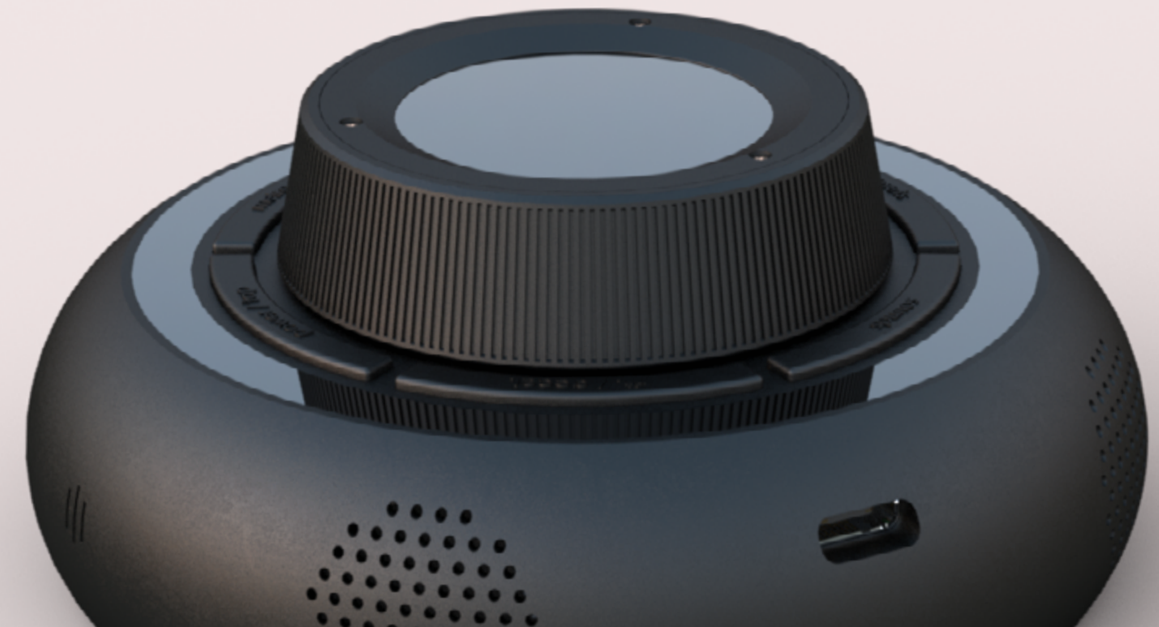
CASIO GROUP 12 / FREDDIE SEIDLER / SAM CASTLE / ALEX GIBSON / OLLY CROSS

CASIO®

ELECTRONIC DIGITAL METRONOME

EDP - SUMMER TERM 2020
DYSON SCHOOL OF DESIGN ENGINEERING
IMPERIAL COLLEGE LONDON



PRODUCT OPPORTUNITY

FINAL PRODUCT OPPORTUNITY STATEMENT

CASIO

PRODUCT **OPPORTUNITY** STATEMENT

THE FOLLOWING PRODUCT OPPORTUNITY STATEMENT SUMMARIZES THE GOALS OF THIS PRODUCT. IT REPRESENTS OUR DISTILLED GOALS, BASED ON RESEARCH FROM PHASES 1 AND 2.

CASIO will produce a time keeping device that has added functionality beyond current metronomes on the market, implemented using a simple user interface. The device is designed around the easy conveyance of time, improving on the method of time communication used by current metronomes. It will be intuitive to use as a stand-alone time keeping product, and will also be capable of taking advantage of the remote and wireless LEARN @ HOME feature, key to CASIO's growth in the electronic music market.

Shown on the right is the breakdown of this statement, outlining how we arrived at these goals.

PRODUCT OPPORTUNITIES FROM OUR **RESEARCH**

EXPLORING SENSORY STIMULI

Our HCR showed that communicating time in methods other than audible ticking would be beneficial to users in certain situations, such as quiet practice or group settings.

CHANGING TIME SIGNATURES

For more advanced musicians, playing music with irregular time signatures is inevitable - our device allows the user to select the varying time signatures, and the metronome will adapt accordingly.

WIRELESS TECHNOLOGY

We are bringing inclusivity and connectivity to CASIO's music product lineup, with wireless capabilities in our product - allowing features such as sharing of presets and remote learning.

PROGRAMMABLE FLEXIBLE TEMPI

The ability to input gradual tempo changes - ie. accelerandos - of a piece was a frequently requested feature during research, and improves the basic functionality of a metronome.

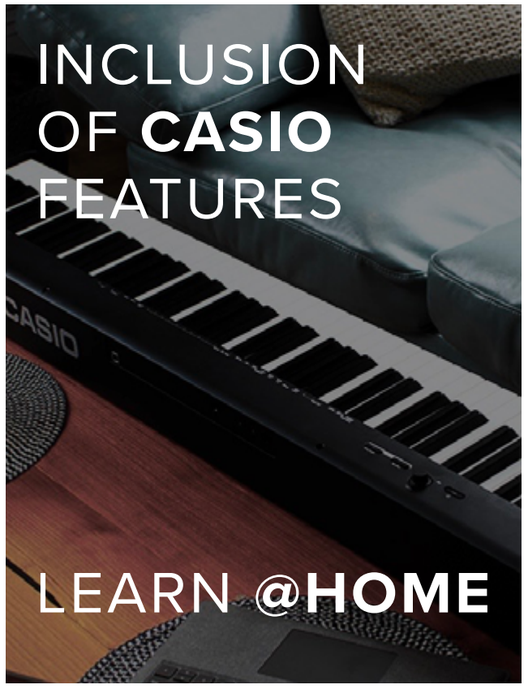
IMPROVED USER INTERFACE

Our goal is to offer added functionality without increased complexity - our user interface offers features normally reserved for complicated software in an intuitive layout.

TARGET MARKET

Our product targets intermediate to advanced musicians who require more from their metronome, but does not exclude learner musicians - the device provides all features that a novice would require.

INCLUSION OF **CASIO** FEATURES

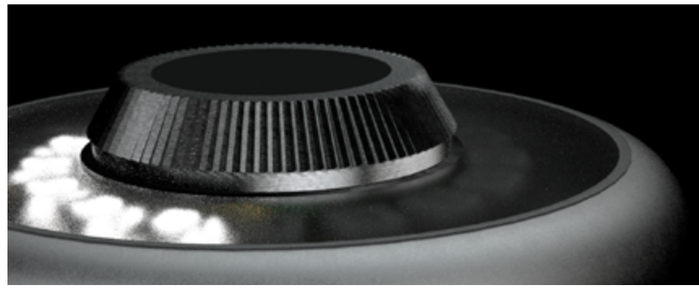


CASIO's LEARN @HOME scheme provides a system in which users can attend an online academy to help learn to play the keyboard. This is done through a combination of how-to videos and interactive software that maps progress. All this is acheived remotely, and is delivered through the built in software provided on many of their keyboards.

As living with COVID 19 remains a potential reality, remote learning is a massive growing industry and the LEARN @HOME scheme is poised to provide learners with a distanced learning environment comparable with live teaching. For this reason, we believe LEARN @HOME should be incorporated into our product.

CONCEPT **SELECTION**

Each group member created a concept designed to effectively tackle the product opportunity area with a device that addresses all the needs of our user group, which were uncovered with extensive research. The positives and negatives of each concept are described here.



CONCEPT **1**

ALEX GIBSON

+ POSITIVES

1. Tackles the product opportunities raised by users in research.
2. Ergonomic design that will fit in a musicians bag and is pleasing.
3. Creatively provides a different method of time output (LEDs).

- NEGATIVES

1. Difficult to implement all functions due to simplified interface.
2. Slim design means feasibility is lowered.
3. Circular interface not immediately intuitive, and so could be hard to use

CONCEPT **2**

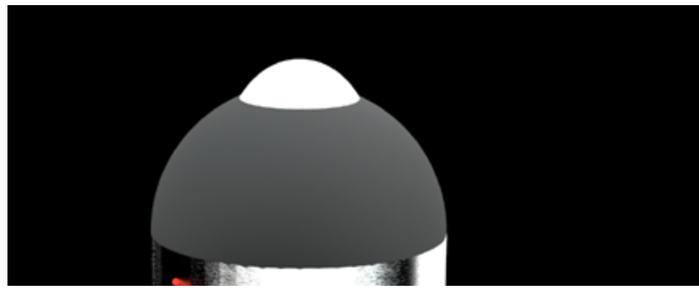
SAM CASTLE

+ POSITIVES

1. Delivers all functions and corrects all issues requested by user group.
2. Large screen allows for easy viewing of displayed information.
3. Simple build and design means a high feasability.

- NEGATIVES

1. Lots of functionality could complicate use.
2. Similar design and functionality to smartphone app.
3. Bulky design could be unappealing to some users.



CONCEPT **3**

FREDDIE SEIDLER

+ POSITIVES

1. Very clear delivery of time output - large 360° flashing light.
2. Small LEDs give user feedback, signalling when user is out of time.
3. Simple communication of time means it is easy to use for our younger target market.

- NEGATIVES

1. Simplified design could discourage more advanced musicians from using
2. Lack of screen or signifiers means it is not intuitive to input key functionality such as BPM.
3. Inefficient at conveying accelerando, a feature required by our user group.

CONCEPT **4**

OLLY CROSS

+ POSITIVES

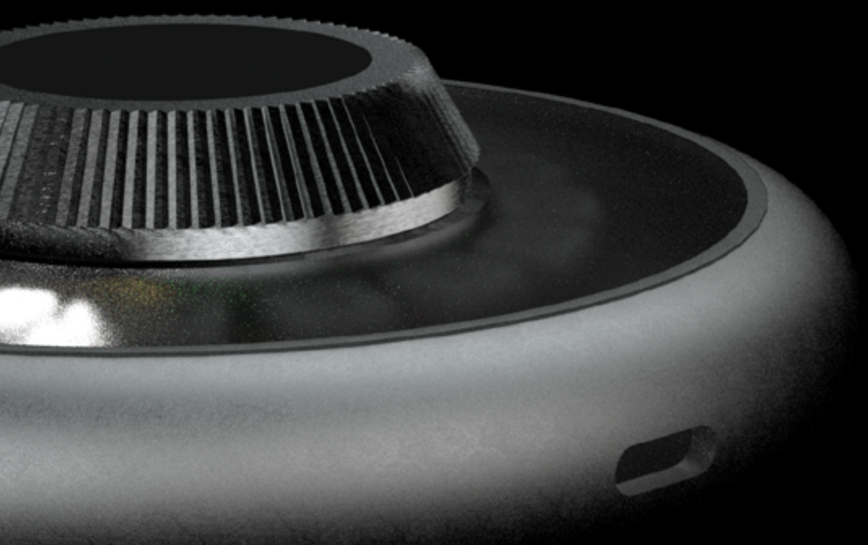
1. Wearable, and so allows easy access to all functions.
2. Creatively conveys time by physically tapping users arm.
3. Slim design is easily portable and comfortable to wear for all users.

- NEGATIVES

1. Lack of demand for a wearable in the musical accessory market, as it can restrict movement.
2. Input is hard, as the device is worn halfway up one arm.
3. Constant physical tapping could be distracting during practice.

CONCEPT **INTEGRATION**

The products that scored most highly in a vote amongst fellow Design Engineers were Concepts 1 and 2. We then conducted further surveys, and participants agreed that these two concepts were most viable. We decided to integrate the best features of both into a single product, ensuring the ideas behind both were maintained.



CONCEPT **1**

FEATURES TO KEEP

The method of use of Concept 1 appealed to users, as they could see a way of implementing all the features in a way that was satisfying, intuitive and aesthetically pleasing.
The combination of visual and audio time communication was also a desired feature, both in previous research, and in feedback after concept development.

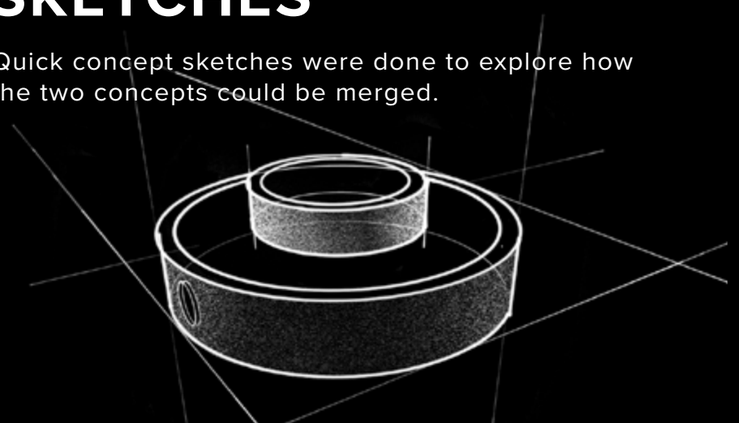
CONCEPT **2**

FEATURES TO KEEP

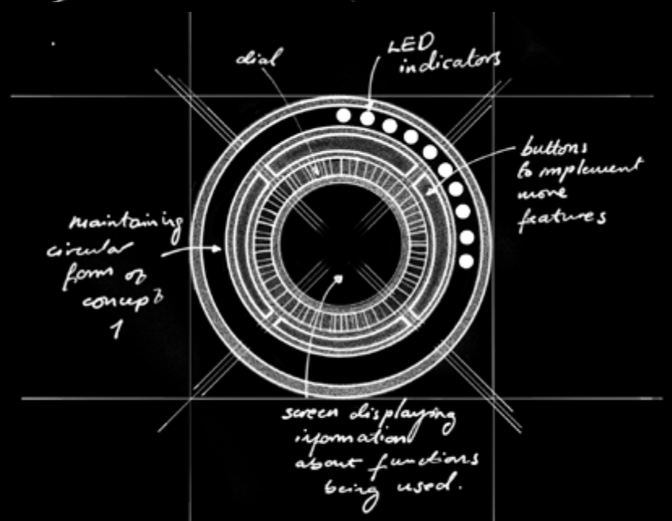
The breadth and depth of included features in Concept 2 meant that users could see that it has the most potential to satisfy an extended user group.
The feasibility of this concept is high as well, as the build is simple and can easily fit a wide range of components.
Another added benefit is accessibility - this concept utilises common ports and charging connectors, and so users will not be discouraged from purchasing by the requirement of new accessories.

INTEGRATION **SKETCHES**

Quick concept sketches were done to explore how the two concepts could be merged.



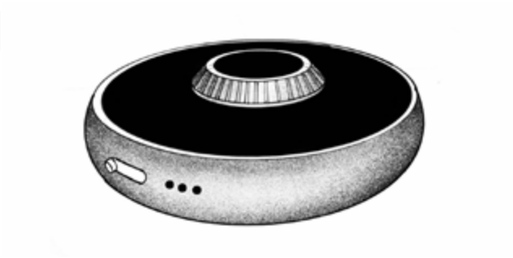
The form was explored to ensure that the concept was feasible, could be easily manufactured and could fit all required components.



This birds eye view shows how buttons could be added to the circular form to make the addition of extra functions easier.

FORM SURVEY AND SELECTION

1



DESIGN 1:

Design 1 has curved edges and a subtle speaker grill so that all the focus is on the user interface. However, the curved body could prove difficult to fit components into efficiently, and could also be difficult to manufacture.

2

DESIGN 2:

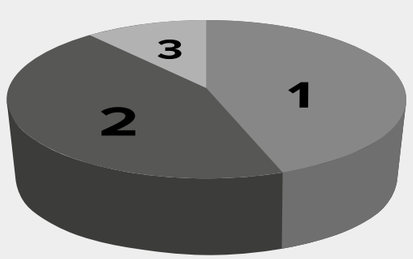
Design 2 has a smaller dial and chamfered edges - a form that is more reflective of functionality than aesthetic. The straight edges allow for more compact components, but the raised dial could hinder the view of the LEDs.

3

DESIGN 3:

Inspired by the Apple iPod click wheel, Design 3 takes advantage of an alternative method navigating the user interface. However this design is less intuitive to many users, as the click wheel does not immediately signify turning.

SURVEY **RESULTS**



A survey was conducted to determine which design would be most popular within our user group, in which there were 25 participants.

11/25 said they preferred Design 1.
9/25 said they preferred Design 2.
5/25 said they preferred Design 3.

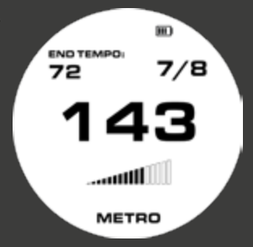
As opinions on Design 1 and 2 were similar, aspects of both were included in the final form (function allowing).

UI DESIGN CONCEPTS AND SELECTION

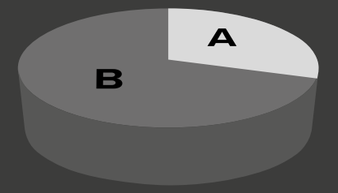
A number of choices for screen designs were put out in a survey to our user group to gain feedback on the features they preferred. The results are summarised below.

LIGHT OR DARK COLOUR SCHEME:

A



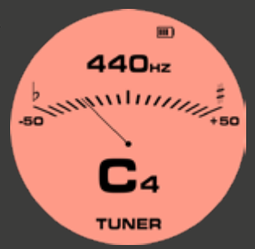
B



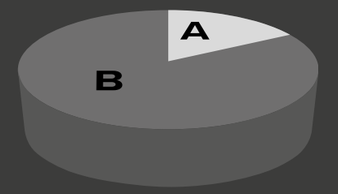
A = **6/25**
B = **19/25**

TUNER INTERFACE:

A



B

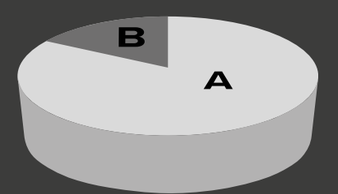


A = **3/25**
B = **22/25**

SELECTING INPUTS:

A

B



A = **20/25**
B = **5/25**

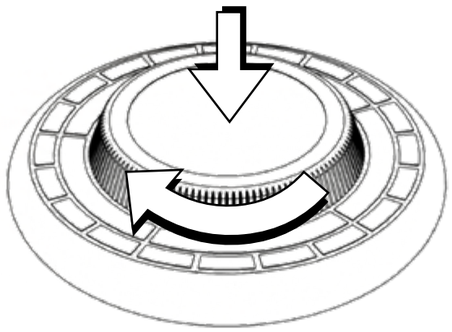
INTERFACE DESIGN SELECTION

Having decided on the general form of the product, the design of how the user interacts with the product was immediately prioritised. The user interface has to be as intuitive as possible, as our goal is to add functionality to a standard metronome, without detracting from the ease of use. We surveyed 29 musicians to uncover the most popular option.

PRESS/TWIST

SURVEY SCORE: **5/29**

When the dial is pressed and twisted simultaneously, the metronome switches between modes. Mode section lights up and the dial screen changes to the relevant mode screen.

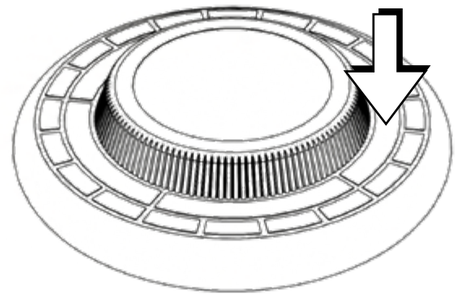


IMPLEMENTATION:
Circuitboard button and potentiometer which are being used for the normal settings are used in conjunction to change between modes. The code logic would be IF button is pressed AND dial is turned through 0-72 degrees, show the next mode screen and light up corresponding LED.

PUSH **BUTTONS**

SURVEY SCORE: **16/29**

Similar to PRESS/TWIST layout, however each section for the different modes is a physical button which can simply be pressed to access the various functions.
This was the chosen interface design.

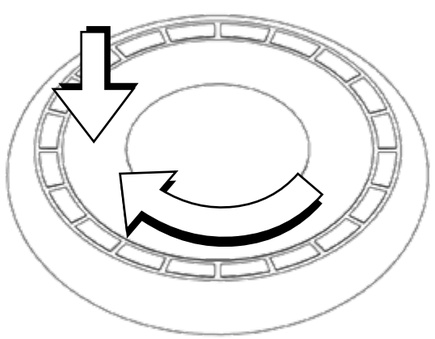


IMPLEMENTATION:
There is a circuitboard button below each mode selection button. If a specific button is pressed, the display will show the screen for that function, and also light up the LEDs for user feedback.

CLICK **WHEEL**

SURVEY SCORE: **5/29**

Inspired by the iPod clickwheel; drag a finger around touch sensitive wheel to flick through settings. Click the middle to select. Buttons around the wheel can be used to switch to different modes.

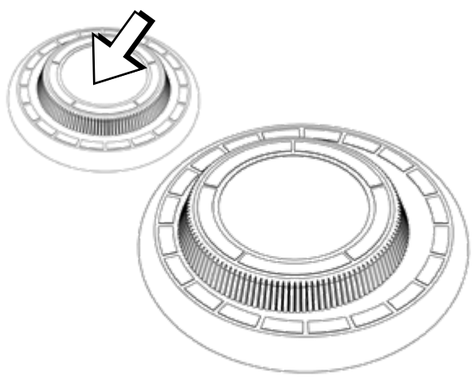


IMPLEMENTATION:
Capacitance-sensing system contacts circuitboard. Mechanical circuitboard buttons lie underneath the graphic for each mode.

