

The following figure illustrates the local interface (front panel) of the IndexBraille Basic-D V5 embosser:



### 7.5.1.3 ETC Juliet 120

The user interface of the ETC Juliet 120 embosser is identical to that of the IndexBraille Basic-D V5, including 13 keys, some of which are illuminated, as well as 12 descriptions that will lit, in order to signal connection status (Bluetooth, cable network, Wi-Fi) as well as other states, including error situations. The control panel is text and Braille labeled as well, which allows for easy use of the interface. It features a built-in speaker, and therefore does not require the use of external speakers.

The following figure illustrates the local interface (front panel) of the ETC Juliet 120 embosser:



## 7.5.2 Voice interface

### 7.5.2.1 ViewPlus Columbia

The Voice Interface of the ViewPlus Columbia embosser presents some limitations, namely options in the menu that are not verbalized, and values associated with options that are not verbalized. This is the case for example of Braille tables. Another disadvantage may be the need to use of external amplified speakers to achieve voice output. However, the clarity of the voice used, as well as the fluidity of navigation in the menus, is emphasized.

### 7.5.2.2 IndexBraille Basic-D V5

The voice is usually clear, but not all menus are translated to Portuguese, and menu navigation is somewhat slow. The voice synthesizer could also be a little better. During menu navigation, some inconsistencies between the selection via the "OK" button or right arrow (for example, in *wizards*) were found. However, in English, navigation in the menus is more fluid and the voice clearer. The voice interface can be configured in 19 different languages.

### 7.5.2.3 ETC Juliet 120

The voice is usually clear, but not all menus are translated to Portuguese, and menu navigation is somewhat slow. The voice synthesizer could also be a little better. During menu navigation, some inconsistencies between the selection via the "OK" button or right arrow (for example, in *wizards*) were found. However, in English, navigation in the menus is more fluid and the voice clearer. The voice interface can be configured in 19 different languages.

### 7.5.3 Embedded features

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>• The ViewPlus Columbia embosser, natively, only provides basic features.</li> <li>• Advanced features are only available using the TigerBox, which also functions as a print server: <ul style="list-style-type: none"> <li>○ Wireless connections: Wi-Fi Direct and in infrastructure mode, and Bluetooth;</li> <li>○ Direct translation to Braille;</li> <li>○ Direct printing from Android, iOS and PC mobile devices;</li> <li>○ "EmbossMe" feature- allows uploading and printing files from the existing USB <i>pen</i> repository;</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• The IndexBraille Basic-D V5 embosser natively incorporates several advanced functions.</li> <li>• Advanced features: <ul style="list-style-type: none"> <li>○ Built-in Wi-Fi and Bluetooth <i>wireless</i> connections;</li> <li>○ idB: IndexBraille-Direct-Braille, direct printing from Windows, Mac OS and Linux (.txt, .doc, .docx, .pdf, .epub, .brl or .brf);</li> <li>○ Direct printing from USB <i>pen</i> (USB <i>host</i> port);</li> <li>○ BrailleApp, embedded webserver that allows direct printing and embosser configuration;</li> <li>○ Automatic <i>firmware</i> update via Ethernet;</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• The ETC Juliet 120 embosser natively incorporates several advanced functions.</li> <li>• Advanced features: <ul style="list-style-type: none"> <li>○ Built-in Wi-Fi and Bluetooth <i>wireless</i> connections;</li> <li>○ idB: IndexBraille-Direct-Braille direct printing from Windows, Mac OS and Linux (.txt, .doc, .docx, .pdf, .epub, .brl or .brf);</li> <li>○ Direct printing from USB <i>pen</i> (USB host port);</li> <li>○ BrailleApp, embedded webserver that allows direct printing and embosser configuration;</li> <li>○ Automatic <i>firmware</i> update via Ethernet;</li> </ul> </li> </ul>

### 7.5.4 Direct printing support

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>• The ViewPlus Columbia embosser, autonomously, does not provide direct print support.</li> <li>• The ViewPlus Columbia embosser allows direct printing via TigerBox from a PC or from mobile devices.</li> <li>• You can print from Android devices via Bluetooth, but on iOS only via <i>iPrint</i>.</li> <li>• The translation can be done without resorting to a separate Braille translator, by selecting the desired language. The process usually runs smoothly, and the translation is correct.</li> </ul>	<ul style="list-style-type: none"> <li>• The IndexBraille Basic-D V5 embosser provides direct and native print support.</li> <li>• The IndexBraille Basic-D V5 embosser incorporates idB technology, which allows direct printing of documents from PC (Windows, Mac OS or Linux) or mobile devices (Android and iOS), without requiring prior translation.</li> <li>• You can print from Android devices via Bluetooth (share via Bluetooth).</li> <li>• The BrailleApp can also be used to print directly from a PC or mobile devices (via Wi-Fi or Bluetooth), using idB technology.</li> </ul>	<ul style="list-style-type: none"> <li>• The ETC Juliet 120 embosser provides direct print support autonomously and natively.</li> <li>• The ETC Juliet 120 embosser also incorporates dB technology, which allows direct printing of documents from PC (Windows, Mac OS and Linux) or mobile devices (Android and iOS), without requiring prior translation.</li> <li>• You can print from Android devices via Bluetooth (share via Bluetooth).</li> <li>• The webserver can also be used to print directly from a PC or mobile devices (via Wi-Fi or Bluetooth) using dB technology.</li> </ul>