HAT **SWITCH**

SURVEY SCORE: **3/29**

Push dial towards edge of the metronome in the direction of one of the modes shown at the edge of the screen to select the relevant mode. Mode signs could either be placed on the dial or on the lower section of the device.



IMPLEMENTATION:
Using a 5 way hat switch, used in gaming joysticks, the dial will be pushable a short distance in any direction from the centre. Alternatively, contacts could be placed under each mode and on the dial - if the dial contact touches a specific mode contact, then the corresponding mode is selected.

BRAND **SELECTION**

To help determine which brand our product best suits, three distinct brands were looked at. These brands (outlined below) all have existing connections to the audio industry but have quite distinct identities and product ranges. This research presented a clear brand that matches well with our product, has a clear opportunity in developing such a product, and a consumer base open to being introduced to such a product.

BANG AND OLUFSEN

A Danish audio-visual company that designs high end, considered products.

SUCCESSFUL PRODUCTS

BEOPLAY A9
£2,250

BEOSOUND A1
£200

BEOLAB 90
£61,000

SIGNIFICANT POINTS

Driven by a desire for a better sound.
Unafraid to have the most expensive products.
Belief that music is an art-form.
Products are positioned at the intersection of architecture and technology.

WOULD OUR PRODUCT FIT THE BRAND?

Bang and Olufsen's constant pursuit of music perfection and their appreciation for material selection make them a good fit for our user group of advanced musicians. However, their usual high price point is far beyond what professional musicians can afford. B&O are more focused on the sound of music, rather than performance.

ULTIMATE EARS

An American speaker company, with a narrow product range focused on the younger demographic

SUCCESSFUL PRODUCTS

MEGABOOM
£169.99

BOOM 3
£129.99

WONDERBOOM
£89.99

SIGNIFICANT POINTS

Known for their big, bold, rugged products.
Their products are extremely customizeable.
Iconic circular form.
Knowledge of music performing with their professional in-ear moniter products.

WOULD OUR PRODUCT FIT THE BRAND?

Ultimate Ears is a growing company. They occupy a different market segment to B&O due to their affordable price point and their young, outgoing, music-loving target consumers. However, recent moves have been away from professional products and towards a consumer aspect of music enjoyment. Their products are visually 'loud', whereas our target users desire a discrete product.

CASIO

A Japanese consumer electronics company with a wide product portfolio. The product would sit within their music subdivision.

SUCCESSFUL PRODUCTS

A164WA-1VES
£32.90

FX-9860GII
£69.99

SA-46AH5
£39.99

SIGNIFICANT POINTS

Product lineup is diverse and ever changing.
Excellent heritage in technical capability.
Brand familiarity across the world.
Music division established 1980.
Driven by the end-user benefits of their products.

WOULD OUR PRODUCT FIT THE BRAND?

CASIO are a hugely diverse company, with many product lines. The music sub-brand matches well with our user group's desire for a highly functional product from a respected and trustworthy brand. CASIO's recent innovations have been focused on advanced musicians, but also cater for musical novices. This is essential for wider market appeal.

CASIO

CASIO was founded in Japan in 1946 by the four Kashio brothers. Their emblem of four Ks represents the continued family values the brand still holds on to, even though it has gained global status. Within a few years of launching, they released their first product; the 14-A electronic calculator. Within 10 years, it was exporting its product worldwide, and had built a trustworthy reputation.

In 1980 CASIO launched their music division with the CT-201. The worlds first keyboard, and the worlds first digital sound bank, due to the 29 preset sounds stored on the device.

As a brand, CASIO have a strong ethos of creating a future society that is more satisfying and rewarding. They do this through a repeated trial and error approach to product design. All of their products are highly successful, but they are continuously improved upon based on incorporating customer ideas into the iterative design process. CASIO produce products with innovative functions that assist people doing the things they love in their daily lives. Our product is a seamless fit into this product landscape.

CREATIVITY + CONTRIBUTION 創造

This phase has been key to CASIO's journey as a brand over its almost 80 year history. It is the corporate creed of the wider CASIO company across the globe and it expresses the company's commitment to contributing to society by offering the kind of original, useful products that only CASIO can. Originally a way for the company to ensure that it was making a positive impact on the world after World War II, it has evolved over the years and is now enshrined in the company's Charter of Creativity.

CASIO MUSIC 貢献

CASIO have a long history in electronic musical instruments. For 40 years they have been making compact, affordable keyboards, and selling them in markets across the world. They have developed a reputation for delivering products that meet the high standards of musicians. Their existing line of keyboards are found in professional recording environments, and their basic keyboards are a default choice for novice musicians. One of the key characteristics of their products are their affordability; CASIO is not a premium brand, and the price point is what attracts many customers. It is a clear product opportunity pathway for the brand to develop a metronome using their electronic technology to increase the familiarity of the brand with a wider user group.

LEARN @HOME

CASIO have developed an online academy to help users learn to play the keyboard. This is done through a combination of how-to videos and interactive software that maps progress. CASIO have also partnered with Gigajam to develop software that records what is played to provide coloured feedback based on what it was expecting to hear.

MIDI (musical instrument digital interface) is an industry standard method of enabling electronic musical instruments to communicate in the same language. It is used in professional settings for recording and editing, and by CASIO in its LEARN @HOME feature. Recent MIDI developments have allowed recordings to be converted to MIDI format. By implementing this technology into our product, this feature could be extended to a wider group.

PRODUCT **GAP**

When considering the CASIO brand, in-depth research was undertaken to verify that there is indeed a suitable gap in the market for CASIO to launch our product. CASIO's direct competitors in the electrical musical instument market were studied. The insights gained from this research are presented here.

CASIO MARKET **COMPETITORS**

YAMAHA

KORG

ROLAND

Yamaha, Roland and Korg are CASIO's biggest competitors in CASIO's market segment. They all have a range of electric keyboards and pianos. However, they each have significant other offerings that elevate them within the musical product market. Roland in particular are known for their high end offerings, but their products are often out of reach for most musicians. All of these brands are located in Japan, and all have a long history of direct competition among themselves in the market.

COMPETITOR **METRONOMES**

ME - 55
YAMAHA
£35

MA - 2 KORG
£19.99

DB - 30
ROLAND
£25

All three of CASIO's main competitors produce a range of musical accessories. Their own digital metronome offerings are similar to each other in both form and function: there is a clear product opportunity space for CASIO to develop our product with its increased functionality and improved aesthetic. CASIO are the only brand amongst their competitors that do not make musical accessories - it would be a significant brand differentiator for them to release a substantially superior product to what is currently on the market.

PORTER'S FIVE **FORCES**

BARGAINING POWER OF BUYERS

As the product appeals to the wider music consumer market as well as our target market of advanved musicians, the number of consumers is high. However, there is a risk of customers being price sensitive.

THREAT OF NEW ENTRANTS

There are limited switching costs associated with our product which raises the risk factors from other competitors in the market. This is reduced by utilising CASIO's global distribution channel to quickly get the product around the world and establish loyalty. Our product also has significant differentiators being part of the CASIO brand (LEARN @HOME) that reduces the risk of competitos attempting to imitate our product.

COMPETITIVE RIVALRY

BARGAINING POWER OF SUPPLIERS

Our product utilises solely standard components and fittings, and with the global CASIO brand able to procure parts at scale, there is negligible risk here.

THREAT OF SUBSTITUTION

As learned from our research, metronome users are loyal to a particular brand, and only replace their metronome a few times. Once they have experienced the product, the chance of substitution reduces greatly - the challenge is convincing the customer to purchase our product initially. This is acheived by differentiating it substantially from existing products on the market through unique features and pleasing aesthetics.

ECONOMIC JUSTIFICATION

15% GROWTH + PURSUING VALUE

CASIO'S BUSINESS STRATEGY

CASIO's Medium-Term Management Plan, published year end 2019, provides excellent economic insight into the company and suitable validation for the brand to be developing our product concept.

Key economic validation points:
1. Aiming for a 15% growth in music sales over the next 2 years, driven by new product innovation.
2. Pursue value by leveraging CASIO's strengths, returning to their core DNA of 'creativity and contribution'.

CASIO's value proposition has been made clearer recently and is defined as: 'continuously creating the most familiar and important things for people's lifestyles'. This is good justification for CASIO Music to develop a metronome that becomes part of a musicians daily life, used continuously for over 10 years, as learnt in discovery research.

VALUE ADDED

C. BECHSTEIN

Gigajam

RSL

CASIO have been adding value to their products through their various different partnerships with market leaders. As discussed previously, they have partnered with Gigajam and C. Bechstein. More recently they have partenered with RSL, a contemporary music school and examination board, to provide free sheet music to their keyboard customers. These partnerships are part of what differentiates the brand from its competitors; the combination of CASIO's technological expertise with the music industries leading companies illustrates how CASIO understands the needs of their customers.

CASIO **MUSIC** DESIGN

CASIO launched their Celviano grand piano in 2015. It was produced to sound as real as a traditional grand piano, and was made in partnership with C Bechstein, a leading maker of exquisite upright grand pianos. This marked the first product in CASIO Music's drive to innovate in partnership with industry leaders.

This product won the iF Design Award in 2017 for the piano's ability to fuse acoustic tradition with superior technology. CASIO have won further design awards (iF Design Award 2020, Red Dot 2020) for their more recent PXS-1000 keyboard.

This new company focus on producing designed products that musicians appreciate illustrates how they are listening to their consumers, and responding to direct feedback from their users. This matches well with what our product aims to acheive; a highly functional device that combines technological excellence with an appealing design aesthetic to suit a professional musician.

DESIGN AWARD 2017

reddot design award

DIGITAL TESTING - ESTABLISHING PERFORMANCE REQUIREMENTS

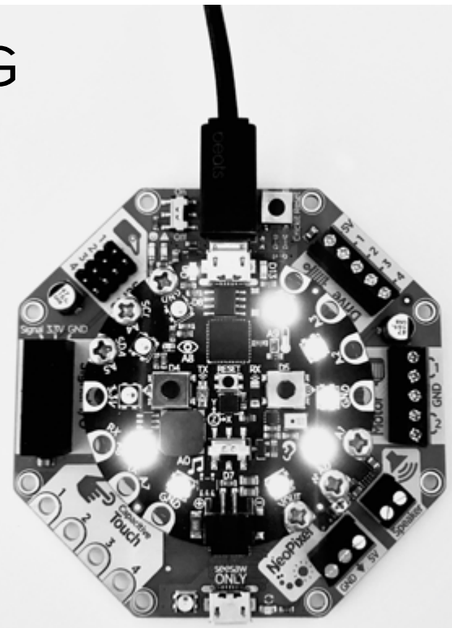
While physical prototyping has not been possible for this project, various other methods of prototyping have been used to develop our final design. This includes some testing that has been conducted in safe home environments to help establish component requirements.

ARDUINO TESTING

An arduino was used to help experiment and iterate with the code that controls the LEDs around the dial. Three code files were created that indicated beats and bars in a slightly different manner:

1. All 24 LED's pulsing for every beat.
2. One LED turning on, and staying on for every beat until all 24 were on, before being reset.
3. One LED being turned on and off in turn around the ring for each beat. All 24 pulsing to indicate a new bar.

Shown to the right is an image of the arduino running the second code file, with brighter LEDs indicating bars - this code is programmed to time '3/4' time.



```
int buttonA = 4;
int buttonB = 5;

bool buttonStateA;
bool buttonStateB;

void setup() {
 Serial.begin(9600);

pinMode(buttonA, INPUT_PULLDOWN);
pinMode(buttonB, INPUT_PULLDOWN);
```

```
void loop() {
  CircuitPlayground.clearPixels();

buttonStateA = digitalRead(buttonA);
buttonStateB = digitalRead(buttonB);

if (buttonStateA){
CircuitPlayground.setPixelColor(9, 255,   255,   255);
CircuitPlayground.playTone(100,10);
delay(500);
CircuitPlayground.setPixelColor(8, 25,   25,   25);
```

CONTROLS COLOUR AND BRIGHTNESS OF LEDs

CONTROLS FREQUENCY AND VOLUME OF SOUND

VOLUME TESTING

One of the key insights gained from our research was that many people struggle to hear their metronome devices when they are playing loudly, or playing louder instruments (i.e. trombone). To help determine how loud our speakers needed to be to be heard over most instruments a test was conducted. Various instruments our Design Officer had at home were played 0.5 m away from a decibel meter. The results are summarised in the table below.

INSTRUMENT	VOLUME (dB)
Violin	94.6
Grand Piano	101.6
Guitar	87.9
Cello	91.6
Trombone	114.2
Clarinet	94.3
Singing	98.9

Through our testing, it was observed that most peak volumes were only maintained for short periods of time. From this observation we decided to implement a new feature - Adaptive Volume. Much like in some cars, the power output of the speakers is proportional to the decibel reading from the built in microphone.

We also took the opportunity to benchmark some current popular metronomes on the market to help determine the requirements of our product:

METRONOME	VOLUME (dB)
Wittner Mechanical	75.2
ENO EMT-10C DIGITAL	73.7

As a result it was determined that our speaker needed to be able to produce sound at least 88dB in volume at 0.5m away. It was deemed unecessary to set this requirement any higher; even though it is possible to play some instuments louder than this, it is not usual to have any instument playing this loud for an extended period of time (more than a few notes).

PLANS FOR **PROTOTYPING**

As with any consumer product, physical prototyping is a necessary part of the design process; used to discover any potential issues with the current design, and highlight the areas for improvement. Due to current (March-June 2020) working restrictions, physical prototyping has not been possible. However, a detailed plan has been developed by the teams Technical Officer following the conclusion of Phase 2. This is detailed here. Images used are from Phase 2, during concept development.

STAGE 1 - **LOW FIDELITY** PROTOTYPE

A blue foam model would be used to determine the rough overall dimensions of the product as well as determine correct ergonomic proportions.

This model would be used to help answer several key design questions:

Can the product fit in a musical bag?
Can the product be held and operated comfortably?
Are the control and display interfaces in correct proportions to each other?

This prototyping would lead to more defined overall dimensions and a comfortable ergonomic form. However, low fidelity prototyping is limited as it is unable to model the moving parts or internal mechanisms of the design. While overall dimensions can be determined, precise accuracy cannot be acheived at this stage.

The series of questions would ideally have been put to a small focus group of members from our user group. We developed a network of 35 musicians early in the research phase who indicated they would be willing to get involved with this project beyond responding to our needfinding surveys. Direct user feedback at this point in prototyping is vital to have a good, validated concept.

STAGE 2 - **FDM 3D** MODEL

The next step would be to create a looks like prototype, creating an accurate 3D model of the body. This model would be used to test component clearance and fitting inside the product; the moving parts are incorporated into the model at this point.

This model would be used to help answer several key design questions:

Is there sufficient component clearance?
Is there scope for making the product more space efficient?
Does the stand keep the product stable during use?
What is the most effective assembly order?
Can the screws be easily accessed?
Is the product well designed for assembly?
Is the product wall thickness suitable?

It is important to consider the assembly process and build time at this stage. Design for Manufacture principles have been incorporated into the design: they should be tested and refined before the design is finalised. Component layout can be reorganised and fittings rearranged to ensure the product can be assembled quickly and efficiently.

The FDM model would aim to acheive final component layout and an accurate looks-like model of the design. However, it is limited in that it is unable to illustrate surface finishes and appearances.

STAGE 3 - **HIGH FIDELITY** PROTOTYPING

SOURCE: DYSON

The final stage of prototyping would be to create a high quality looks like model using polyjet printing. The tolerances of the mechanical components of the design, the dial and the stand, would be checked to ensure the previous calculations are correct. Both components would need to rotate and travel freely so a H9/d9 fit would be used. With the higher dimensional accuracy of this model, DFM snapfit features would be tested.

This model would be helpful for considering the mass production viability of the product. Properties to consider include:
Parting lines
Wall thickness
Draft angles
Mould extraction
Different tolerances
Different dimensional accuracies

These would be dependent on the parts function.

The polyjet model would give a high-fidelity functional prototype, combining the final form of the product with the working electronic components - providing us with a consolidated vision of our product.

ELECTRONICS AND UI PROTOTYPING

Alongside these form models, electronics prototyping would take place. A full layed out circuit would be constructed using a breadboard to gain an understanding of the complexities involved with the compact circuit design. This would then be combined with the arduino to test the working of all the buttons and components.

While UI testing and development has not been compromised, it has not been possible to conduct a controlled focus group test to see if the buttons, labelling and layouts are intuitive. The test would have involved users being given the product. The focus group would have been observed to expose pain points associated with using the product for the first time, and how the design could be improved to reduce these.

One of the final stages of prototyping would involve practicing the circuit board assembly process; which components are soldered on at which point etc. Practicing and making the soldering process more efficient are important details in ensuring the final prototype works and is optimised for manufacture.

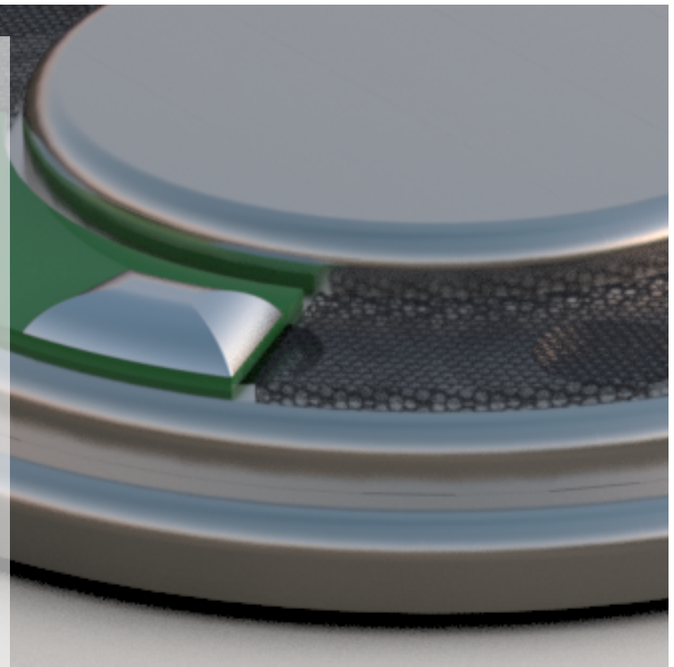
POWER AND LOAD **CALCULATIONS**

Before the components for the device could be selected, certain specifications had to be set to ensure that our product meets the needs of our users:

1. The device has to be able to produce at least 88dB of sound when being used 0.5 m away.
2. The device has to be able to produce at least 3 lumens of light.

Both requirements have been drawn from various methods of observational research and testing. These were conducted and recorded in the discovery phase of this project, and so were unaffected by current social distancing guidelines.

Extensive research was conducted online, evaluating the suitability of the various components required. As the product has to be compact, as discovered during HCR, the overall size of each component was an important selection factor. Cost and power draw were also considered when making selections.



SPEAKERS - RS PRO 8 OHM 0.5W

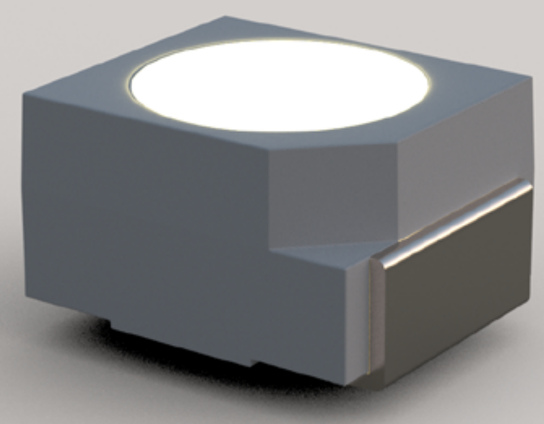
Speaker selection was complicated due to the logarithmic scale on which sound levels are measured.

An RS Pro 8 Ohm 0.5W speaker was chosen for its cost and size benefits. It is rated 89dB for a 0.1W power supply - by increasing the power to 0.8W, the speaker reaches 98dB.

By increasing the number of speakers to four, the maximum sound level was increased to 104dB. However, this level is from a 0.1 m distance - by increasing the distance to 0.5 m, the dB level decreases to 90dB.

89 + (3 x 3) + (2 x 3) - 14 = **90dB**

It should be stressed that this is a maximum level and would not be reached during normal use. Only particularly loud instruments would require this volume; for example, tubas and trombones. The device would display a small warning when the user increases the volume above a certain level.



LEDS - T.E.M. OPTOFLASH

The LEDs that surround the central dial act as the alternative sensory stimulation to keep the user on the correct tempo. As the basic use mode involves just one of the LEDs pulsing, they all have to be bright enough to be seen individually by the user. The LED also has to be able to be viewed from different angles due to how musicians use and display their devices.

The T.E.M. Optoflash was selected based on its optimal characteristics - it has a soft white colour that is not too harsh and its maximum viewing angle is 120°. It has a luminosity of 2500 mcd at 20mA, with an operating current of 3.0V.

Power = 0.002 x 3.0 = **0.06W**

SCREEN - IPS TFT LCD CIRCULAR DISPLAY

It was decided to use a non-touch LCD screen. Careful consideration was given to whether a touch screen would be more suitable but it was decided this added unnecessary complexity and cost to the design. The screen was quite small so there would not be ample room for a touch UI.

The selected screen is the IPS TFT LCD Circular Display. The display size is 33.8mm in diameter and it has a full RGB colour range, with 400 cd/m^2 brightness. It draws 40mA at 3.0V.

Power = 0.04 x 3.0 = **0.12W**

POWER - 3.6V 3350MAH LITHIUM ION BATTERY

With all the components selected it was possible to determine the total power and current requirements to help select the best battery. When selecting the battery it was important to consider the size, weight and the relative risk.

The selected battery is a 3.6V 3350mAh Lithium ion rechargeable battery. This gives the battery 12.06Wh.

Estimated power consumptions were done to help select the battery. It was decided that the battery needed to have enough capacity for 10 Hrs of expected use.

The maximum power consumption assumes all 24 of the LEDs on, with a BPM of 300 and beat duration of 0.1s.

(24 x 0.06) + 0.12 + (4 x 0.5 x 0.1 x 5) = **1.95W**

The minimum power consumption assumes only one LED is on, with a BPM of 60 and a beat duration of 0.1s.

(1 x 0.06) + 0.12 + (4 x 0.5 x 0.1) = **0.353W**

Under expected use it is assumed that 6 LEDs will be on (on average), at 120 BPM, with a beat duration of 0.1s.

(6 x 0.06) + 0.12 + (4 x 0.5 x 0.1 x 2) = **0.852W**

Minimum battery life: 12.06 / 1.95 = **6.18 Hrs**
Maximum battery life: 12.06/0.353 = **34.16 Hrs**
Expected battery life: 12.06/0.853 = **14.14 Hrs**

This battery life is perfect for musicians who typically practice for 45 minutes at a time. The battery has fast charging capability to reach 80% in 2.5 Hrs. Assuming 20 mins of metronome practice a day, for normal use the metronome battery life is expected to last for approximately **42 days**.

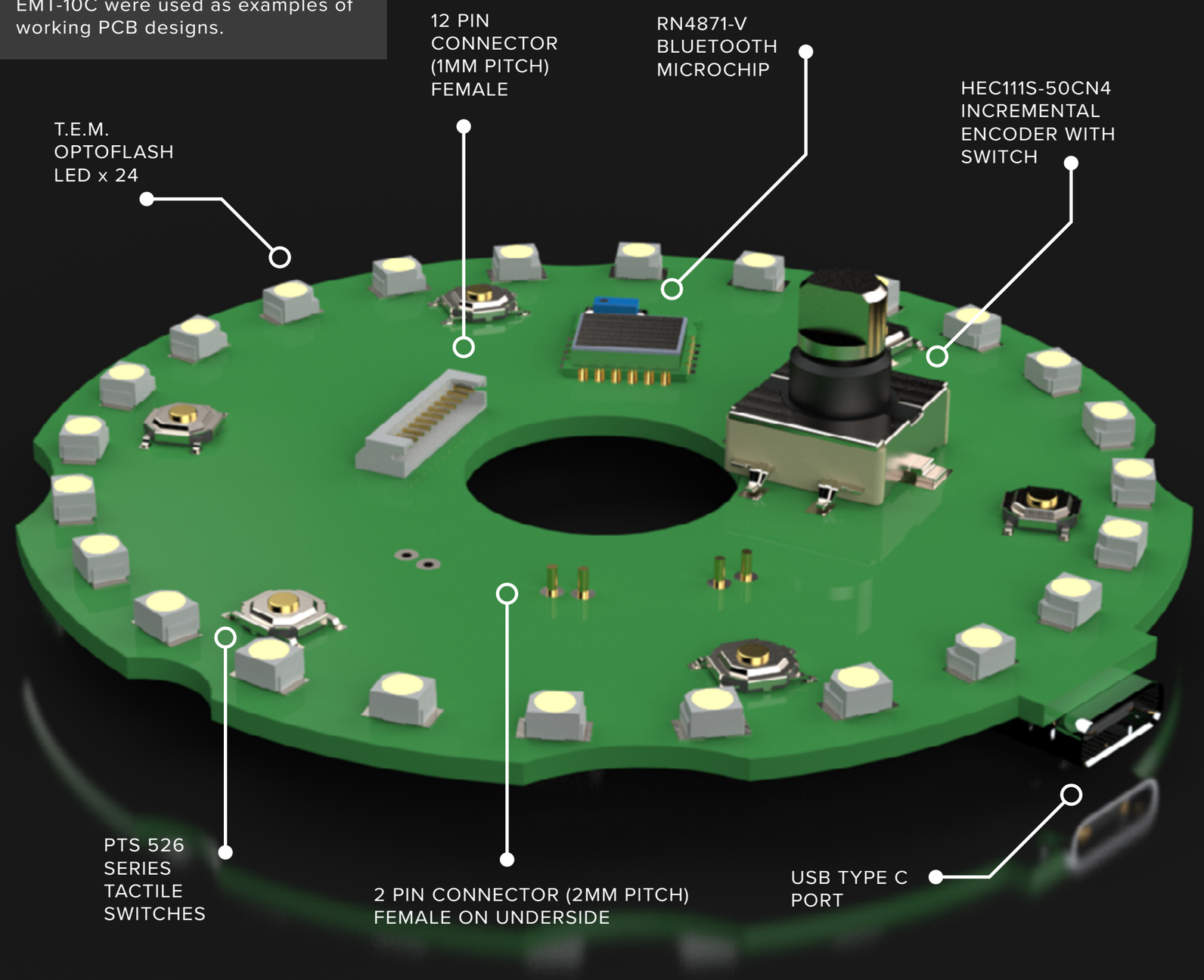
CIRCUITBOARD DETAIL

We designed the PCB to incorporate as many of the electrical components as possible in order to make assembly as easy and as quick as possible. The following details highlight this.

- The microphone wires are soldered straight onto the PCB.
- The screen connects to the 12-Pin connector.
- The 18650 Li-Ion battery plugs into one of the 2-pin connectors and the speakers plug into the other 2-pin connectors.
- The 2 pin connectors are located on the underside of the PCB to allow easy access for the components situated below the circuit board, whilst the screen is above, so its 12-pin connector is located on the top side of the PCB.
- All components have SMD mounts and are soldered to pads on the PCB.
- The PCB was designed to be non symmetric for quick alignment.
- The incremental encoder and tactile switches both are subject to vertical pressure to actuate the switches. Therefore the security of the PCB is important.
- The PCB is screwed into the top casing with three self tapping M1 screws. This, combined with the tight fit and pressure from other components keeps the board secure.
- The battery has a rated voltage of 3.6V so all components were chosen based on 3.6V or less. Resistors are used to step down voltage for individual components.

N.B. This diagram only shows the main components of the circuitboard.

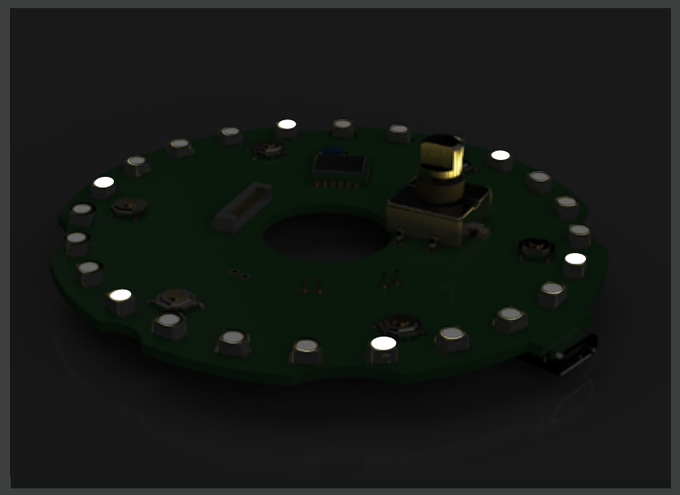
The PCBs from the donor product and from the teardown of the ENO EMT-10C were used as examples of working PCB designs.



SENSORY STIMULI

A significant product opportunity area that was uncovered during Phase 1 and 2 of our project was the exploration of using other senses to convey time. The LEDs and speakers in the EDM 120 provide simultaneous output to enrich the experience of keeping in time and allowing for more information to be conveyed instinctively.

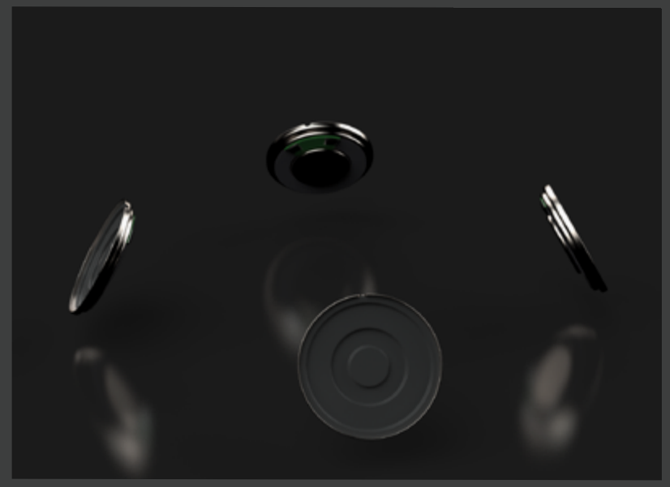
LED RING **VISUAL OUTPUT**



The 24 LEDs that form a circle around the dial light up as a method of time conveyance - one LED will light up to represent 1 beat, with the start of a bar indicated as a brighter light. This way, a glance at your metronome will give you information about how many beats and bars you have been playing.

24 LEDs were used, as the number 24 is divisible by many of the numbers that feature significantly in common time signatures, meaning that the visual output is adaptable to whatever time signature you're playing.

SPEAKERS **AUDIO OUTPUT**

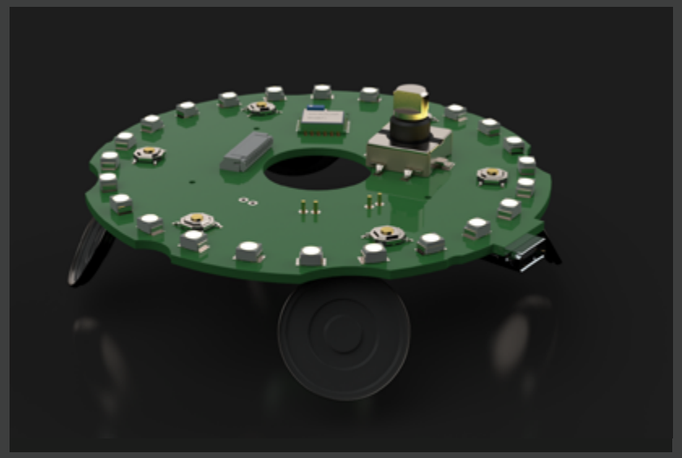


The speakers are arranged around the outside of the EDM 120 to allow equal sound volume from any angle around the speaker - this feature is key if the product is being used in a small ensemble setting - each player can hear the beat adequately.

Due to the Adaptive Volume feature, the audio output of the metronome adapts to how loud you play your instument, so constant volume tweaking is no longer necessary.

The EDM 120 offers a variety of sounds to suit your practice, including 'Woodblock', 'High-hat' and 'Clapping'.

VISUAL AND AUDIO **THE FULL SENSORY EXPERIENCE**



Following our product opportunity statement, and building on the responses we got in the first two phases of this project, we have added an extra stimulus to the metronome. The combination of visual and audio stimuli provides the user with an immersive time keeping experience that goes beyond the standard metronome ticking - doubling the number of senses used to convey time helps to build a keener internal sense of rhythm. This sensory combination is synonymous to watching a drummer tap out a beat, far superior to just hearing the beat remotely.

DETAIL DESIGN

KEY PARTS / ASSEMBLY FEATURES

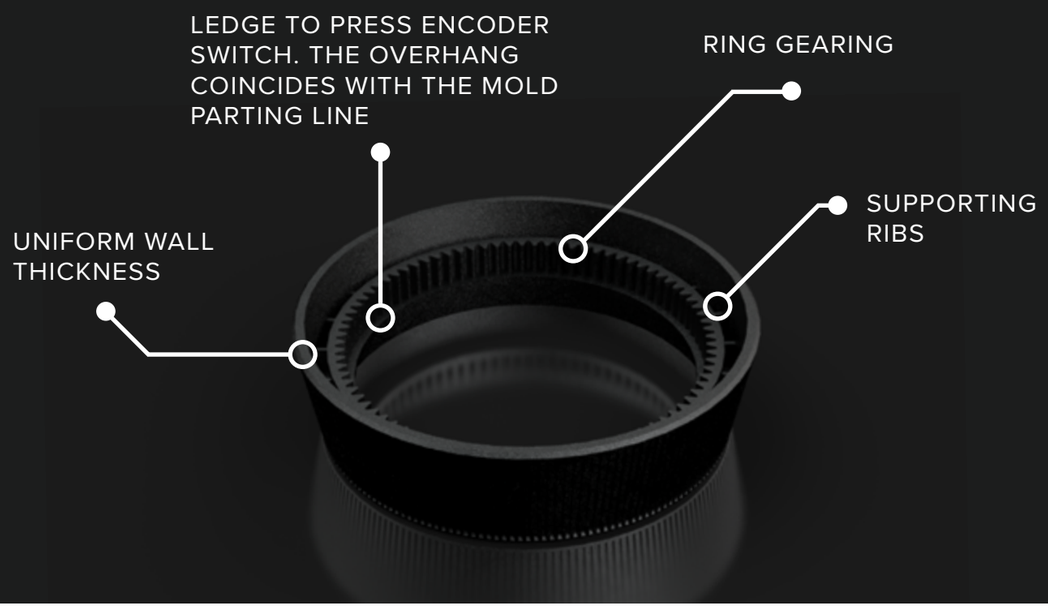
CASIO

DIAL MECHANISM

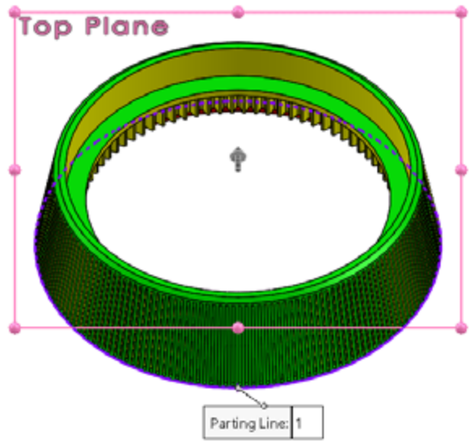
As the screen is placed on top of the dial, a method of keeping the screen stationary whilst the dial revolves around it had to be designed. A ring and spur gear system was employed with the off-centre incremental encoder.

The gearing has two main benefits - greater accuracy of rotation and provision of passive sensory feedback; the user can feel the rotation of the dial in a more tactile way.

GENERAL CASING FEATURES:
Draft angles of 1°.
Wall thickness is largely uniform, with very little variation.
Ribs are used to support and set at 50% of wall thickness.
Sharp corners have been removed with chamfers and fillets to reduce stress concentrations and maintain uniform wall thickness.
Self locating bosses are used for all screwed parts.

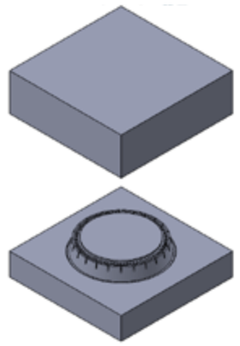


DESIGN **FOR MANUFACTURE**



The dial, and all casing parts, were designed with injection moulding in mind, for easy replication and efficiency in manufacture. From the inital draft analysis of the part, a number of surfaces were shown to have no draft, causing issue with part removal after being moulded. The part was redesigned with a draft angle of 1° and draft analysis was reconducted. This showed all the surfaces had positive drafts so the part could be easily separated from the mould. All parts were scaled up by 2% to account for shrinkage.

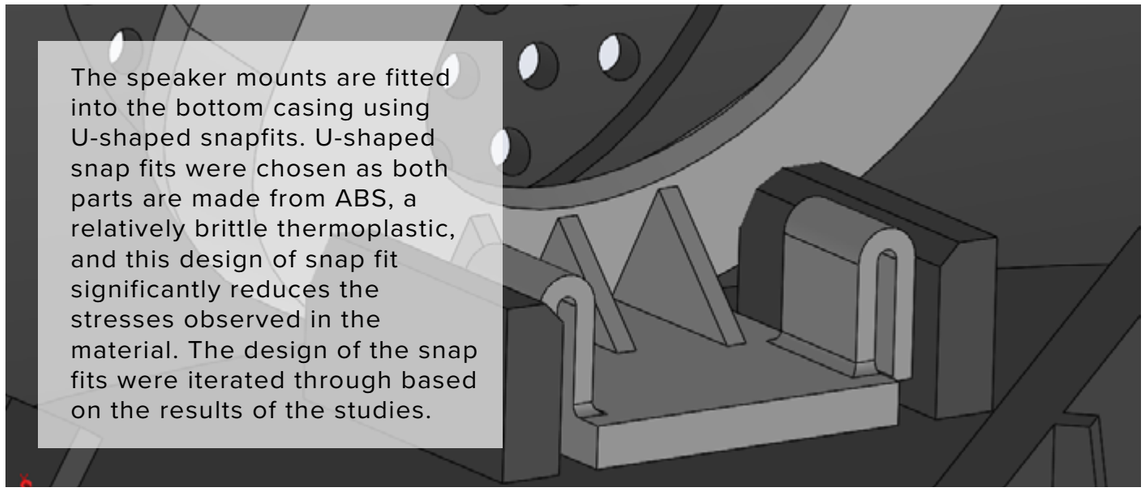
TOOL **COSTING**



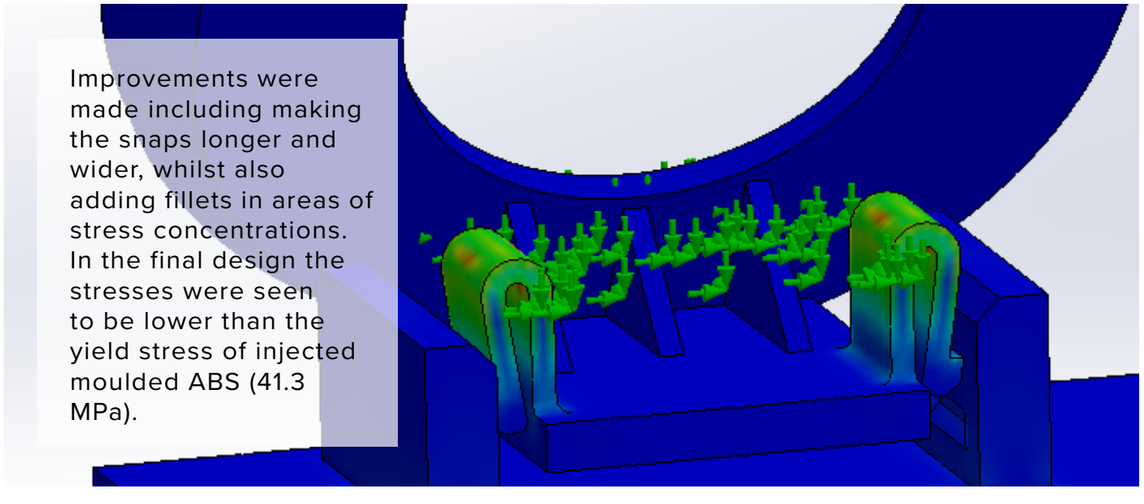
A cost estimate was conducted for the part at different production scales to indicate the impact of tooling cost on the overall cost of the product. The cost of the mould was estimated at $5000 with each part costing $53.68 at a production run off of 100 units. A total of 93% of this cost was due to recouping the cost of the mould. At a production run of 10,000 units, the cost part dropped to $3.85 with only 13% of this cost covering the cost of the mould.

SNAP FITS

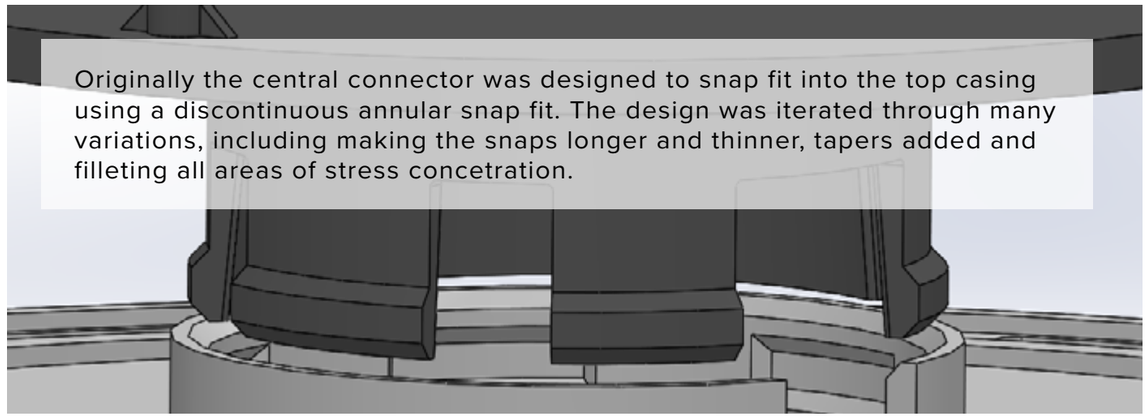
Snap fits are featured heavily in the casing design of the product. They are used for ease, speed and cost reduction in assembly and manufacture, and for ease of recycling. Initial designs were tested, improved and replaced using Finite Element Analysis, in particular non-linear dynamic studies.