<ul style="list-style-type: none"> <li>• Printing via USB <i>pen</i> from the repository in the USB <i>pen</i> (folder "<i>EmbossMe</i>").</li> </ul>	<ul style="list-style-type: none"> <li>• Printing via USB <i>pen</i> supported natively by the embosser.</li> </ul>	<ul style="list-style-type: none"> <li>• Printing via USB <i>pen</i> supported natively by the embosser.</li> </ul>
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#### 7.5.5 Driverless usability (Webserver)

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>• The ViewPlus Columbia embosser, autonomously, does not provide <i>driverless</i> support.</li> <li>• The External TigerBox module adds <i>webserver</i> functionality to the ViewPlus Columbia. Allows direct configuration and printing. It is easy to use and adds wireless capabilities. The translation of menus into Portuguese is, however, dubious.</li> <li>• The webserver allows you to configure the embosser, manage network connections, as well as configure the Braille translator and direct printing of documents.</li> <li>• However, you miss truly simple printing from mobile devices. In general, the process should be easier, printing from webserver on mobile devices is not very intuitive.</li> </ul>	<ul style="list-style-type: none"> <li>• The IndexBraille Basic-D V5 embosser provides <i>driverless</i> support autonomously and natively.</li> <li>• The IndexBraille Basic-D V5 webserver is called BrailleApp. Allows embosser configuration and printing from both PC and mobile devices, representing the new generation of IndexBraille V5 embosser interface.</li> <li>• The <i>webserver</i> allows you to configure the embosser, direct printing of documents, and translation via idB. It also allows viewing in ink mode or Braille dots, as well as editing the translated Braille file.</li> <li>• However, their use on mobile devices is not practical, given the nature of these. In general, the process should be easier, because printing from <i>webserver</i> on mobile devices is not very intuitive.</li> <li>• Module to print labels.</li> </ul>	<ul style="list-style-type: none"> <li>• The ETC Juliet 120 embosser provides <i>driverless</i> support autonomously and natively.</li> <li>• The <i>webserver</i> of the ETC Juliet 120 is similar to that of IndexBraille Basic-D V5. Allows embosser configuration and printing from both PC and mobile devices.</li> <li>• The <i>webserver</i> allows you to configure the embosser, direct printing of documents, and translation via idB. It also allows viewing in ink mode or Braille dots, as well as editing the translated Braille file.</li> <li>• However, their use on mobile devices is not practical, given the nature of these. In general, the process should be easier, because printing from <i>webserver</i> on mobile devices is not very intuitive.</li> </ul>

#### 7.5.6 Additional Software

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<p>The Tiger Software Suite (TSS) includes:</p> <ul style="list-style-type: none"> <li>• VP Formatter, which allows translation into Braille and has an <i>add-in</i> for direct integration into MS Word and MS Excel ("Tiger Ribbon").</li> </ul>	<p>Additional software available:</p> <ul style="list-style-type: none"> <li>• ibPrint - <i>drag-and-drop</i> icon that lets you send files for direct printing.</li> <li>• IndexBraille-direct-Braille for Windows – allows direct printing of files, with a right-click of the mouse on a</li> </ul>	<p>Additional software available:</p> <ul style="list-style-type: none"> <li>• Firebird – free software included with the ETC Juliet 120, which allows the creation and editing of tactile graphics, for printing, supporting file of types .jpg, .tif, .png and .prn.</li> </ul>

<ul style="list-style-type: none"> <li>• Tiger Designer, which allows the creation of graphics with up to 8 different heights of Braille dot.</li> <li>• VP translator, which allows the conversion to Braille of other types of documents (PowerPoint, text file, etc.).</li> </ul>	document, without the need to use a Braille editor.	<ul style="list-style-type: none"> <li>• dB - direct-Braille for Windows - allows direct printing of files, with a right-click of the mouse on a document, without the need to use a Braille editor.</li> </ul>
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## 7.6 BRAILLE DOT QUALITY (TACTILE SENSATION)

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>• Unsatisfactory quality. There is a difference in the quality of the dot from the beginning to the end of the lines.</li> <li>• On interpoint printing, and on the opposite page, you can feel the dot on the other side. The dot is always lower in height, and less uniform.</li> <li>• The dot is less pleasant to tact. Pages printed on the back show a lower height dot (default settings).</li> </ul>	<ul style="list-style-type: none"> <li>• Excellent dot quality, even and homogeneous dot, "rounder", "fuller" and pleasant to tact.</li> <li>• Printing on both sides (interpoint) is good.</li> <li>• This assessment can be confirmed objectively by the physical characterization of the Braille dot presented in this report.</li> </ul>	<ul style="list-style-type: none"> <li>• Excellent dot quality, even and homogeneous dot, "rounder", "fuller" and pleasant to tact.</li> <li>• Printing on both sides (interpoint) is good.</li> <li>• This assessment can be confirmed objectively by the physical characterization of the Braille dot presented in this report.</li> </ul>

## 7.7 GRAPHICS QUALITY (DOT HEIGHT TACTILE FEEL)

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
Tiger Designer graphics editing software (part of the TSS – Tiger Software Suite package). Software is free. Allows direct printing.	TactileView software can be used, however, it is a licensed application.	It includes free Firebird graphics software, which is very easy to use. Allows the conversion of graphics to Braille dot as well as direct printing.
For assessing ViewPlus Columbia's graphical capabilities, demo files made available by ViewPlus on their <i>Website</i> were printed ( <i>Tactile Graphics Example Files</i> ).	For evaluation of the graphics capabilities of IndexBraille Basic-D V5, demo files made available by IndexBraille Braille ( <i>demo files</i> ) were printed.	To evaluate ETC Juliet 120's graphics capabilities, sample <i>files (sample files)</i> made available by Enabling Technologies, were printed using Firebird graphics software, for conversion to Braille and direct printing.
<p>The ViewPlus Columbia stands out for its graphs, allowing representation at seven or eight different heights of the Braille dot.</p> <p>In practice, this difference is mitigated because small dot differences are not easily noticeable.</p> <p>It is a feature that at first seems interesting, but that in practice does not represent a significant added value.</p> <p>In addition, very dense areas become confusing, making it difficult to perceive the graph/design.</p>	Although it only uses a single dot height, the graphs produced by IndexBraille Basic-D V5 are clear, and the quality of the dot is excellent, allowing for improved graph/drawing perception compared to the ViewPlus Columbia.	Like the IndexBraille Basic-D V5, the ETC Juliet 120 only uses a single dot height. The graphics produced by the ETC Juliet 120 are clear, and the quality of the dot is excellent, allowing an improved perception of the graph/drawing compared to the ViewPlus Columbia.

## 7.8 SUPPORT/TROUBLESHOOTING

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>ViewPlus offers a ticket-based support service from the ViewPlus website. It is easy to place issues, with online follow-up. Email notifications are generated whenever there is a change in the ticket state. Overall, the service works well.</li> <li>No remote diagnostic service is available. General issues may be addressed via support email (<a href="mailto:support@viewplus.com">support@viewplus.com</a>).</li> </ul>	<ul style="list-style-type: none"> <li>IndexBraille offers a complete remote internet, telephone, and <i>supportcenter</i> service.</li> <li>There is also a TeamViewer-based support service.</li> <li>It is also possible to diagnose and provide remote support with an internet connection, via SSH tunnel.</li> </ul>	<ul style="list-style-type: none"> <li>Enabling Technologies offers a telephone support service within the U.S.</li> <li>It is also possible to diagnose and provide remote support with an internet connection, via SSH tunnel.</li> </ul>

## 7.9 DEVICE STRUCTURAL ROBUSTNESS

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>The embosser uses mostly plastic in its construction, presenting some soft plastic areas.</li> <li>The cover over the paper feed zone is plastic.</li> <li>The printing mechanism is fully metallic, but it is screwed internally to the base of the embosser, which is made of plastic.</li> <li>The main printed circuit board as well as the (internal) power supply are assembled on an aluminum sub-chassis, which in turn is screwed to the plastic base of the embosser.</li> </ul>	<ul style="list-style-type: none"> <li>The embosser presents remarkable structural robustness and stability.</li> <li>The chassis is metallic and integral, and only the sides of the embosser are plastic.</li> <li>The cover over the paper feeding zone is also metallic.</li> <li>However, the pins of the power connector do present some weakness and can warp if forced. A more robust rectangular connector would be preferable.</li> </ul>	<ul style="list-style-type: none"> <li>Just like the IndexBraille Basic-D V5, the ETC Juliet 120 embosser presents remarkable structural robustness and stability.</li> <li>The chassis is metallic and integral, and only the sides of the embosser are plastic.</li> <li>The cover over the paper feeding zone is also metallic.</li> <li>However, the pins of the power connector do present some weakness and can warp if forced. A more robust rectangular connector would be preferable.</li> </ul>

## 7.10 EASE OF MAINTENANCE/CALIBRATION

ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<ul style="list-style-type: none"> <li>Firmware update via PC (using USB connection): download of an executable that updates the firmware. The update to the latest <i>firmware</i>, 11.11.25, ran smoothly, and has been successfully tested.</li> <li>During the tests, a TigerBox <i>firmware</i> update was also performed to the latest version, which also ran smoothly.</li> <li>It is possible to calibrate the strength of the hammers, as well as the "skew" if the Braille dots 1,2, 3 or 4, 5, 6 are not aligned.</li> </ul>	<ul style="list-style-type: none"> <li>The <i>firmware</i> update can be performed via USB <i>stick</i>, or remotely via Ethernet. Both methods were successfully tested.</li> <li>Firmware updates were performed during the tests without any problem.</li> <li>The paper output position and offset can be adjusted via the control panel, as well as the adjustment of the paper sensors.</li> </ul>	<ul style="list-style-type: none"> <li>The <i>firmware</i> update can be performed via USB <i>stick</i>, or remotely via Ethernet. Both methods were successfully tested.</li> <li>Firmware updates were performed during the tests without any problem.</li> <li>The paper output position and offset can be adjusted via the control panel, as well as the adjustment of the paper sensors.</li> </ul>

## 8 CONCLUSIONS

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This section summarizes the results of tests carried out on three Braille embossers available in the domestic market, with respect to low cost and fairly high printing speed devices (> 100 CPS), namely ViewPlus Columbia, IndexBraille Basic-D V5 and ETC Juliet 120.