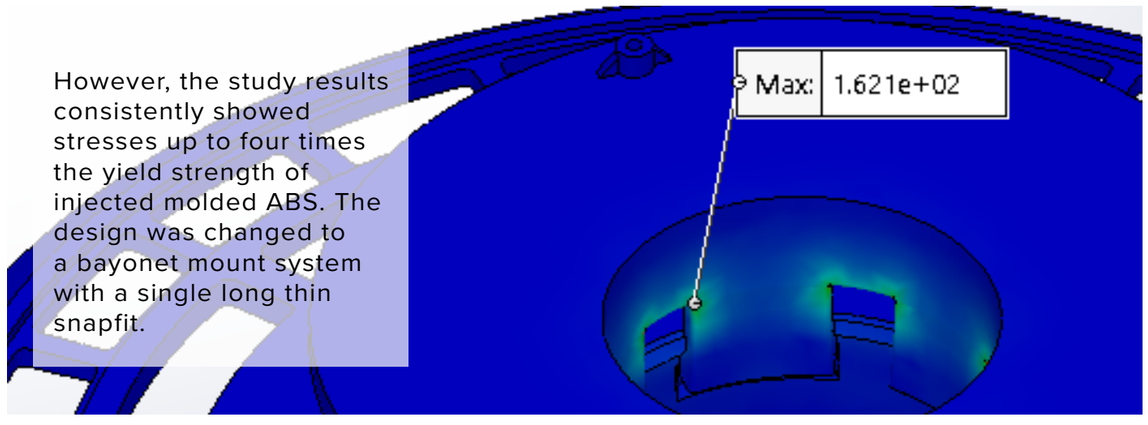
The speaker mounts are fitted into the bottom casing using U-shaped snapfits. U-shaped snap fits were chosen as both parts are made from ABS, a relatively brittle thermoplastic, and this design of snap fit significantly reduces the stresses observed in the material. The design of the snap fits were iterated through based on the results of the studies.



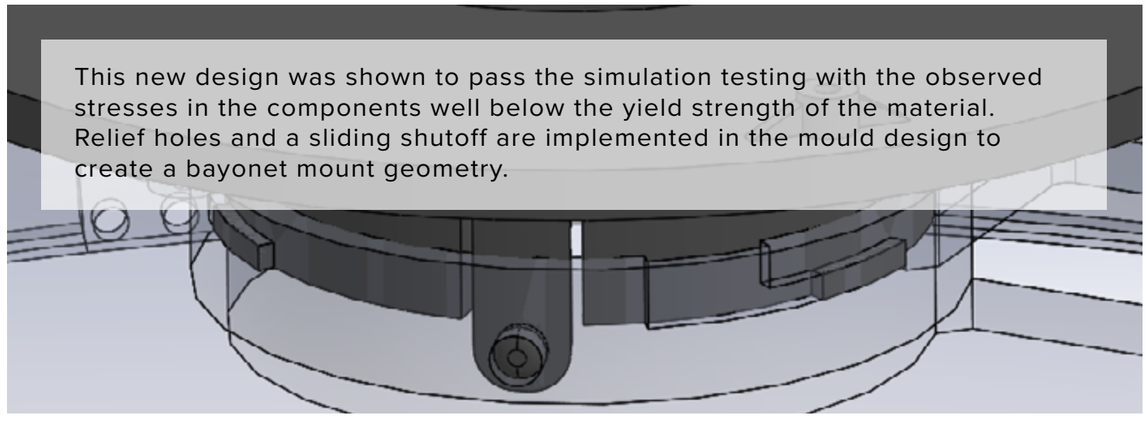
Improvements were made including making the snaps longer and wider, whilst also adding fillets in areas of stress concentrations. In the final design the stresses were seen to be lower than the yield stress of injected moulded ABS (41.3 MPa).



Originally the central connector was designed to snap fit into the top casing using a discontinuous annular snap fit. The design was iterated through many variations, including making the snaps longer and thinner, tapers added and filleting all areas of stress concetration.



However, the study results consistently showed stresses up to four times the yield strength of injected molded ABS. The design was changed to a bayonet mount system with a single long thin snapfit.

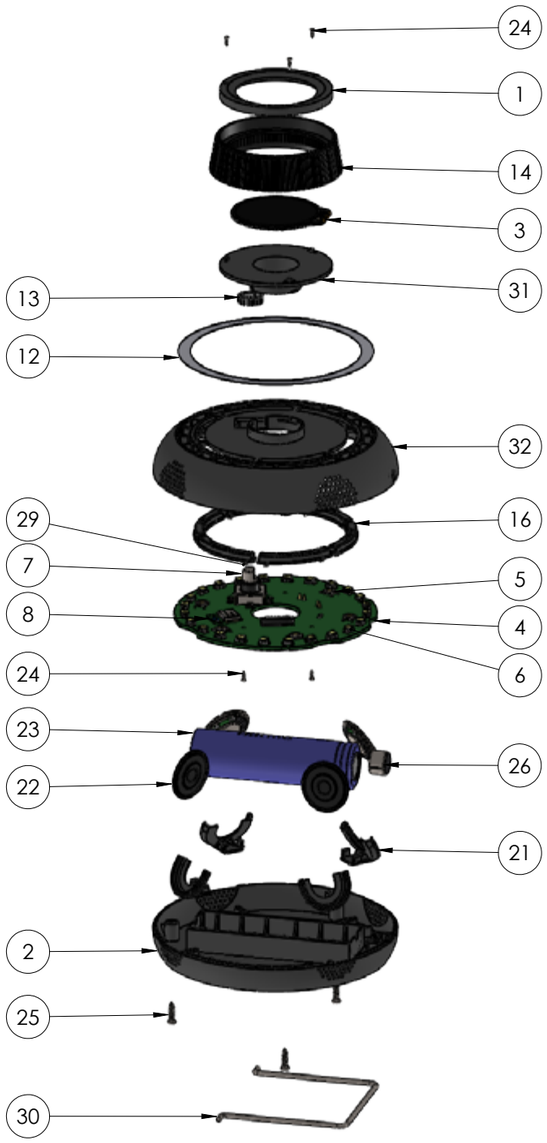


This new design was shown to pass the simulation testing with the observed stresses in the components well below the yield strength of the material. Relief holes and a sliding shutoff are implemented in the mould design to create a bayonet mount geometry.

GENERAL **ASSEMBLY** AND **BILL OF MATERIALS**

Shown here is the product assembly drawing, which concisely and comprehensively displays every component and its position within the device. The product is displayed on one axis to demonstrate the ease of manufacture - it has a 'sandwich' structure that allows for quick and intuitive assembly and dissassembly.

The bill of materials is also displayed, giving the full name and number of all the components.



ITEM NO.	PART NUMBER	QTY.
1	Screen Cover	1
2	Bottom Casing	1
3	1.28" IPS TFT LCD Display	1
4	PCB Circuit Board	1
5	PTS 526 Series Tactile Switches	6
6	Optoflash LEDs	24
7	HEC111S-50CN4 Incremental Encoder (with switch)	1
8	RN4871-V Bluetooth Microchip	1
9	12 Pin Connector Male	1
10	2 Pin Connector Male	2
11	USB Type C Port	1
12	LED Cover	1
13	Spur Gear	1
14	Dial	1
15	Metro/Tuner Button	1
16	Power/Tap Button	1
17	Presets Button	1
18	Rit./Accel. Button	1
19	Sounds Button	1
20	Time Signature Button	1
21	Speaker Mounts	4
22	RS PRO 8Ω 0.5W Miniature Speaker 20mm Dia	4
23	MR18650 Li-Ion Battery	1
24	M1 Self Tapping Screw	6
25	M2 Self Tapping Screw	3
26	AOM-6545L-R Microphone	1
27	12 Pin Connector Female	1
28	2 Pin Connector Female	2
29	Compression Spring 0.15 Dia	12
30	Stand	1
31	Central Connector	1
32	Top Casing	1

DO NOT SCALE DRAWING	REVISION

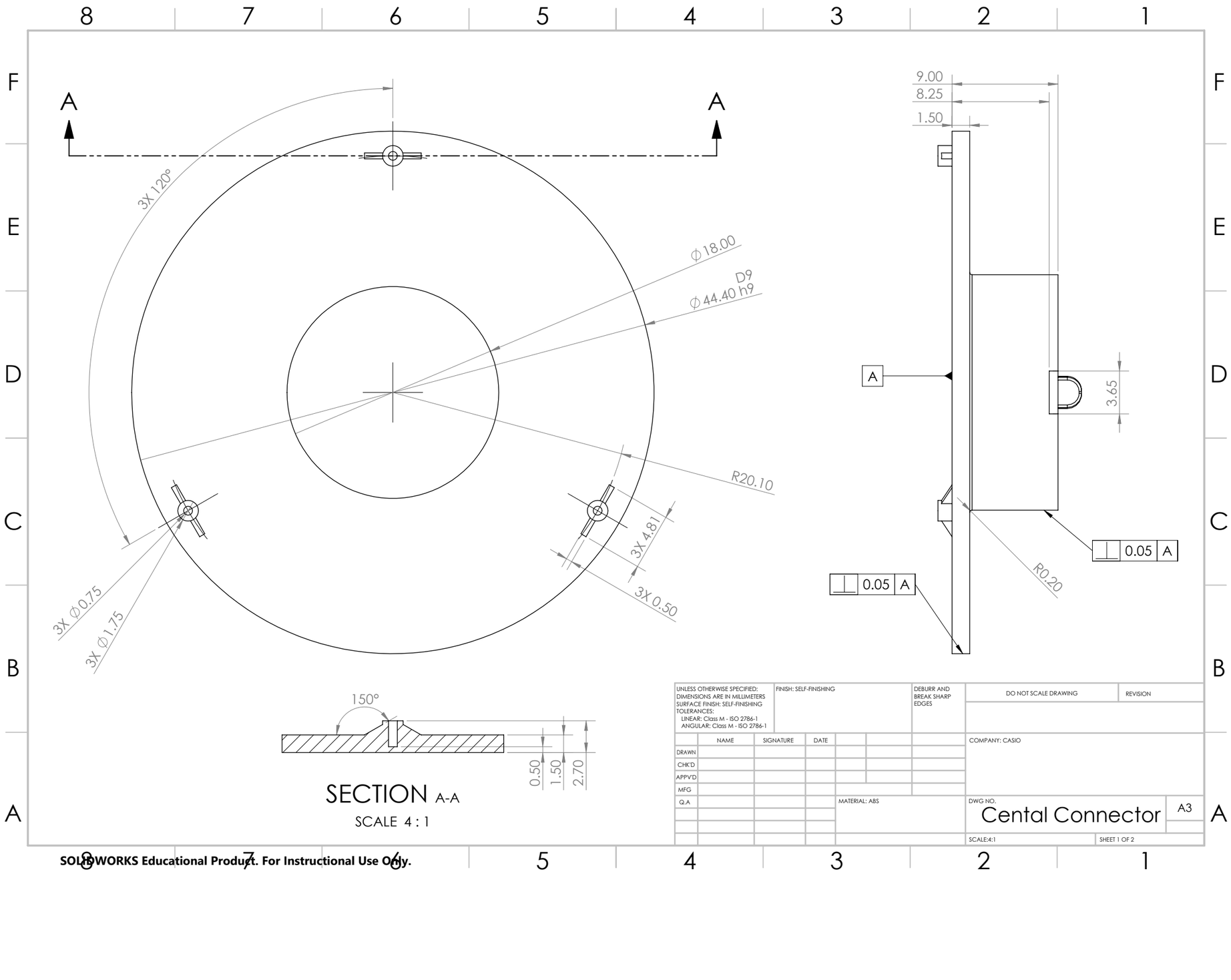
TITLE: EDM 120 Assembly Drawing

DWG NO. 1 | A3

SCALE: 1:1.7 | SHEET 1 OF 1

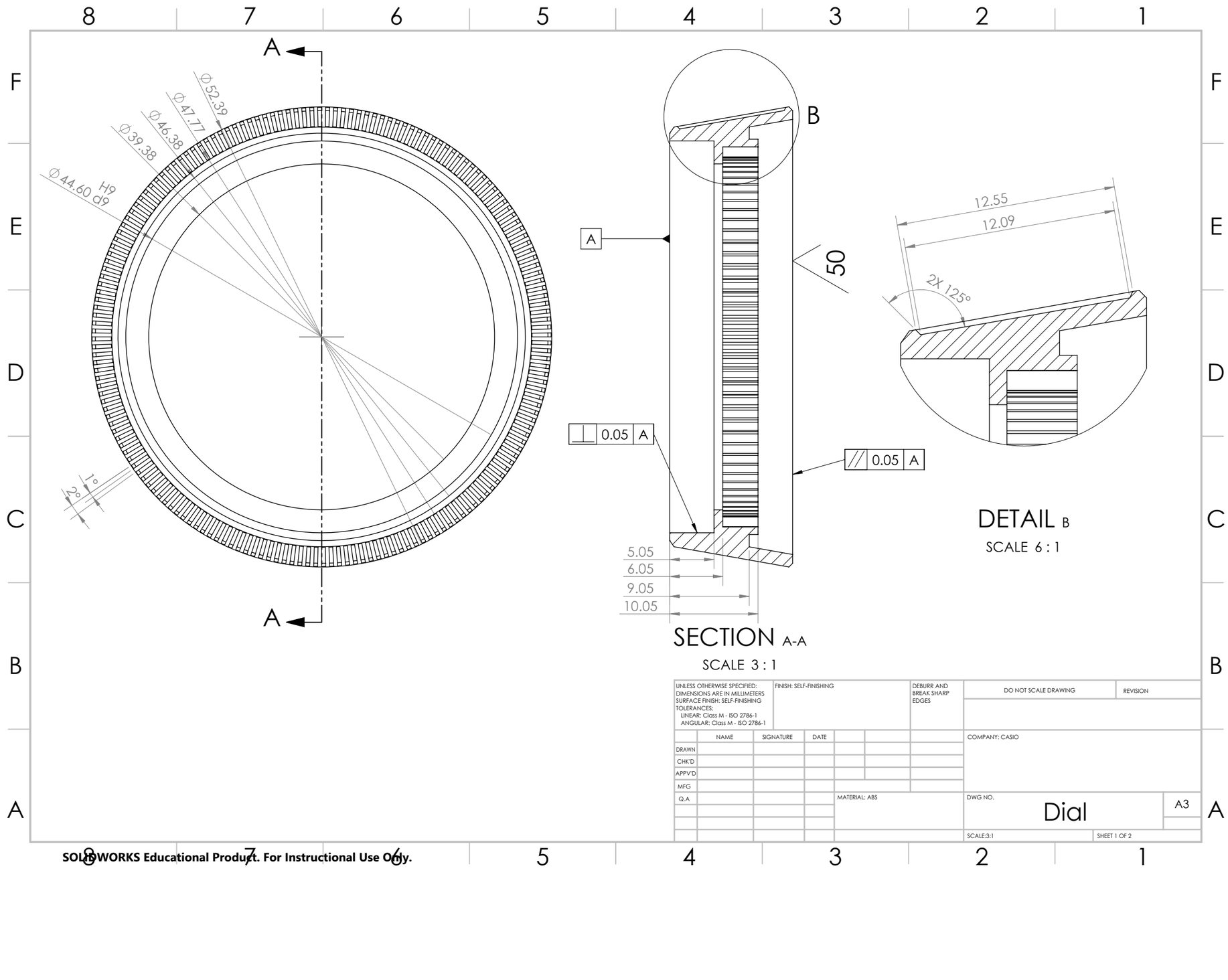
PART DRAWING 1: **CENTRAL CONNECTOR 1 OF 2**

The central connector has been highlighted in this document because it is an essential part for the useability and longevity of the EDM 12 - it allows the dial to rotate separately from the screen, so that the user interface does not spin with the dial. For this reason, it is important that this part does not fail, and is dimensioned accurately.



PART DRAWING 2: **DIAL 1 OF 2**

The dial is a key part of the EDM 120 - it is essential for navigation around the user interface, and is a distinguisher for the aesthetics of our product. Because it is so heavily intertwined with how the user interacts with the device - on both a physical and software level - it is important to ensure that the fine detail is correct. This drawing should allow the manufacturer to create a dial that turns effortlessly yet gives taptile feedback, and provide the dial with a surface that is pleasing to interact with.



PRODUCT **ASSEMBLY** GUIDE

This product is assembled in two separate halves before being joined together at the final stage. Most of the components snap into place, or are held in place by other components around them. Only one part is glued in place - the acrylic LED cover - but as this sits flush with the surface, it is very hard to remove during use. Having two main subassemblies speeds up the assembly time as these can be done simultaneously during mass manufacturing.
The simple assembly process of this product is in line with ISO standard 8887. This product also meets the standard's requirements for dissassembly and recycling. The standard fixings can be easily removed once the product reaches its end-of-life. At that point all principal parts and components can be safely disposed of, recycled or reused. It is important for any new product entering the market today to take these considerations seriously if we are to shift to a more circular economy model. This assembly has been optimised to have as few parts as possible (47), similar to the donor product given at the outset of this project.

ASSEMBLY **PROCESS AND INSTRUCTIONS**

NB. This guide assumes that PCB is outsourced and delivered as a single part.

BOTTOM CASING

1.1 Snap fit each speaker mount into the base. (x4)

1.2 Press fit each speaker into its mount. (x4)

1.3 Slot in the battery and tape it in place.

TOP CASING

2.1 Secure the clear acrylic ring into the groove with adhesive.

2.2 Place the buttons into the slots in the upper casing. (x6)

2.3 Place the springs over the pegs protruding from the buttons. (x12)

2.4 Screw the circuit board in place, securing the buttons and springs with M1 screws. (x3)

2.5 Snap the central tube in place.

2.6 Place the cog on the encoder.

2.7 Place the dial over the tube, taking care to ensure it is meshing with the cog.

2.8 Place the screen on the top of the central tube.

2.9 Screw the screen cover in place with M1 screws. (x3)

2.10 Attach all the wires from the components to the circuit board.

FINAL ASSEMBLY

3.1 Combine the two halves, screwing them together using M2 screws. (x3)

3.2 Attach the wire stand by bending each end in slightly and inserting it into the holes.

PRODUCT **COSTINGS**

The cost build of the product is summarised below. It has been assumed for the purpose of this estimate that there would be a product run of 1000 units to reduce component costs. Standard assumptions have also been made for the assembly cost; each movement would take 3 seconds, and product labour costs of $7.00 per hour. Additional time has been allocated for movements that would reasonably take longer than 3 seconds, such as screwing parts in (this has been estimated at 10 seconds). It should also be noted that CASIO would have access to many of the standard fixing components (such as the M2 screws) and would be able to source most of the components from its own global supplier network at costs likely lower than those quoted here. Where costs were unavailable from online retailers, quotes were requested for 1000 units worth of components. These are referenced in the appendix.

COMPONENTS	COSTS (GBP)	QUANTITY	TOTAL (GBP)
1.28” IPS TFT LCD Display	5.06	1	5.06
LG Li-Ion MR 18650 3350Ah Battery	3.07	1	3.07
RS Pro 8 Ohm 0.5W Miniature Speaker x4	5.35	1	5.35
AOM-6545L-R Audio Recorder	0.49	1	0.49
HSR110-1 Rotary Encoder	0.78	1	0.78
RN4871-V/RM140 Bluetooth Module	5.30	1	5.30
OF-SMD3528W Optoflash White LED	0.07	24	1.68
PTS526 SKG15 Mechanical Button	0.05	6	0.30
0.15mm Compression Spring	0.36	12	4.32
M2 8mm Self Tapping Screws	0.06	3	0.18
M1 6mm Self Tapping Screws	0.05	6	0.30
Farnell 105450 USB Type C Connector	1.05	1	1.05
JST 12 Way PCB Header	0.62	1	0.62
TOTAL			**28.50**

Currency conversions have been used for this cost estimate where 1 GBP converts to 1.26 USD (correct as of 15/06/20).

COMPONENTS	MATERIAL	VOLUME (mm^3)	WEIGHT (g)	TOTAL (GBP)
Bottom casing	ABS	16974.17	16.97	0.192
Top casing	ABS	12698.99	12.70	0.144
Central tube	ABS	2401.04	2.40	0.027
Dial	ABS	4462.84	4.46	0.051
Buttons (x6)	ABS	1659.36	1.66	0.019
Screen Cover	ABS	1263.19	1.26	0.014
Speaker Mounts (x4)	ABS	1358.52	1.36	0.015
Spur Gear	Nylon	113.63	0.13	0.002
Clear ring	Acrylic	565.49	0.65	0.008
TOTAL				**0.47**

ASSEMBLY	NO. OF MOTIONS	ADDITIONAL TIME	TOTAL TIME (S)	TOTAL (GBP)
Bottom casing	10	0	30	0.046
Top casing	31	82	175	0.269
Final Assembly	4	21	33	0.51
Packaging	8	0	24	0.037
TOTAL				**0.86**

FINAL MANUFACTURE COST: **£29.83**
BUILD TIME: **2 MINS 22 SECS**

This is a reasonable time frame for the product and demonstrates good utilisation of DFMA principles. The cost estimate for the materials is based on bulk ordering of the plastics, but does not include any estimates for tooling costs. As our products body is a complex part, the injection moulds would be a significant initial sunk cost, but the cost per part of this would decrease as production scaled up.