In terms of CE Marking and compliance with the Electromagnetic Compatibility and Low Voltage Directives, both devices manufactured in Europe have the Compliance Reports available for consultation, which does not happen with the equipment manufactured in the US (ViewPlus Columbia). Therefore, it was chosen to perform this type of testing only on the equipment manufactured in the US (ViewPlus Columbia).

Given its relevance on regulatory policy, special emphasis was given regarding Electromagnetic Compatibility (EMC). With regard to electrical safety, some key points were also evaluated relating to the Low Voltage Directive, Directive of the European Parliament and Council 2014/35/EU. As shown in this report, the ViewPlus Columbia complies with the Electromagnetic Compatibility Directive, Directive 2014/30/EU of the European Parliament and Council.

In terms of structural and handling robustness, it should be noted that the IndexBraille Basic-D V5 and the ETC Juliet 120 construction is superior, using a metallic and integral frame, which does not happen with the ViewPlus Columbia, using mostly a plastic-based construction. It is also noteworthy that both the IndexBraille Basic-D V5 and ETC Juliet 120 provide all the features autonomously and natively, whereas the ViewPlus Columbia requires the use of an external module - TigerBox.

In terms of user interface, the ViewPlus Columbia features a voice interface without built-in speaker, which requires the use of amplified external speakers, making it less practical. It also uses a simplistic local interface, while the IndexBraille and the ETC embossers feature a modern and comprehensive local interface, including Braille inscriptions along the keyboard, illuminated panel, and built-in speaker.

Both the IndexBraille Basic-D V5 and the ETC Juliet 120 feature integrated webserver with good functionality, while the ViewPlus Columbia does not offer this feature, requiring an external module - TigerBox - to provide equivalent functionality.

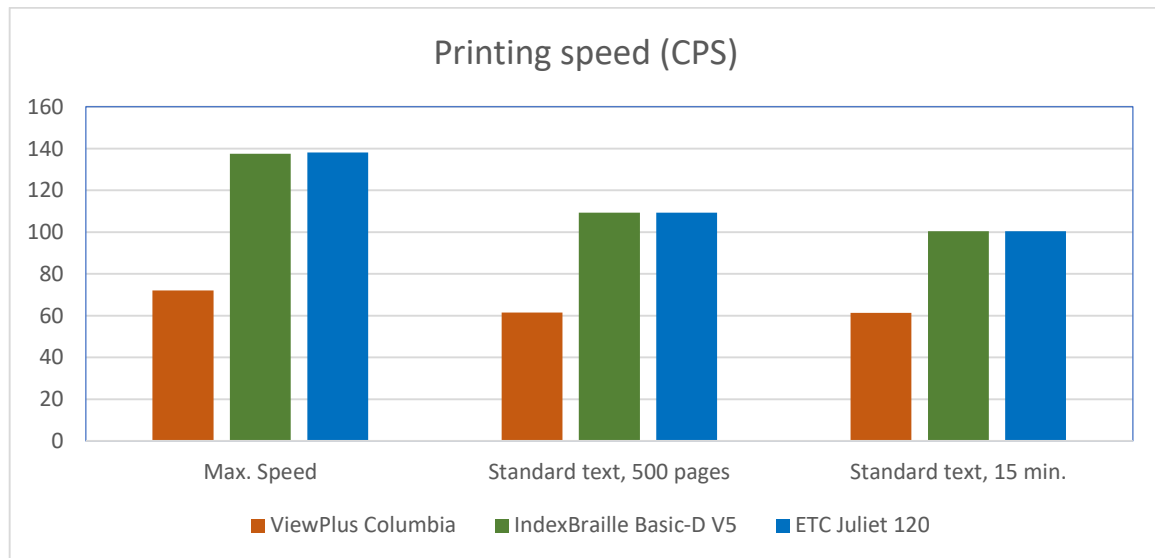
In terms of support for wireless connectivity regarding mobile devices, with the addition of TigerBox to the ViewPlus Columbia, the three embossers offer similar functionality, although the IndexBraille Basic-D V5 and the ETC Juliet 120 prove to be more practical, given that they include these technologies natively, onboard. It should also be noted that the direct-Braille technology used by either IndexBraille and ETC greatly simplify the process of direct printing of documents. The ViewPlus only allows direct printing through TigerBox, and the process is not as practical.

With regard to printing speed, both IndexBraille Basic V5-D and ETC Juliet 120 far exceed the ViewPlus Columbia. The table below summarizes the results obtained. The ViewPlus Columbia showed operating errors when printing long documents, as well as an uneven printing speed, with direct impact on the maximum results obtained, as shown in the following table and graphs:

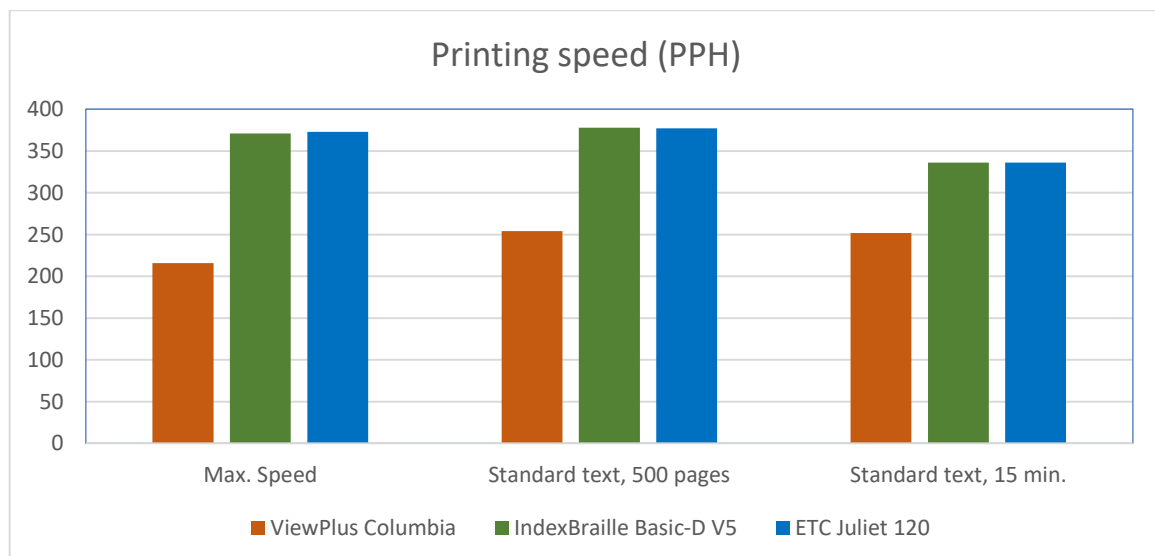
Tests	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120
<b>test 1</b> "Draft" mode, Maximum speed	102 / 72.1 CPS (*)	137.6 CPS	138.2 CPS
	PPH 216 (*)	371 PPH	PPH 373
<b>test 2</b> "Draft" mode, Standard text	CPS 61.49 (*)	109.40 CPS	109.35 CPS
	PPH 254 (*)	PPH 378	377 PPH
<b>test 3</b> Mode "standard / high", Standard Text 15 min.	CPS 61.39 (*)	100.45 CPS	100.44 CPS
	PPH 252 (*)	PPH 336	PPH 336

(\*) Irregular printing speed, results may vary greatly, depending on the number of times it crashes. Maximum / average values obtained.

Printing speed results, showing average CPS speed:



Printing speed results, showing average PPH speed:

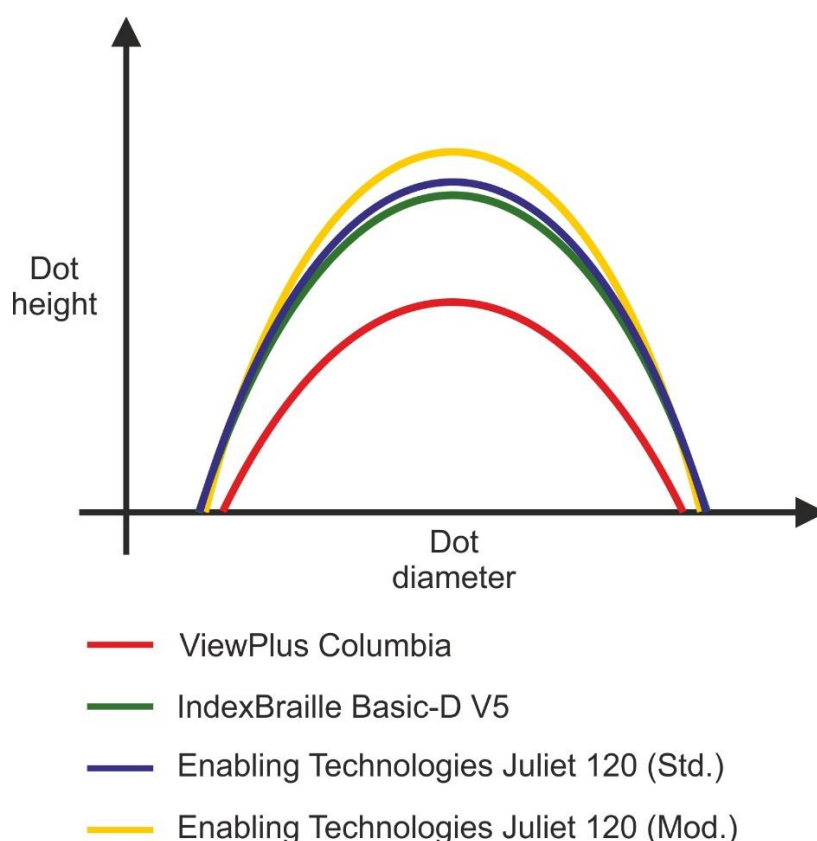


Regarding Braille Dot Quality, exhaustive tests were performed on the four embossers, in order to assess not only the topography of the Braille dot, but also its variation over the printing of a document. It appears that the quality and reading pleasantness of the Braille dot printed by the IndexBraille Basic-D V5 and the ETC Juliet 120 is much higher, presenting a more "substantial" and "rounded", better defined dot, resulting in greater ease of reading and pleasantness to the touch. It is also more consistent along a line and over several pages. These results are presented in the relevant section of this report.