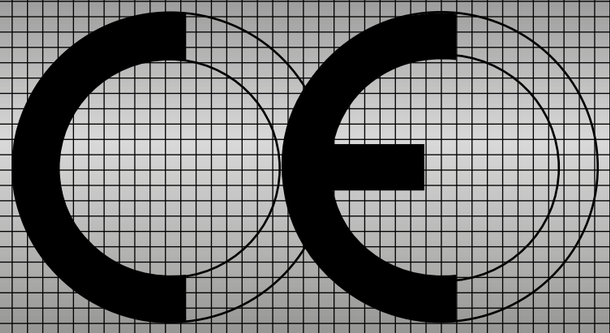
PRODUCT **COMPLIANCE** RESEARCH

An important part of releasing any consumer product is ensuring that the product meets all relevant compliance regulations in all the markets it is being sold in. CASIO, as a global brand, have a wealth of knowledge in this area and would ensure that the product is compliant before its launch. As the product has been designed in the UK, the launch market would be the UK and Europe; as a result the product has been designed to meet the highest levels of EU regulations.

It should be noted that it has been assumed the UK will continue with EU laws post-Brexit transition ending December 2020. Current UK policy papers have announced this will be the case but there is still considerable uncertainty surrounding the issue.

CE MARKING

CE marking is a certification mark that indicates the product conforms to all European health, safety and environmental protection standards. As our product is sold within the EEA (European Economic Area) CE marking is required. Outlined here are the compliance regulations the product has to meet and how it meets them.



This image must be visible on the product and it's packaging to clearly indicate it meets CE standards.

GENERAL **PRODUCT SAFETY** DIRECTIVE

EU Directive 2001/95: places responsibility on businesses to ensure that only safe products are on sale. The business must also ensure that the user of any product is informed of the risks, and have a plan in place to trace products should a serious risk arise with the product after its release (a recall).

CASIO would be the business responsible for this; the user guide must make it clear of the risks associated with the product. A user guide has been produced and is detailed later on in this portfolio.

EAST ASIAN **COMPLIANCE**

The initial launch market for the product would be the EU (and the UK) but as CASIO is a Japanese brand and generates over 37% of its profits from the East Asian region, the product should be designed to ensure it meets compliance for both markets. This would likely incur higher intitial costs for CASIO but would reduce costs in the long term by preventing the need to design a different product for a different market. As EU regulations are known to be some of the most stringent in the world, this should not be a challenge. It should be noted that all documents produced for this product have only been produced in English, translation would be required at a later date.

PRODUCT COMPLIANCE

RESEARCH / REQUIREMENTS

CASIO

RESTRICTION **NAME**	DESCRIPTION	OUR **PRODUCT**
ROHS	Restriction of Hazardous Substances 3 (EU Directive 2015/863): restricts the use of hazardous chemicals and metals in all electrical products. It has been updated more recently (2019) to include phthalates.	Our product does not contain any harmful or hazardous substances pertaining to ROHS.
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals (EC 1907/2006): requires companies to register any substances.	Our product does not contain any harmful or hazardous substances pertaining to REACH.
EU BATTERIES DIRECTIVE	EU Directive 2006/66: states how batteries can be implemented into products and how batteries must be collected to prevent harmful chemical waste.	To meet its requirements, the battery used in our product must have its capacity clearly labelled on it. This is the responsibility of the producer of the battery, but must be checked before being incorporated into the product. The product must also include specific markings to indicate how to recycle the battery (see next page). The battery contains no mercury.
RED	Radio Equipment Directive (EU Directive 2014/53) applies to any product that sends information using the radio spectrum. It is designed to harmonise existing regulations and increase consumer safety.	Our product does not cause any electromagnetic interference when in use in the 2.4GHz band via its bluetooth module, and conforms to the safety requirements of the directive.
EUROPEAN COMMITTEE FOR ELECTROTECHNICAL STANDARDIZATION	Regulation EN50332 - 1:2013 sets out how any consumer products with speakers cannot have them emitting sounds louder than 85dB, unless specifically allowed by the user.	Out of the box, our product would not exceed 85dB, but when the user activates the Adaptable Volume feature of the product, noise levels would be able to rise above 85dB.

PRODUCT **PACKAGING** COMPLIANCE

Attention must also be paid to the regulations concerning the packaging of the product.

As part of the packaging, certain labels must be included. The previously discussed CE marking and wheelie bin must be printed, as well as graphics indicating how to recycle the packaging. As the packaging is made from recycled card (at least 70%), a label from the Forest Stewardship Council can also be included.

FOREST STEWARDSHIP COUNCIL

PRODUCT **ENVIRONMENTAL** COMPLIANCE

An important part of producing any product in todays climate is the impact of the product on the environment (both during manufacturing and end-of-life). The EU has increasingly made its environmental regulations more stringent to reflect the growing importance of the issue, and developing consumer views.

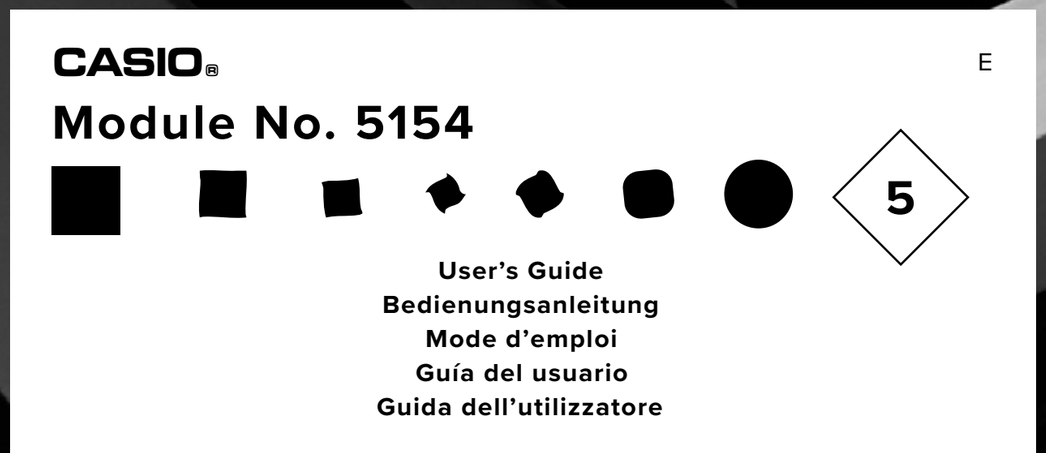
This image, alonside the CE marking, must be included on both the product and its packaging.

RESTRICTION	DESCRIPTION	OUR PRODUCT
EU DIRECTIVE ON PACKAGING AND PACKAGING WASTE (EU DIRECTIVE 2005/20)	This directive encourages companies to produce packaging in the most environmentally responsible way.	Our products packaging has clear information on the safe return, collection and recovery systems available for both the product and it's packaging. Each component of the packaging has been designed to be produced from recycled sources of card and paper and does not include any plastic.
DECLARATION OF CONFORMITY (DOC)	This is a document that states that the product satisfies essential requirements of applicable legislation, and is the final item required for CE marking. Once this document has been produced, CASIO takes responsibilty for compliance. The DoC must include all product details, contact information for the manufacturer, product identification information to allow for tracing, and all regulations that have been complied with.	
TECHNICAL FILE AND TEST REPORT	To be produced in conjunction with the DoC, this file must contain all the technical information regarding the compliance of the product.	
WEEE	Waste Electrical and Electronic Equipment: places the responsibility onto the company to help safely dispose of electrical equipment it manufactures. As part of this, products must display the crossed out wheelie bin logo.	CASIO already offer a take back service (confirmed in email exchange May 2020) to meet WEEE obligations.
ERP	Energy related Products (EU Directive 2009/125) aims to increase the efficiency and environmental protection of electrical products. As part of this, certain household electrical products require energy labels.	Our product does not fall within this scope, so an energy label has not been included.

LABELLING AND USER / SAFETY **GUIDE**

A detailed User Guide and Safety Guide have been produced as part of the packaging of the product. The User Guide is intended to be as clear and simple as possible, enabling new users to begin practicing with their new device as soon as possible after opening the box. The wider target market of our device includes young musicians purchasing a metronome for the first time. As a result, both the User Guide and Safety Guide have to be easily readable and understandable. The User Guide heavily relies on clear and intuitive graphics to help reduce barriers to first-time users of a metronome, who would likely be unfamiliar with operating such a device. A clear and well illustrated user guide removes a number of pain points when using a new and unfamiliar product.

These two documents would be included on a single fold out piece of card made from high-quality, durable paper. It is important that both these documents can last as they contain important safety information.



Shown above for reference is a recreation of the front page of a User Guide for a CASIO watch - it is clear and uncluttered, and allows the user to immediately use the product with ease.

CASIO / SAFETY GUIDE / EDM 120

IMPORTANT SAFETY INSTRUCTIONS.

READ THE FOLLOWING INFORMATION BEFORE USING THE DEVICE FOR THE FIRST TIME.

THESE SAFETY WARNINGS AND PRECAUTIONS APPLY TO THE DEVICE AND ALL SUPPLIED CHARGING ACCESSORIES.

USE: The device should only be used as described in the CASIO User Guide.

HANDLING: Handle device with care. It is made of glass and plastic and contains sensitive electronic components. The device or battery can be damaged if dropped, burned, punctured, crushed, or if it comes into contact with liquid.

DAMAGE: If you suspect damage to device or battery, do not continue use of device. Do not use if screen is cracked as it may cause injury. Do not continue to use charging cable if it becomes damaged. CASIO can replace cables.

REPAIR: Do not open or attempt to repair the device. If there is an issue with the product contact CASIO directly for further help.

CHARGING: Use only CASIO accessories to charge this device. It is not recommended to leave the device charging for longer than necessary as this may reduce battery performance over time.

CHARGING CABLE: Avoid extended skin contact with the included charging cable and connector when the charging cable is connected to a power source, as it may cause discomfort or injury. Do not sleep or sit on the charging cable or connector.

CHARGING CONNECTOR: When inserting charging connector into device, do not be overly forceful. This may damage the connector or device.

CHILDREN: The device is not a toy. Close supervision is required when the device is used by children. It is recommended that this product not be used by children under the age of 8 years old.

LIQUID: The device should not be used in a wet environment, or in a location where it is likely to get wet. Device should not be used with wet hands.

MEDICAL DEVICE INTERFERENCE: The device contains magnets and components that emit electromagnetic fields. These magnets may interfere with medical devices such as pacemakers. Consult your GP for advice on whether you need to maintain a safe distance of separation between you and the device.

MEDICAL CONDITIONS: The device includes flashing lights. Consult your GP if you have any condition that may be affected by these flashing lights before using the device.

FLAMMABILITY: Do not place the device near an open flame or heated surface. Do not incinerate the device even if it is heavily damaged, as this may damage the battery, causing it to explode.

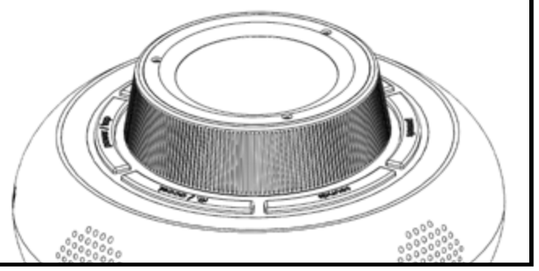
VOLUME: It is not recommended to use the device at full volume for extended periods of time. Continued exposure to sound at high volumes may damage your hearing.

CASIO / USER GUIDE

CASIO / EDM 120

QUICK **START**

1. Long press the power button to turn on the device.
2. Select the BPM by rotating the dial.
3. Confirm the BPM and start the metronome by pressing the dial.



VOLUME **CONTROL**

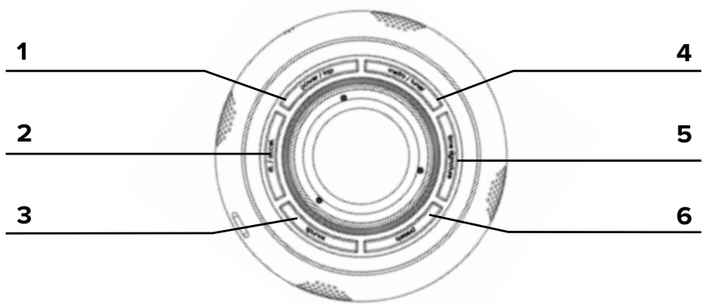
Press and rotate the dial to change the volume.
The volume level is always displayed on the screen.

BUTTON **CONTROL**

SHORT PRESS: A short press will turn on the feature (it will load with the last used inputs).

LONG PRESS: A long press will bring up the input menu for that feature on the dial screen.

DIAL PRESS: A dial press will start the metronome or confirm what is on the dial.



1. Power/Tap button: turn on the device/input a tempo by tapping the button.
2. Tempo change: create an accelerando or ritardando.
3. Sounds: select a sound that suits you.
4. Metronome/Tuner: select between metronome and tuner mode.
5. Time Signature: set a time signature so you know where you are in the bar.
6. Pieces: chose a stored piece that has pre-set settings.

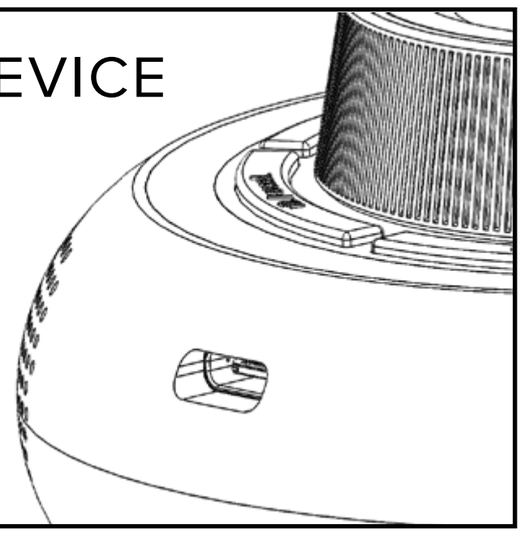
(When activating a piece or an accel./rit. there will be a two bar count in.)
All of this information is available on CASIO's website.

UPLOADING **PRESETS**

1. Bluetooth connection will automatically activate when in the presets menu
2. Pair the device with your mobile phone.
3. On the CASIO LEARN @HOME app select the presets you want to upload to the device.
4. The Bluetooth will automatically turn off after the pieces have been uploaded to save battery.

CHARGING THE DEVICE

The battery level of the device is always displayed on the screen.
The device is charged via the included USB-C cable.
The device has a battery life of 14 hours under typical use.



LABELLING AND USER GUIDE

CASIO / SAFETY GUIDE / EDM 120

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REPAIR: Do not open or attempt to repair the device. If there is an issue with the product contact CASIO directly for further help.

CHARGING: Use only CASIO accessories to charge this device. It is not recommended to leave the device charging for longer than necessary as this may reduce battery performance over time.

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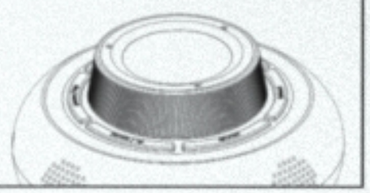
VOLUME: It is not recommended to use the device at full volume for extended periods of time. Continued exposure to sound at high volumes may damage your hearing.

CASIO / USER GUIDE — CASIO / EDM - 120

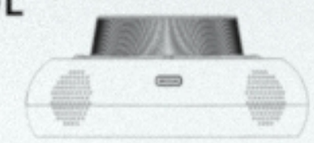
QUICK **START**

1. Long press the power button to turn on the device.
2. Select the BPM by rotating the dial
3. Confirm the BPM and start the metronome by pressing the dial.



VOLUME **CONTROL**

Press and rotate the dial to change the volume
The volume level is always displayed on the screen



BUTTON **CONTROL**

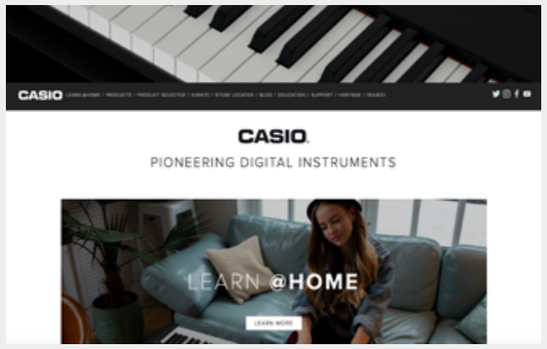
SHORT PRESS: A short press will turn on the feature (it will load with the last used inputs

UPLOADING **PIECES**

1. Make the device Bluetooth discoverable by selecting BLUETOOTH ON in the Pieces menu.

BRANDING AND GRAPHICS

The graphics for the packaging drew inspiration from a number of different sources; including CASIO's music website, CASIO's own branding for its music product line-up, and other CASIO products.



To the left is a screen shot of the home page of the CASIO music website - aesthetic inspiration was taken from there.
The packaging was also designed to reflect the CASIO mantra of creativity and contribution - the outer box is eye catching and also displays the product as though the buyer is already holding it.

OUTER NET

Focused on branding, advertising the product and signifying the method of unpacking.

COMPLIANCE MARKINGS

As described in the Product compliance pages, the CE and wheelie bin mark were included, along with the Forest Stewardship Council marking, letting our customers know that the packaging is made from (at least) 70% recycled card.
Inspiration was taken from the packaging supplied with the CASIO watches - it is compact and made of cardboard, hence many of the markings could be transfered. The similarity in packaging design would also mean that manufacture would be easier for CASIO, as our packaging manufacture could become an extension of their existing systems.

INNER NET

Focused on product protection and compliance markings.

EXPLODED VIEW OF PACKAGING

The packaging was designed to be intuitive to unpack - it is similar to a number of other CASIO products and has guiding cutouts. Construction during manufacture is simple and quick. It protects the product from all sides during transportation, and is as compact as possible, to ensure efficiency when shipping.

PART	MATERIALS	PRODUCTION PROCESS
1 - Charging cord	Copper, plastic	Standard production of USB - A to USB - C charging cord.
2 - Protective Shell	Molded pulp - paper, water	Paper and water are mixed to create a slurry, which is then fed into molds and allowed to dry, retaining its shape. It is sturdy and biodegradable.
3 - Protective film	Polyethylene	Film extrusion - the only part of our packaging which is not biodegradable.
4 - Inner box 5 - Outer box 6 - Guide casing 7 - Guides	70% recycled bio-degradable cardboard.	Recycled cardboard is sorted and shredded - the sorting is required, as some types of cardboard shred and bind better than others. It is then mixed with water and pulp to soften it, before being filtered from small items such as tape. More water is then added to soften the mixture further. The mixture is then rolled and dried, and the sheets are converted to new cardboard.

PACKAGING RENDER

RENDER

CASIO

Our packaging and product, displayed in a music learning situation. This displays how our product is ready to use out of the box, with intuitive unpacking and set up.

CASIO
EDM 120

A CASIO produced time keeping device that has added functionality beyond current metronomes on the market, implemented using a simple user interface. The device is designed around the easy conveyance of time using audio and visual stimuli, improving on the time communication used by current metronomes. It will be intuitive to use as a stand alone product, and will also be capable of taking advantage of the remote and wireless LEARN @ HOME feature, key to CASIO's growth in the music industry. The EDM 120 is a pure distillation of business viability, human desirability and tecnical feasibility.

BUILT IN TUNER
TAP INPUT
TIME SIGNATURE INPUT
STORED PRESETS
MULTIPLE SOUND OPTIONS
PROGRAMMABLE TEMPI CHANGES

PRODUCT SCREEN **USER INTERFACE**

The interfaces were designed in workshops with two professional musicians. There is a particular focus on making each function as intuitive and easy to input as possible. No more than two actions are required to input any feature and are all actuated with a press of the dial.

1. PRESETS
Bluetooth is activated to load new presets onto product.

2. SOUNDS
Scroll through and select from a selection of acoustic and synthetic beat sounds.

3. TEMPO CHANGE INPUT
Choose an end tempo (BPM) and set duration (bars).

4. POWER ON
CASIO start up logo appears as the user switches the device on.

5. TUNER
Toggle between metronome and tuner. Dial indicates whether note is sharp or flat.

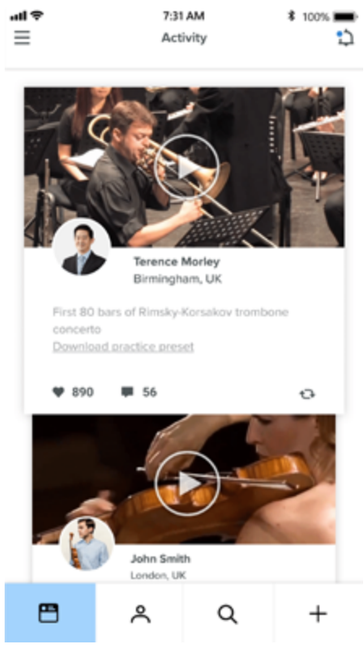
6. TIME SIGNATURE INPUT
Choose number of beats in a bar (0-24). Choose length of the beats (1-16).

LEARN @ HOME APPLICATION

An app has been designed for the creation and sharing of complex presets. This allows you to preset long passages of music with multiple tempo and time signature changes. This is particularly important in modern music that often has lots of tempo and metre changes in quick succession, for which a normal metronome is useless. The app also allows teachers to share practice presets with their students remotely, along with links to suitable recordings and videos. These can be downloaded onto each players metronome. This allows conductors or section leaders to share presets for orchestral or ensemble pieces with the players, for individual practice. This is highly beneficial for a section all getting to grips rhythmically with a piece of music.

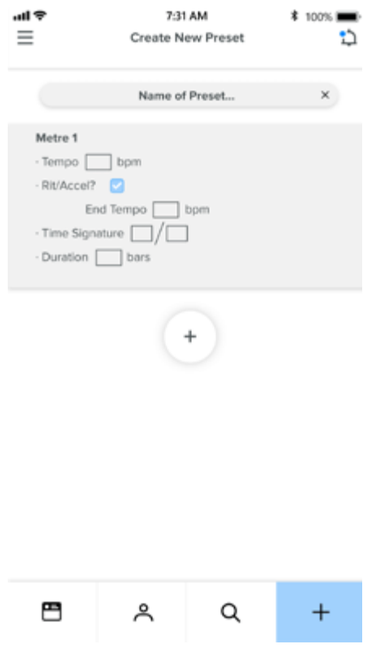
START UP SCREEN

CASIO



ACTIVITY FEED
Browse and search for presets that are useful to you.

PROFILE
Create a profile with all your presets that can be easily shared.

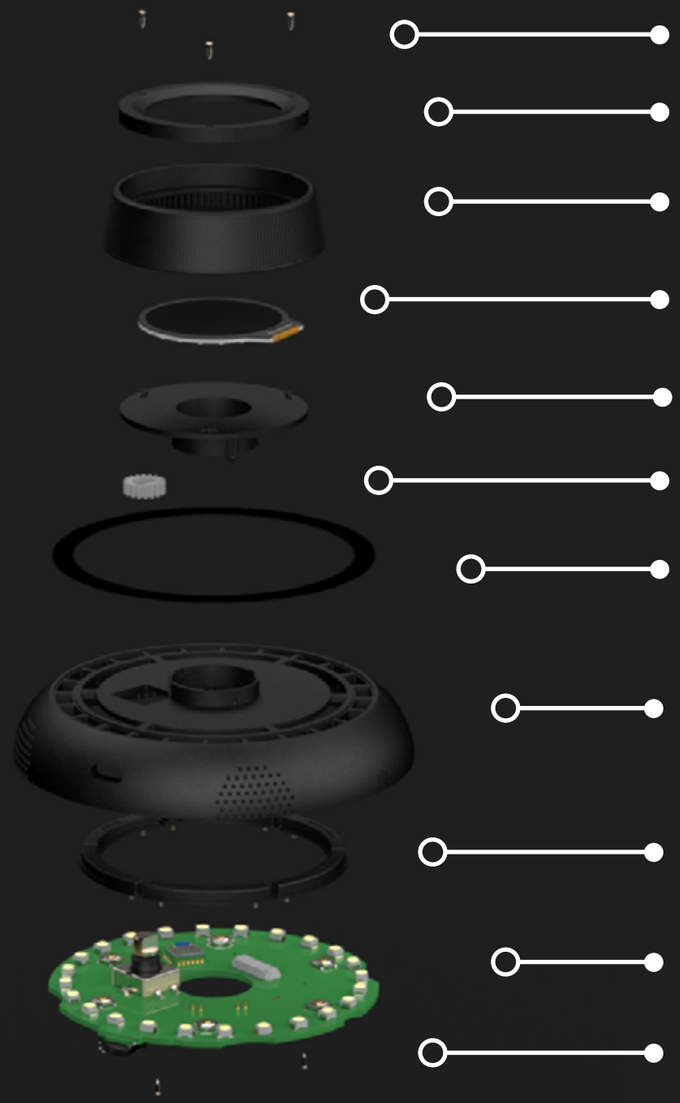


PRESET CREATION
Create long complex presets for difficult pieces of music.

EXPLODED VIEW OF EDM 120

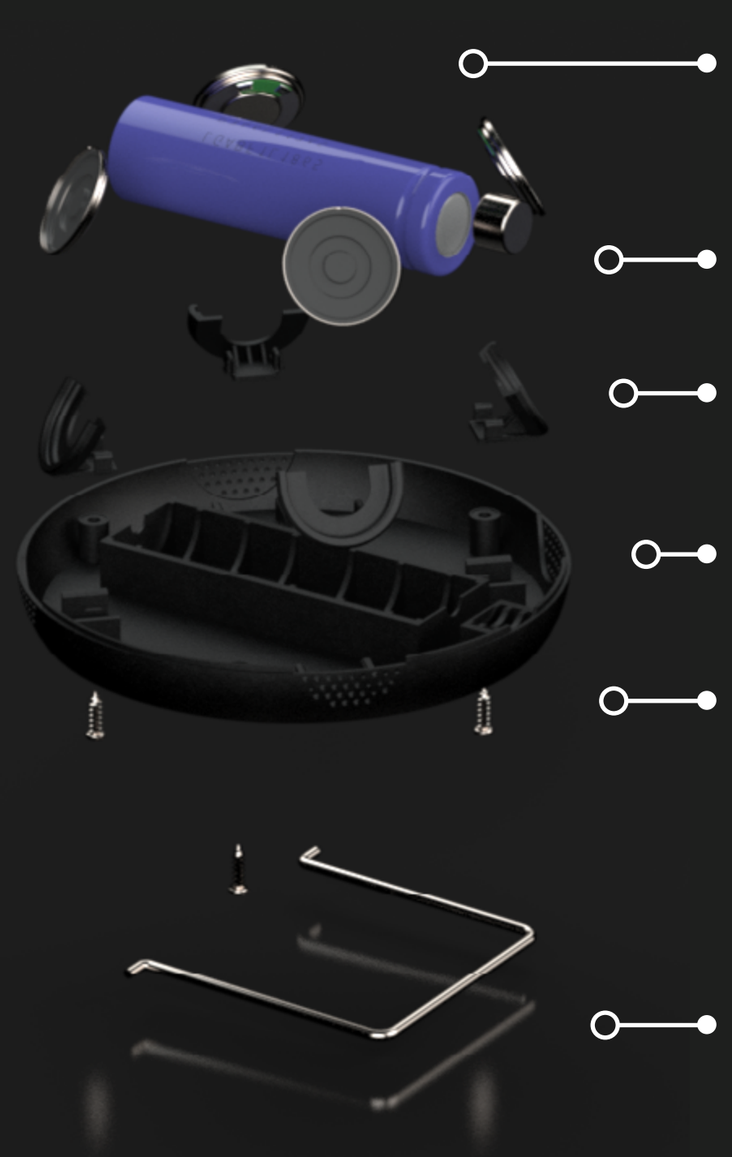
Shown here is an exploded view of the CASIO EDM 120, displaying all components in the arrangement that they would be assembled. The ‘sandwich’ arrangment of the components lends itself to efficient and fool-proof assembly. The exploded view has been split into ‘Upper Section’ and ‘Lower Section’ which can be assembled separately, and then put together as the final assembly step.

UPPER SECTION



- SELF TAPPING M1 SCREWS
  Standard part
- SCREEN COVER
  Injection molded ABS
- DIAL
  Injection molded ABS
- 1.28” IPS TFT LCD DISPLAY
  Outsourced part
- CENTRAL CONNECTOR
  Injection molded ABS
- SPUR GEAR
  Injection molded ABS
- CLEAR LED COVER
  Acrylic
- TOP CASING
  Injection molded ABS
- BUTTONS AND COMPRESSION SPRINGS
  Injection molded ABS
- PCB CIRCUIT BOARD
  Epoxy resin
- SELF TAPPING M1 SCREWS
  Standard part

LOWER SECTION



- RS PRO 8 OHM 0.5W SPEAKERS
  Outsourced part
- 3.6V 3350MAH LITHIUM ION
  Outsourced part
- SPEAKER MOUNTS
  Injection molded ABS
- BOTTOM CASING
  Injection molded ABS
- SELF TAPPING M2 SCREWS
  Standard part
- STAND
  Aluminium

GANTT CHART

PROJECT MILESTONES

CASIO

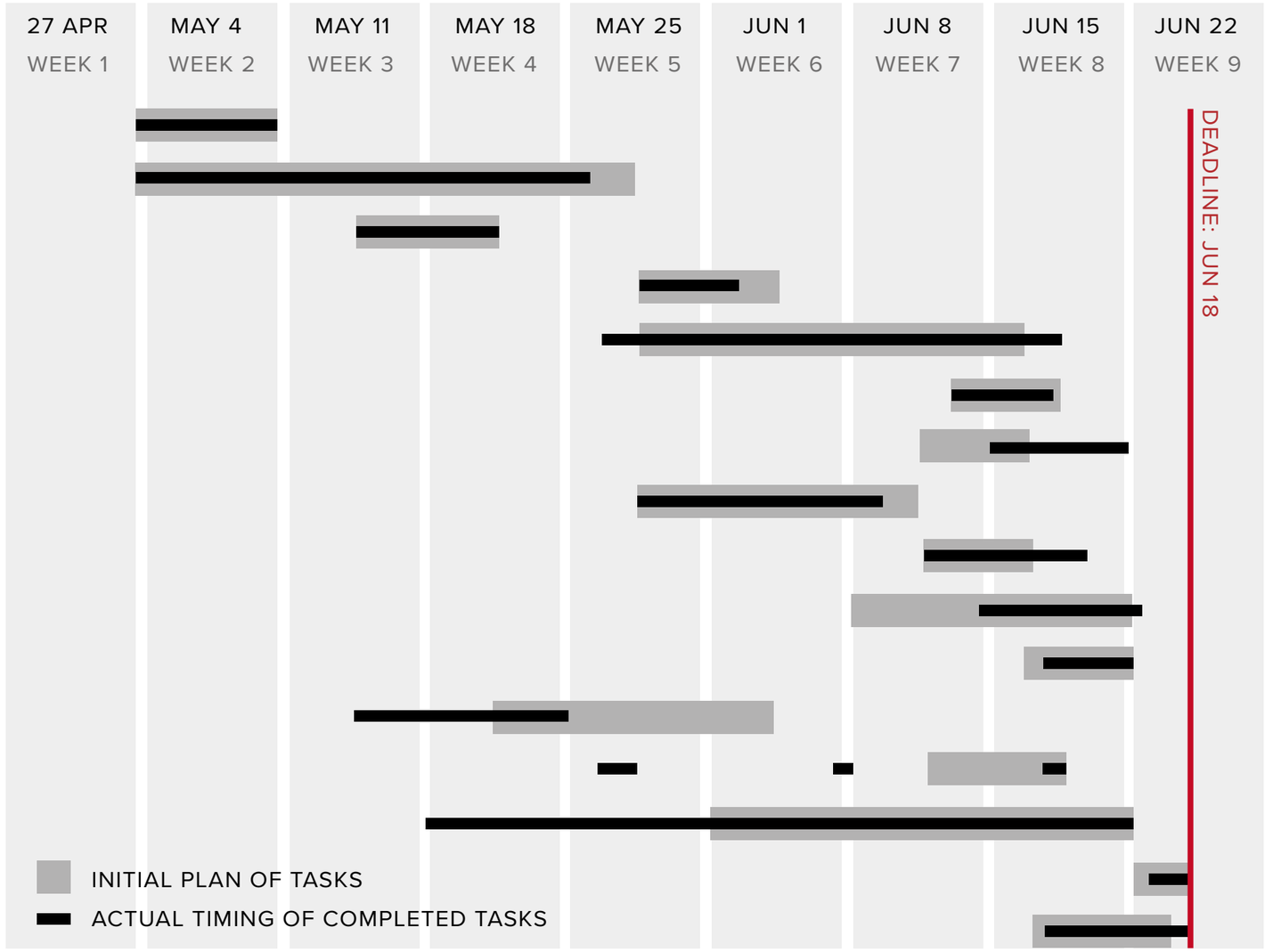
PHASE 3 REVISED PLAN

TEAM 12:

SC	SAMUEL CASTLE	**CCO**
AG	ALEXANDER GIBSON	**CIO**
FS	FREDERICK SEIDLER	**COO**
OC	OLIVER CROSS	**CTO**

A revised plan for the tasks to be completed before the presentation of our product was created following the closure of Imperial's campus, taking into consideration the complexities of remote working and the need for more flexible deadlines. This major design project lasted six months and required advanced levels of organisation and communication from all team members. All meetings were minuted and shared to allow easy referencing. To avoid wasted time, meetings with the whole team were only organised for major decisions and updates, while team members communicated directly with those assisssting on specific tasks. An MS Excel spreadsheet was shared that clearly displayed the progress of completed tasks, and the dependencies most tasks had on each other. This ensured that all members were always aware of the overall project completeness. As tasks were so dependent on each other, short delays often had a snowball effect, but a conducive team working environment helped to mitigate this.

TASK LED BY:	TASK ASSISTED BY:	TASK:
FS		Project Plan reorganised
SC	**AG OC**	Concept iteration and final design
OC	**SC**	Component selection
OC		Digital Testing
SC		CAD
OC		Production Data Package
FS	**SC**	Product assembly guide and costings
AG	**FS**	Brand research and selection
FS	**SC**	Development of product user guides
AG		Product packaging design
SC	**AG FS**	Product renders
SC		Screen UI layout design
FS	**OC**	User focus groups sessions
AG	**FS SC**	Submission Boards
		Presentation Preparation
FS		Video Creation



GANTT CHART

PROJECT MILESTONES

CASIO

WEEKLY KEY **PROJECT MILESTONES**

CASIO 創造貢献

1 27/04

Time had to be spent re-evaluating the project and its intended outcomes, as it became clear that it would not be possible to create a physical prototype. A new project plan was developed by the Operating Officer to guide the team through the following two months.

2 05/05

Following feedback from the end of Phase 2, a final concept was selected and iterated upon, incorporating desirable features from the other designs. This took longer than planned as the team adjusted to working remotely.

3 12/05

The submission boards were started at a much earlier stage than previously to ensure that there was ample time closer to the delivery date for unforseen issues. Many of the boards do not require material from CAD, so these were completed first.

4 19/05

Power and load calculations and component selection were completed ahead of schedule, allowing the CAD to be started early.

5 21/05

Selecting the right brand to incorporate our product into took longer than anticipated due to it being a highly consequential decision. However, this was not an issues as there were no dependant tasks immediately affected.

6 28/05

Focus group testing did not occur in the time frame originally planned, but occured as and when it was possible to arrange virtual meetings (a task considerably harder than anticipated).

7 04/06

The CAD model was completed three days late, preventing the production data package being started. However, this task was made faster by splitting the number of parts between team members.

8 11/06

As soon as the CAD was completed, work began on the visual material required (product renders and videos). The packaging design was completed two days late oweing to a revision of the design.

9 18/06

An internal team deadline was set three days before the submission to ensure any final issues could be resolved, and ample time was left to rehearse presenting a virtual product launch, with all the associated visual materials.

CASIO EDM 120

In order to get honest and productive feedback, some potential users were sent the video and final design slides which they reacted to without external input.

JAEHO B - WORKS IN THE WEST END
“Would be great in a professional setting where you are playing to click track”
“Rit and ral function is super helpful and would be really useful”
“User interface looks really simple – looks like garmin”

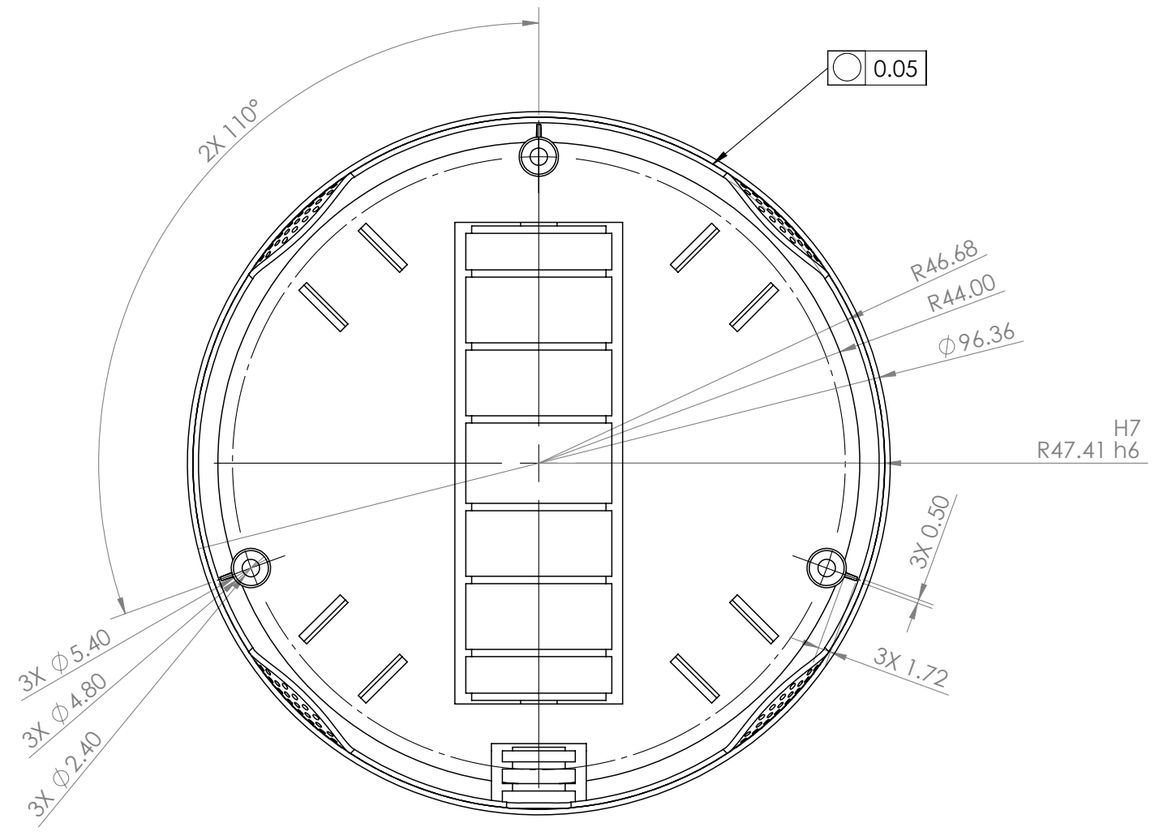
BELLA C - MUSIC AND THEATRE STUDENT TISCH
“I’d say the whole design is presented very clearly and as someone who used to often need a metronome for piano, it’s very clear and simple how you use it”
“I love how it can be made louder because one thing I remember is struggling to hear our very old ticking metronome when I was trying to play in time”

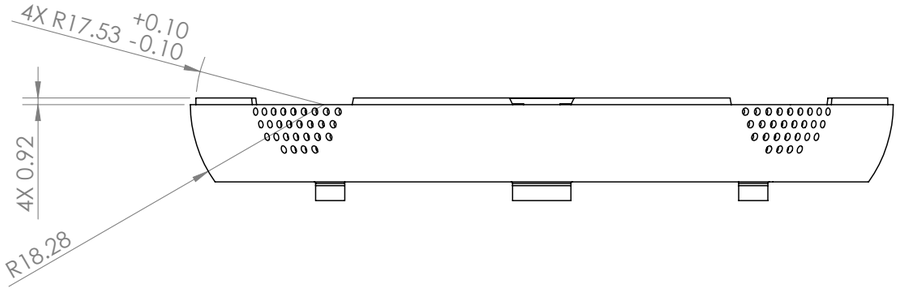
BELLA’S FATHER - SINGING TEACHER
“Considering the two important things with a product like this are the balance between the aesthetic i.e. how sexy and appealing it is to look at and the function and practicality of it; I think you’ve done that beautifully without one overriding the other or getting carried away with the visual.”