The results obtained with the IndexBraille Basic D-V5 and ETC Juliet 120 are similar, since they share the same basic hardware. However, two variants of ETC Juliet 120 were assessed, one with standard hammers, and one with modified hammers, which proved to present a higher and better defined dot, better than the original, and closer to the dot considered the "ideal Braille dot", the Braille dot printed by Perkins Brailler.

The following table and figure illustrates the comparison of the shape of Braille dots printed by the embossers in question, from the average results of the measurements performed by MetrologySolutions for height, diameter (at its base) and curvature radius of the dot (the vertical scale is different from the horizontal scale, in order to allow a better comparison of the most obvious differences):

Measured average values (mm)				
Measurement	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120 (standard)	ETC Juliet 120 (modified)
Height	0.2446	0.3595	0.3937	0.4256
Diameter	1.5353	1.7015	1.7051	1.6559
Radius of curvature	1.3817	1.1951	1.1145	1.0264



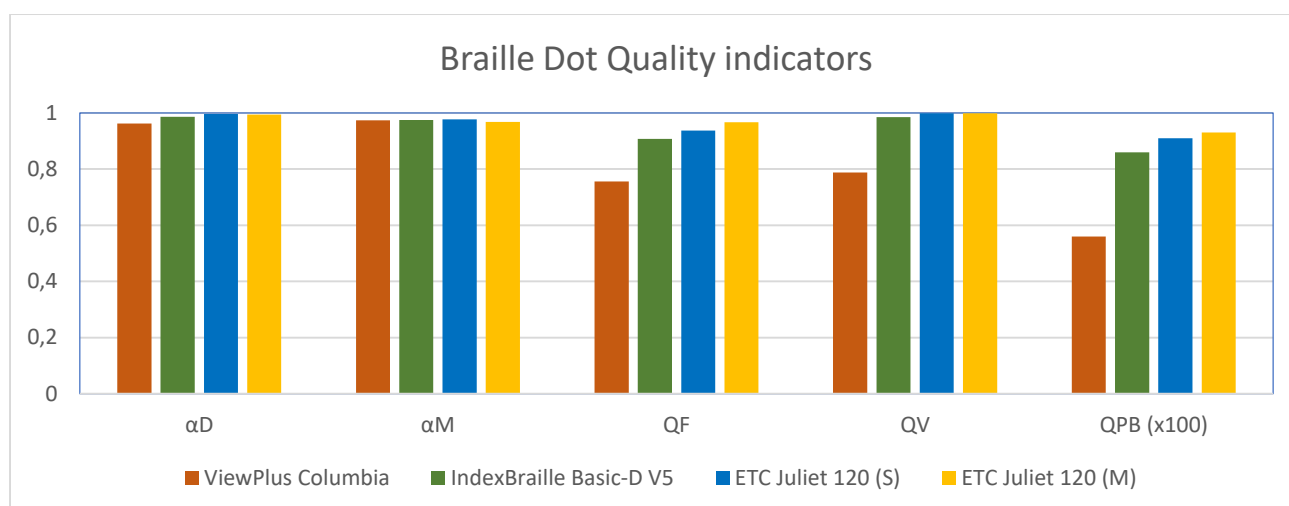


From the global Braille Dot Quality indicator *BDQ* developed in this study, it is clear that the Braille dot of the IndexBraille Basic-D V5, reaching 86 points, is about 50% better than the dot produced by the ViewPlus Columbia, which scores 56 points. This is mainly due to the quality of dot shape and volume. It should also be noted that the stability indicators differ slightly, with a slight advantage of the IndexBraille Basic-D V5.

It follows that the quality of the pre-production Braille dot from Enabling Technologies has the potential to score almost 10% better than the IndexBraille dot, and about 60% better than the Braille dot from ViewPlus. This pre-production Braille dot, which is under development, reproduces the traditional US American dot of Enabling Technologies and Juliet 120.