MARVIN - VIOLA, EX JUNIOR ROYAL ACADEMY OF MUSIC
“Honestly I’d buy that”
“I like how it’s really functional”
“Will say the branding and design look a little on the masculine side”
“It’s nice how compact it is”
“The lights seem like they’d be useful too, if you know a passage by heart”

HARRY - MASTERS IN MUSICAL THEATRE COMPOSITION, YALE
“It looks smart for a rehearsal room”
“It’s good to see a metronome with an expanded set of sounds and metres”
”The preset feature could be really helpful for practising complicated music, and especially if the method for creating presets is as intuitive as the rest of the metronome”

INIS - VIOLA, ROYAL ACADEMY OF MUSIC
“The features that especially stand out with this metronome are:
1) the accel / rit that the user can input
2) automatic volume control
I don’t think any metronomes I have used have ever included these.”
“However I think it could do with a slightly larger screen? Just because there are so many different details to look at and with the volume being what it is, maybe the user might not want to have it so close to them”





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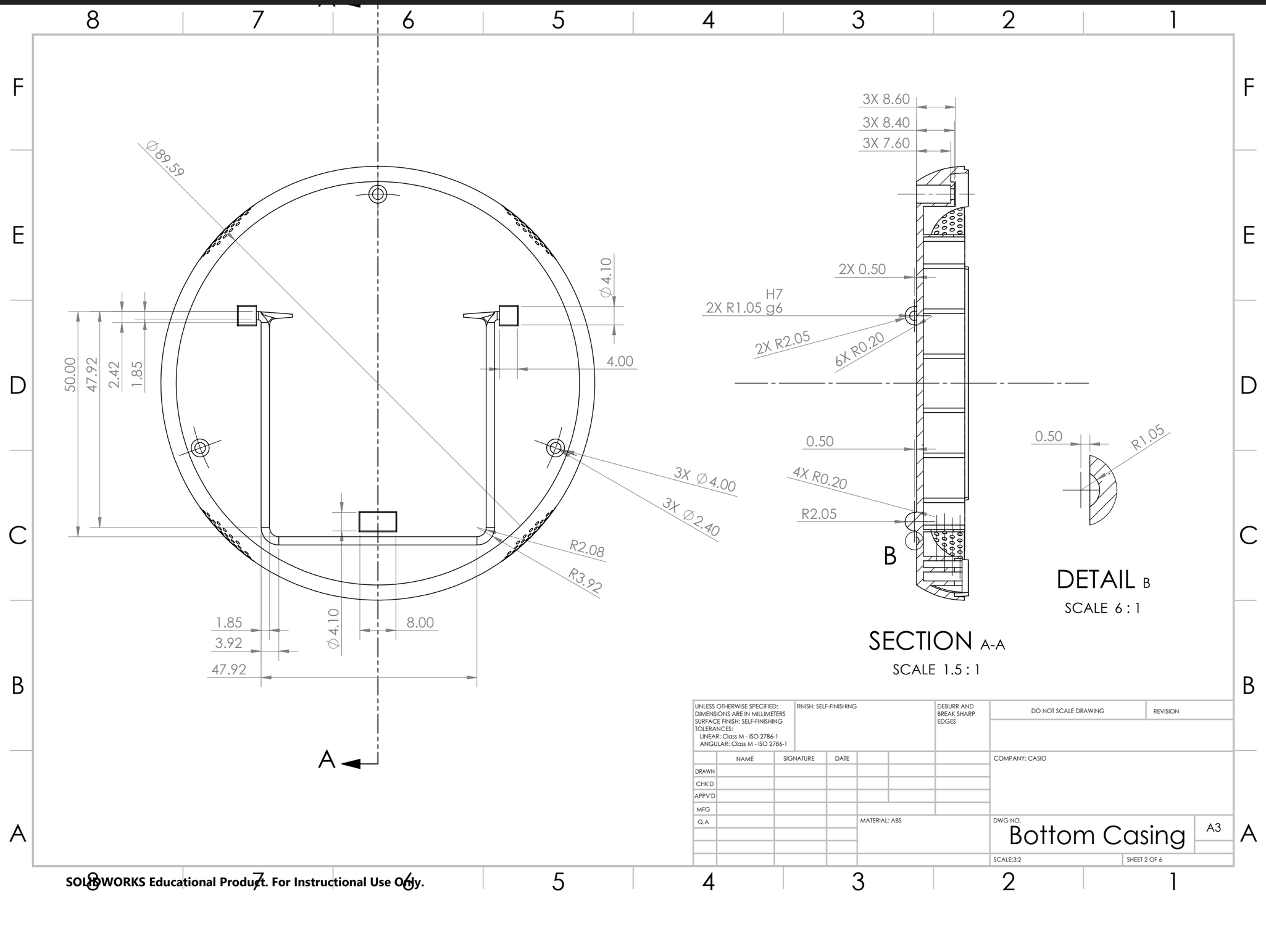

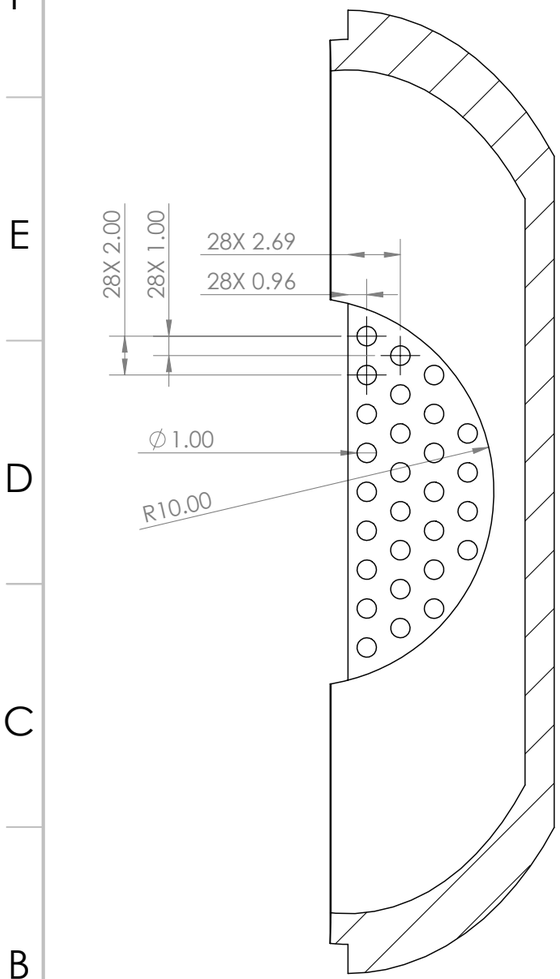

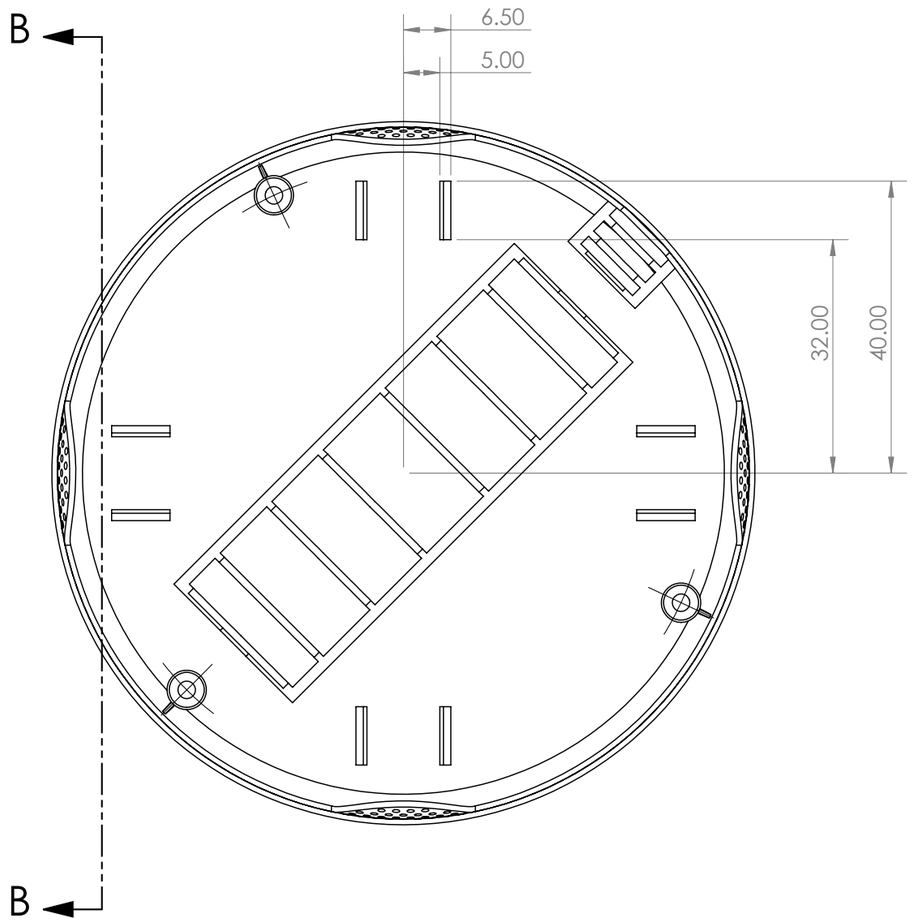

SECTION B-B
SCALE 4 : 1

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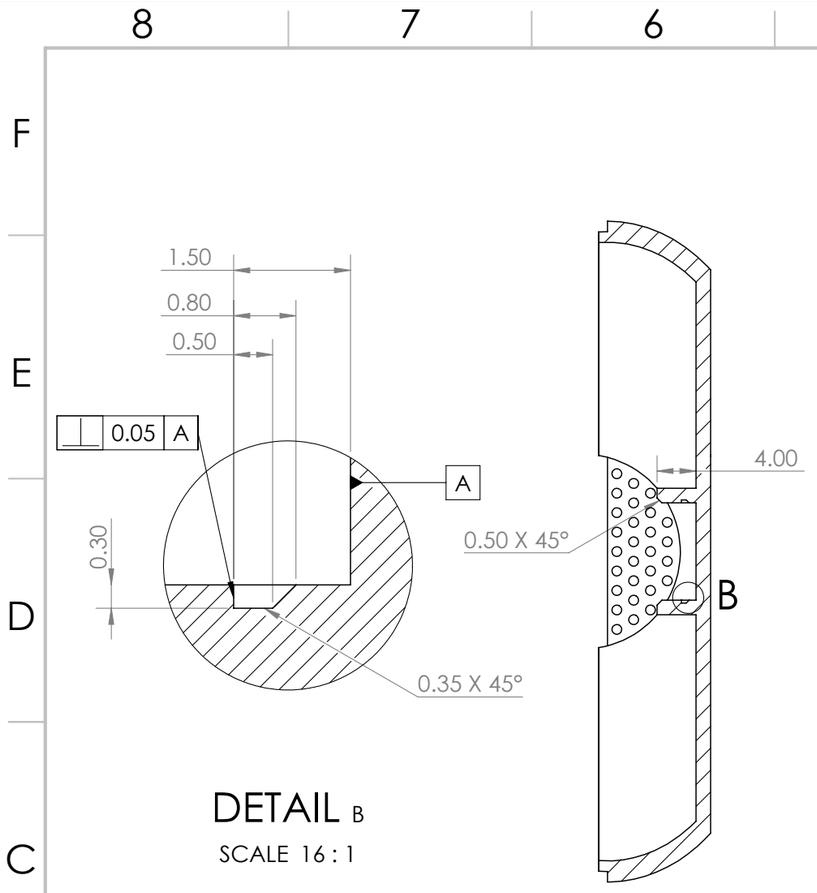
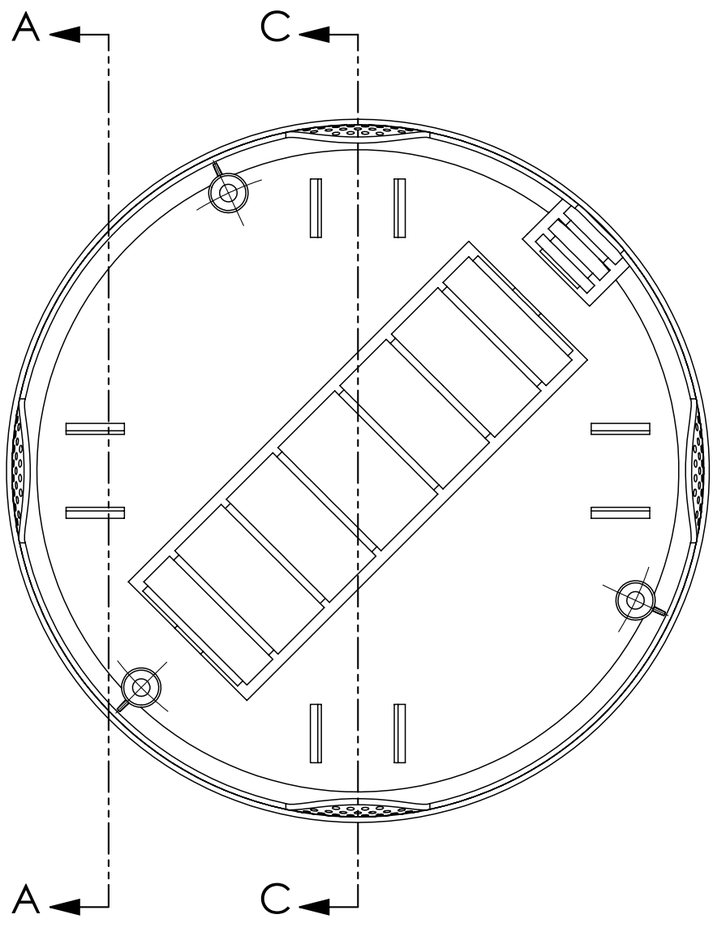
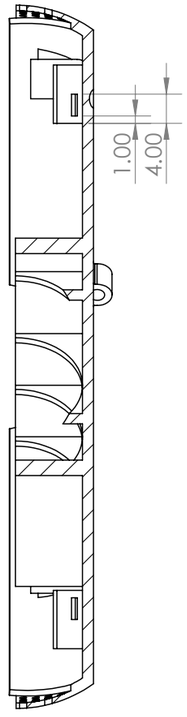


DETAIL B
SCALE 16 : 1

SECTION A-A
SCALE 2 : 1





SECTION C-C
SCALE 1.5 : 1

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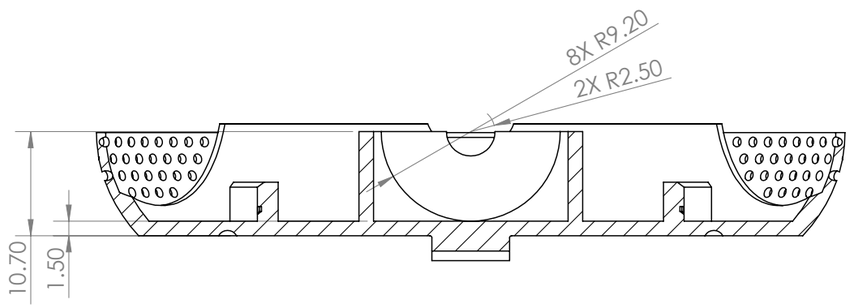
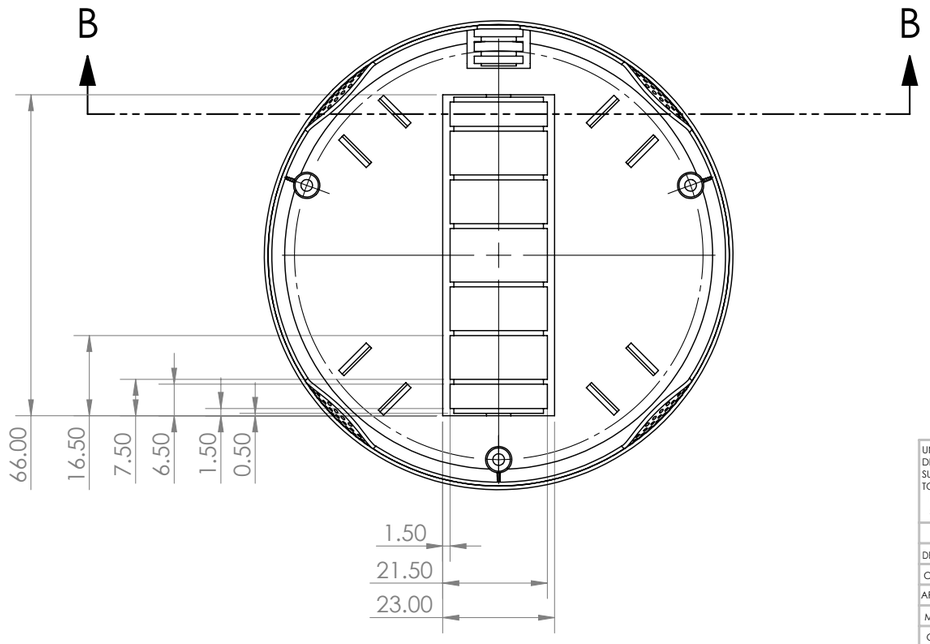


SECTION B-B

SCALE 2 : 1



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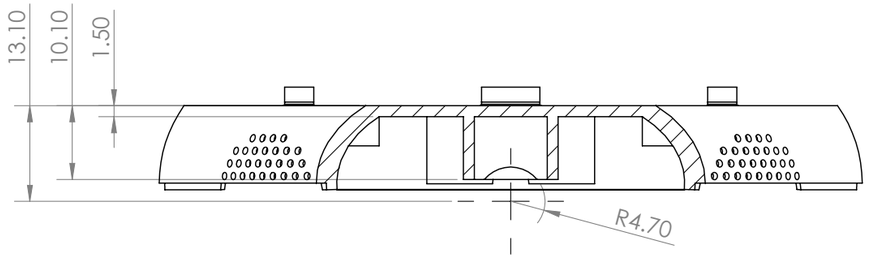
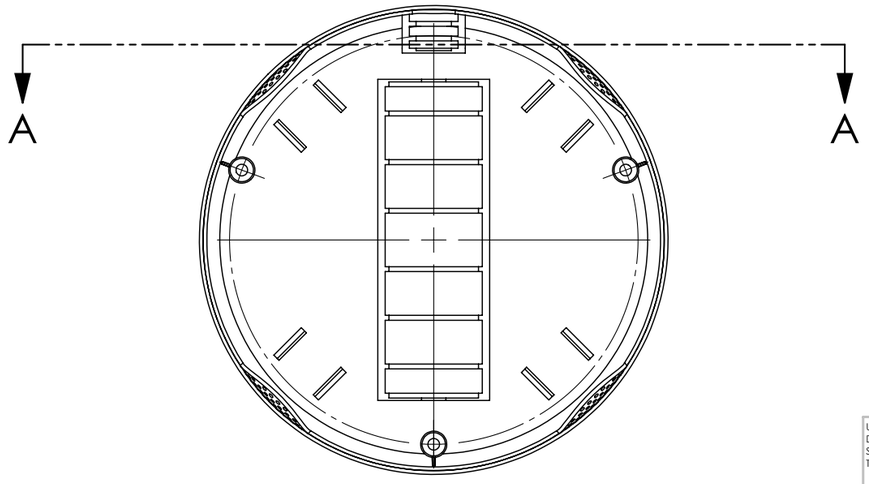


SECTION A-A

SCALE 1.5 : 1



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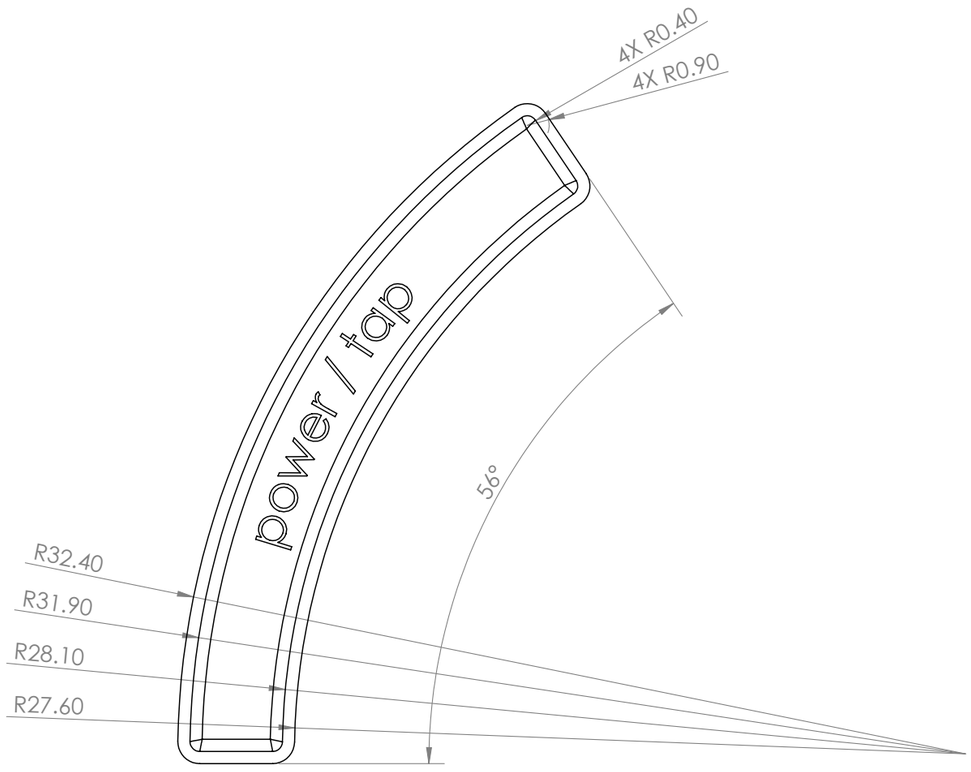

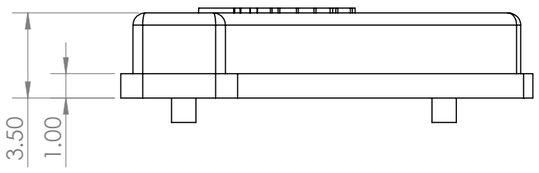

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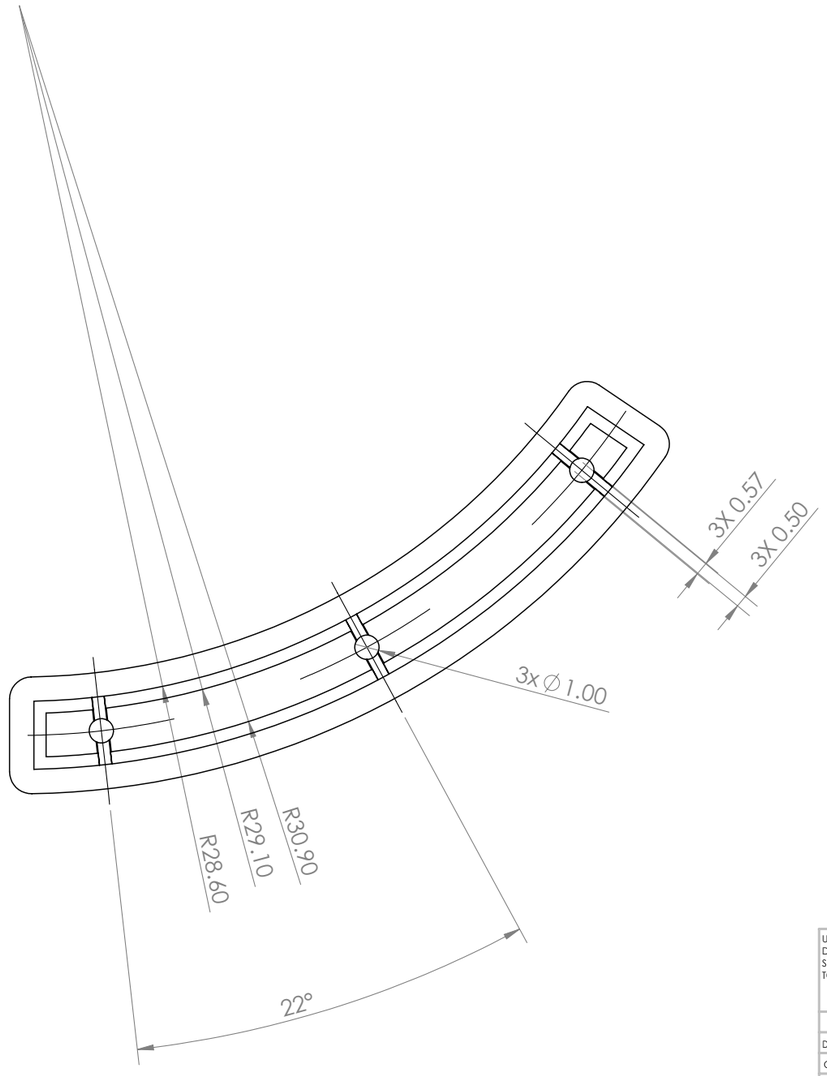