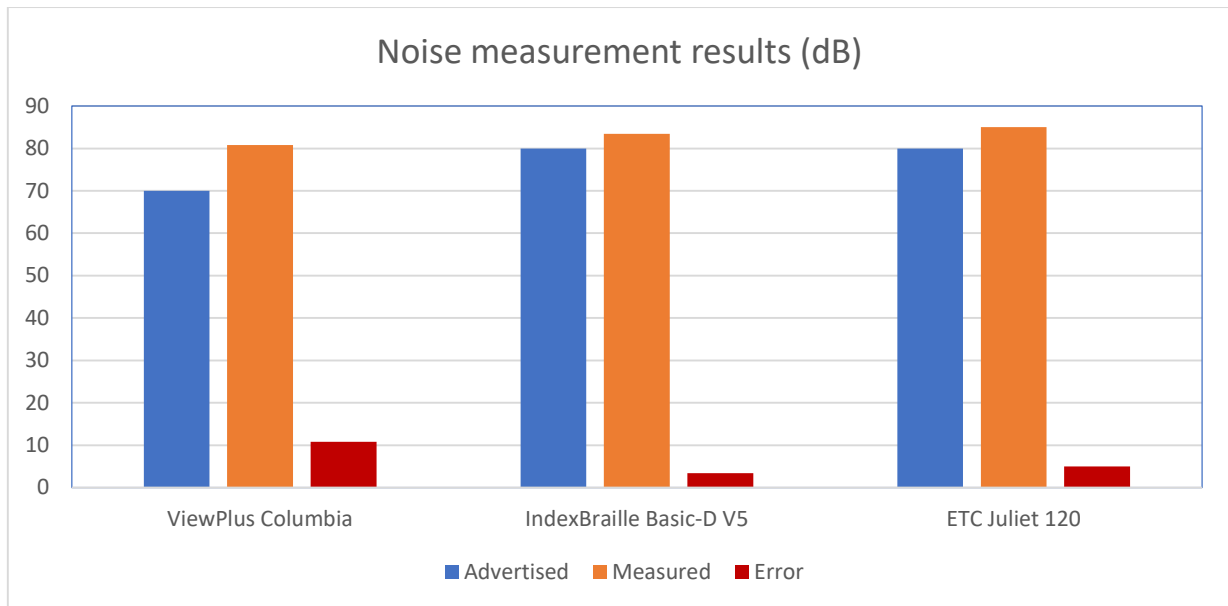
Comparison of Braille Dot Quality indicators				
Indicator	ViewPlus Columbia	IndexBraille Basic-D V5	ETC Juliet 120 (standard)	ETC Juliet 120 (modified)
$\alpha D$	0.962	0.986	0.996	0.994
$\alpha M$	0.973	0.975	0.977	0.968
$QF$	0,756	0.907	0.937	0.967
$QV$	0.788	0,985	0.999	0.999
<b><i>BDQ</i></b>	<b>56</b>	<b>86</b>	<b>91</b>	<b>93</b>

The following chart illustrates the calculated partial quality indicators as well as the global indicator, *BDQ*:

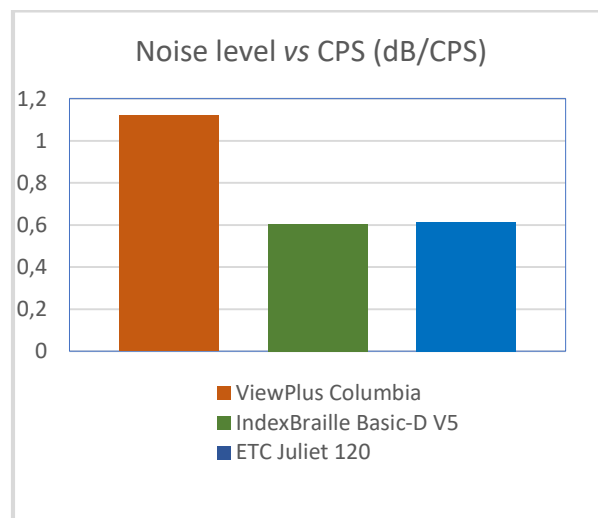


Regarding graphics printing, both the ViewPlus Columbia and the ETC Juliet 120 offer free software for editing, converting and printing graphics, respectively TigerDesigner and Firebird. The IndexBraille Basic-D V5 can be used with TactileView software, requiring a separate license. In terms of the tactile graphics obtained, both IndexBraille Basic-D V5 and the ETC Juliet 120 stand out by producing clear graphics with an excellent dot. The ViewPlus Columbia offers the ability to print graphics with up to 7 different dot heights, but in practice this feature did not present itself as an added value for ACAPO, given the difficulty in interpreting the different dot heights.

Additional tests were also carried on regarding the measurement of operating noise generated by the three embossers during Braille printing. It was found that all exceeded the values advertised by the respective manufacturers, with the ViewPlus Columbia being the one which deviates the most, by a margin of 10.8 dB (i.e., more than three times the noise level advertised by the manufacturer). IndexBraille Basic-D V5 and ETC Juliet 120 exceeded the stated values, respectively, by 3.4 dB and by 5 dB, as shown in the following charts:

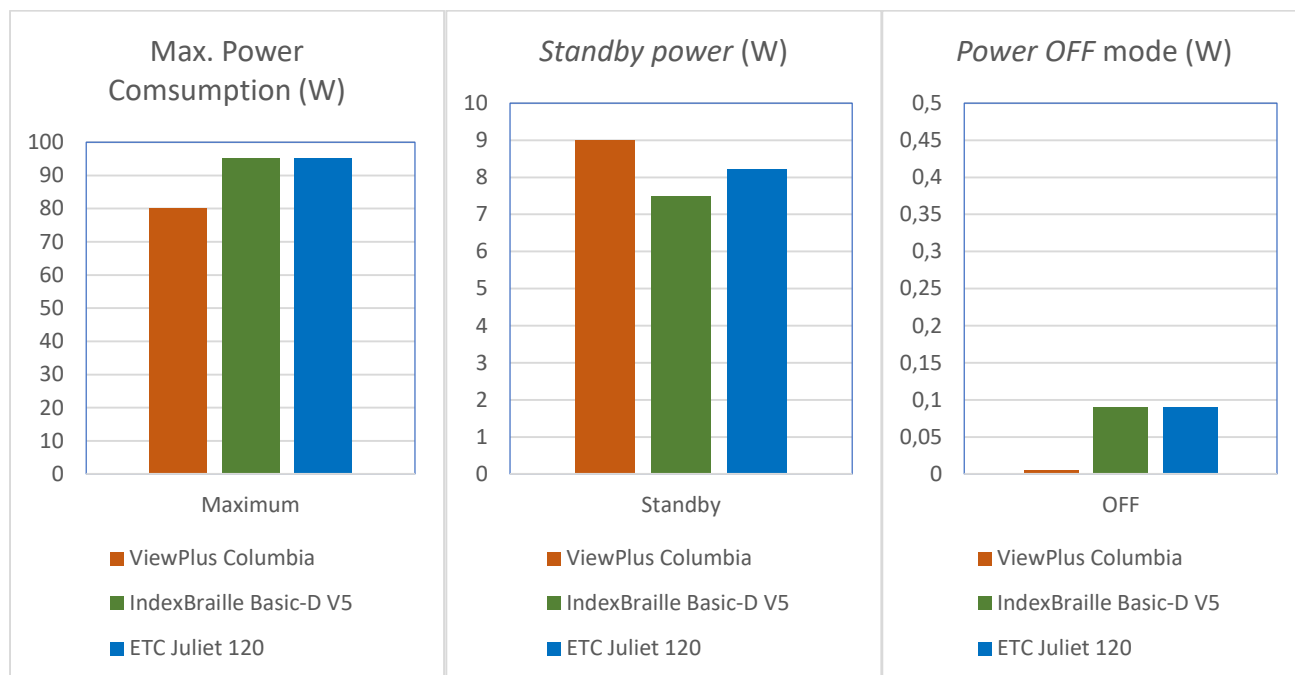


On the other hand, if taken into account the performance in terms of print speed of the embossers in question, considering the indicator noise *versus* CPS, (dB / CPS), we found that both IndexBraille Basic-D V5 and the ETC Juliet 120 are more efficient when it comes to this indicator, producing almost half of the noise by printed character per second (dB / CPS):



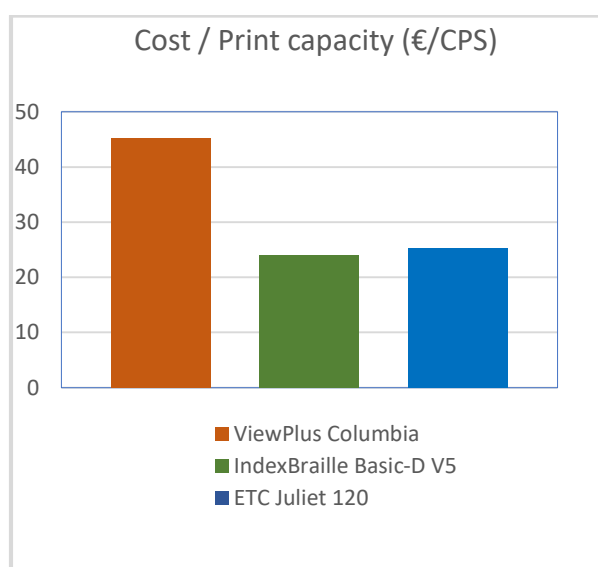
With regard to power consumption, none of the embossers has ever exceeded 95W, even during heavy interpoint embossing. The ViewPlus presents the highest consumption during standby, but by a small margin. However, in OFF mode, the power consumption of the ViewPlus Columbia is virtually zero, whereas for both IndexBraille Basic-D V5 and ETC Juliet 120 the power consumption is less than 0.1W, due to the use of external switched-mode power supplies.

Graphs relating to power consumption (maximum power consumption, power consumption in standby mode and OFF mode, in W):



Regarding support and problem solving, the ViewPlus offers a support system based on tickets, with e-mail notifications, which reveals a good operation, and a general e-mail support. In addition to remote support via e-mail and telephone, IndexBraille and ETC offer remote support via SSH tunnel, where the IndexBraille also adds remote support based on TeamViewer.

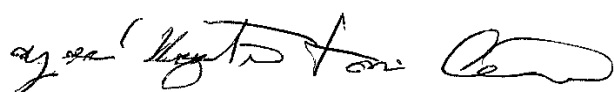
In terms of investment, it is important to evaluate the cost *versus* print speed, € / CPS. Thus, it becomes clear that the ViewPlus Columbia embosser stands out for being the one that has a higher productivity cost, almost 80% higher than the IndexBraille Basic-D V5 and the Juliet ETC 120:



For the existing technology regarding Braille embossers available in the domestic market in 2019, we can state that the Braille embosser that in our opinion is the most balanced offer is the IndexBraille Basic-D V5, mainly because it may cost about 3% more than the ViewPlus Columbia (prices in \$ USD as of December 2019), but:

- It has a complete interface, adapted for people with special needs;
- It has a Braille Dot Quality - *BDQ* - about 50% better;
- It prints Braille, on average, almost twice as fast (CPS);
- Prints almost 50% more pages per hour (PPH in draft mode) without technical stops;
- It offers all the modern technology onboard, i.e., without the need for external modules;
- It allows for more efficient processes with special preference for automatic direct printing;
- It produces half the noise for the same work (dB / CPS);
- It costs almost half of the price for the same work (€ / CPS);
- And it presents no technical faults, no various configuration problems, and everything is performed in a practical and intuitive way.

President Nacional Board

A handwritten signature in black ink, appearing to read 'Tomé Coelho', with a stylized flourish at the end.

Tomé Coelho