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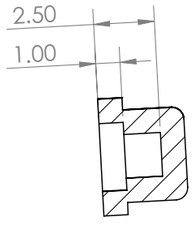
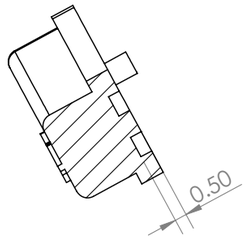
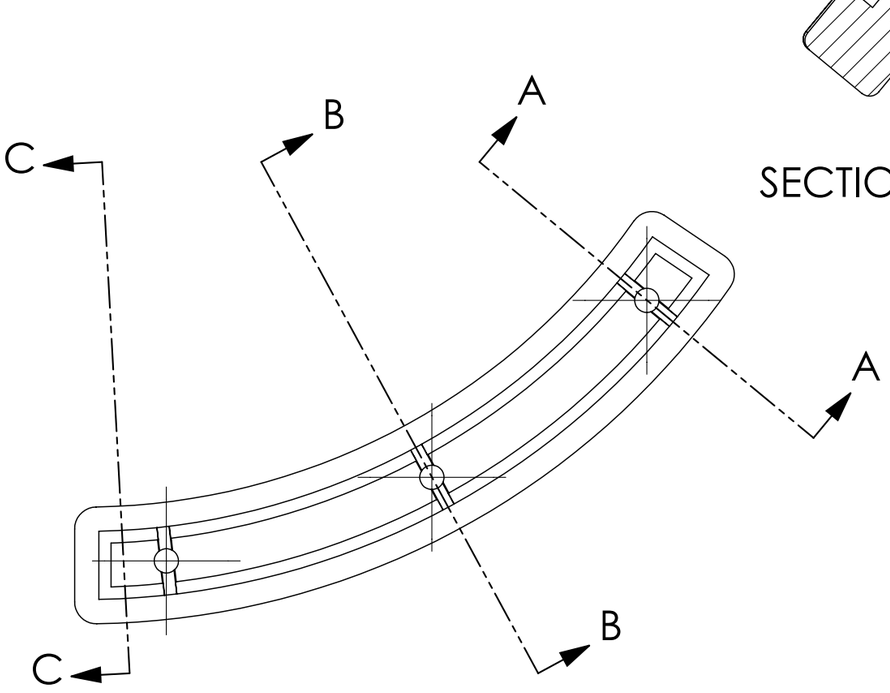
SECTION C-C

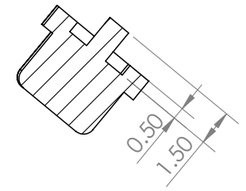


SECTION B-B





SECTION A-A



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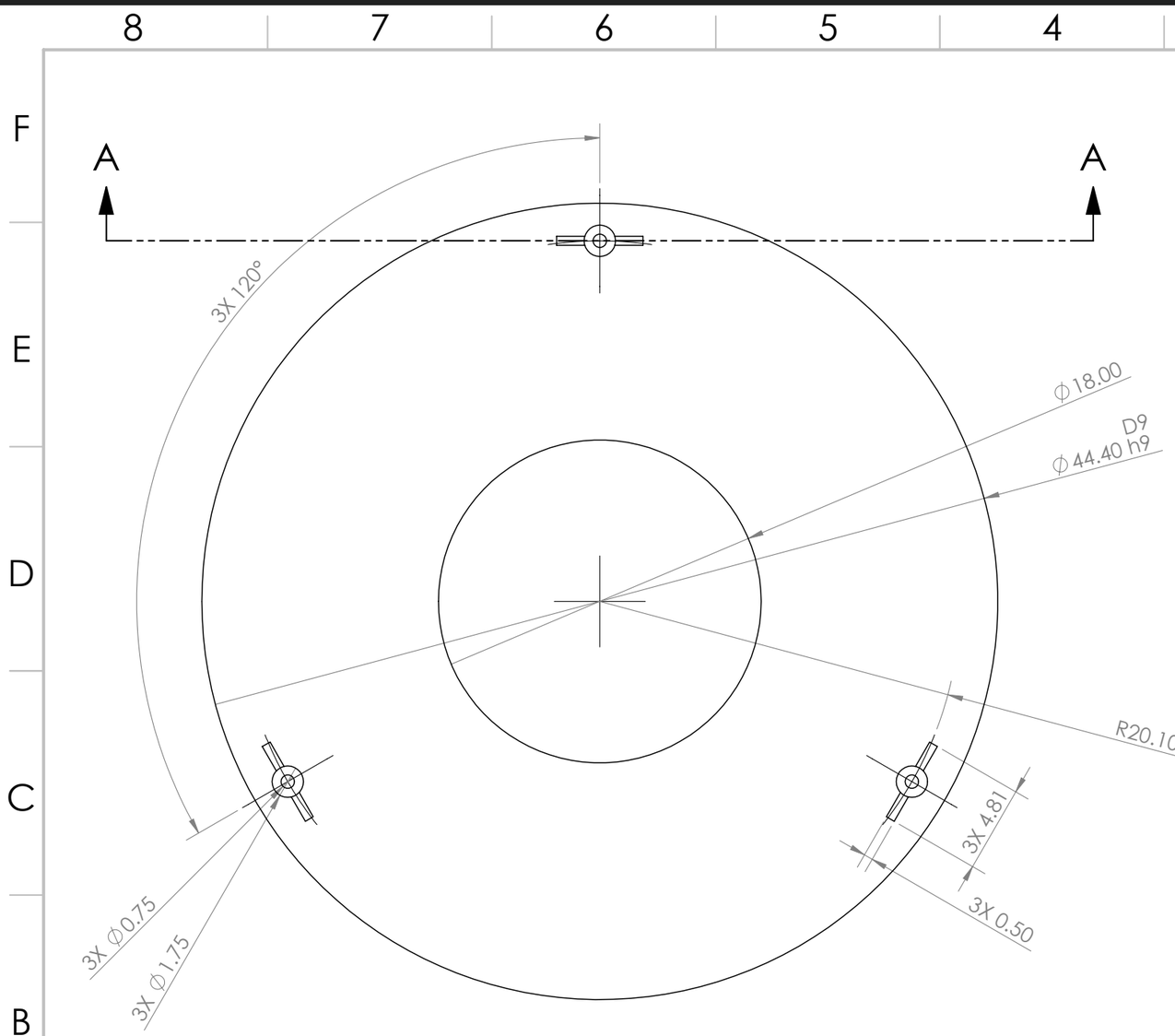

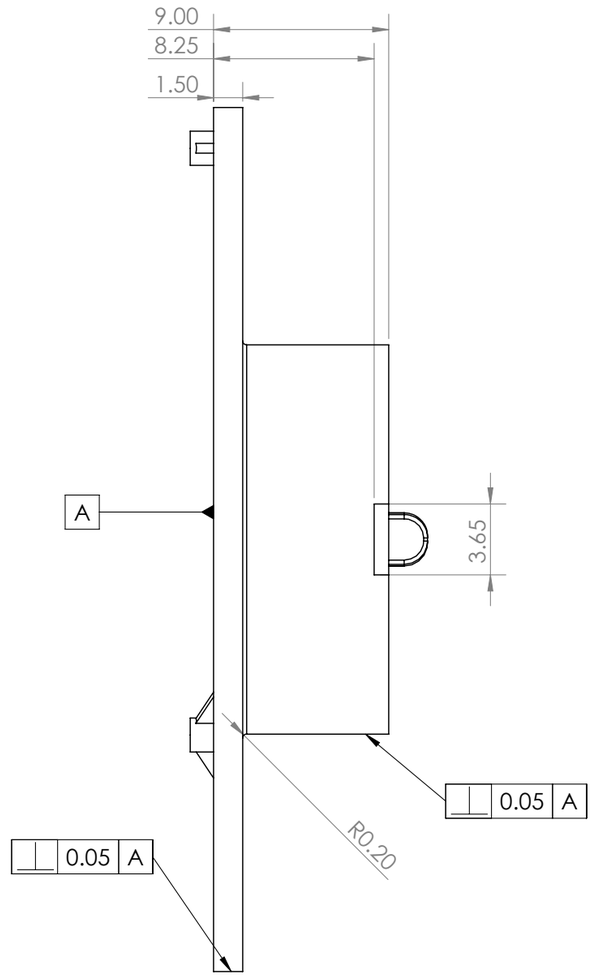

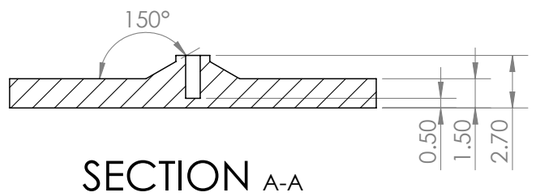

SECTION A-A

SCALE 4 : 1

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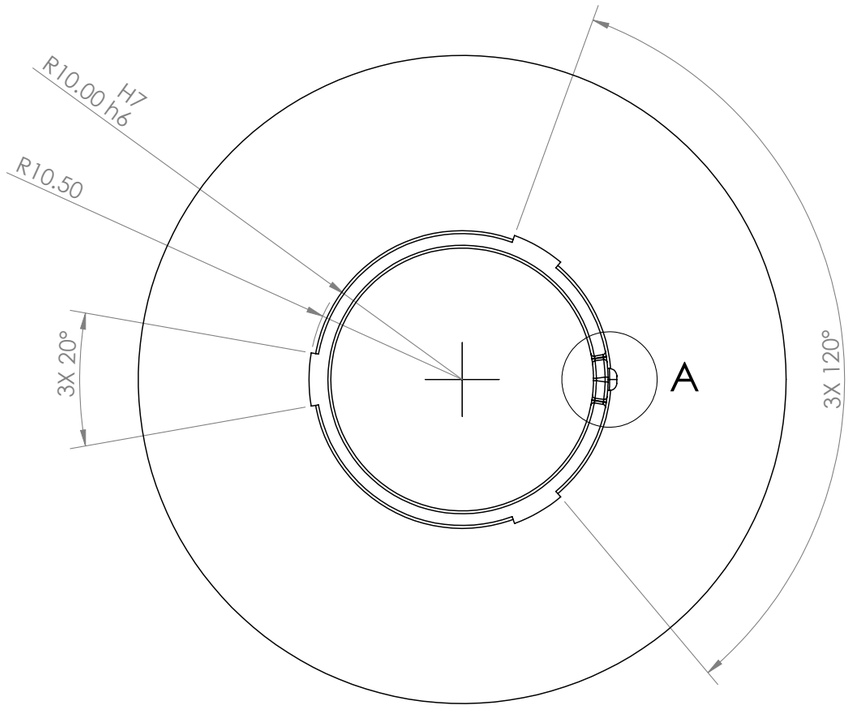
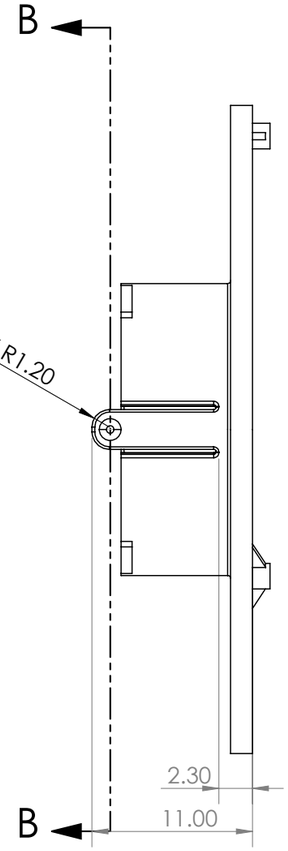
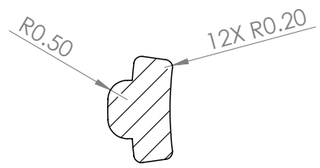
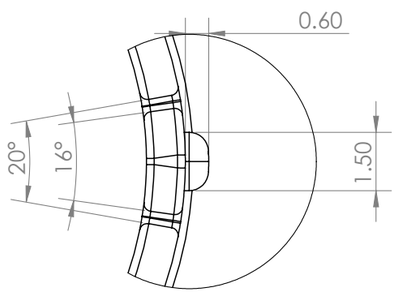






SECTION B-B
SCALE 8 : 1



DETAIL A
SCALE 8 : 1

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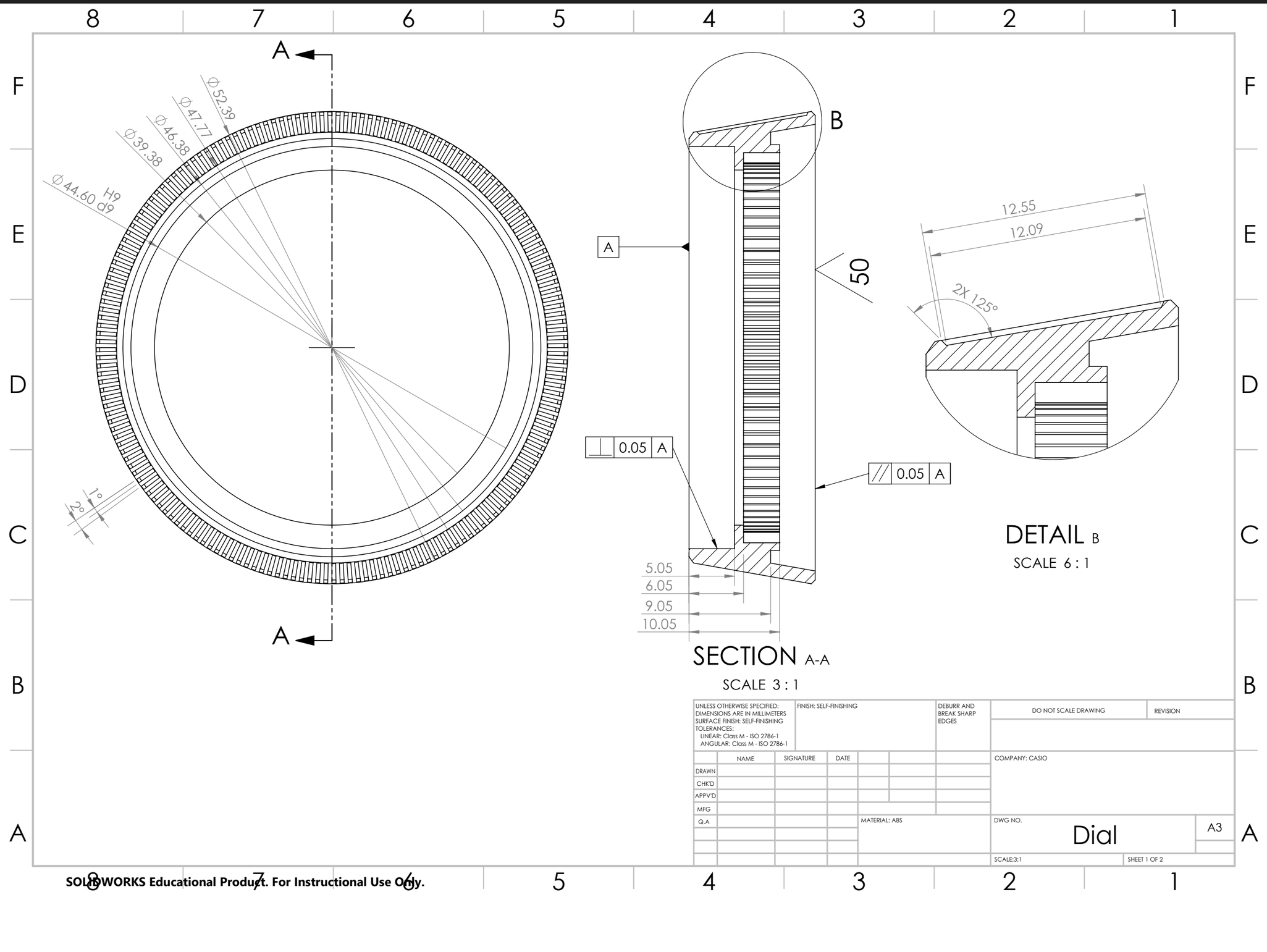

DETAIL B
SCALE 6 : 1

SECTION A-A
SCALE 3 : 1

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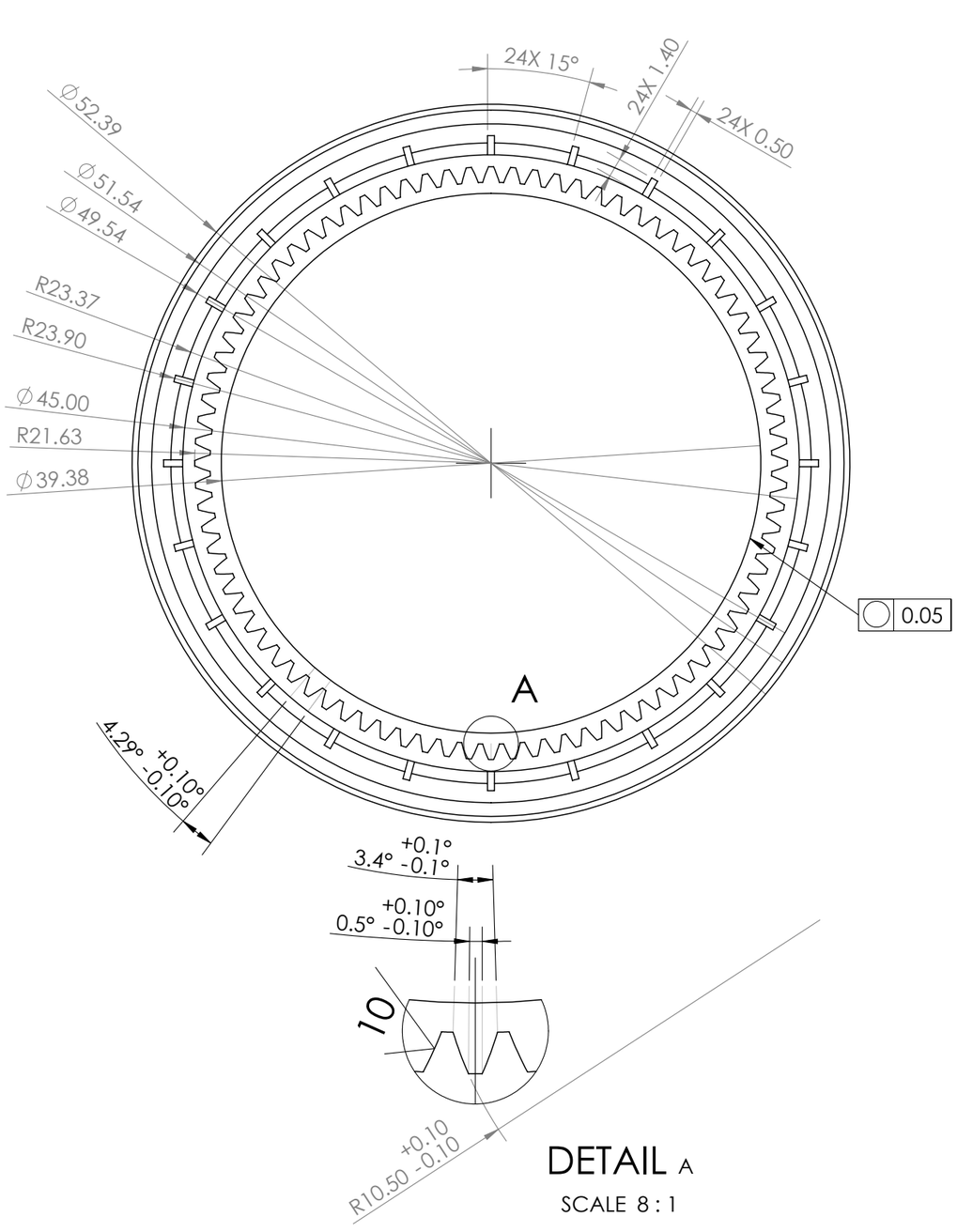
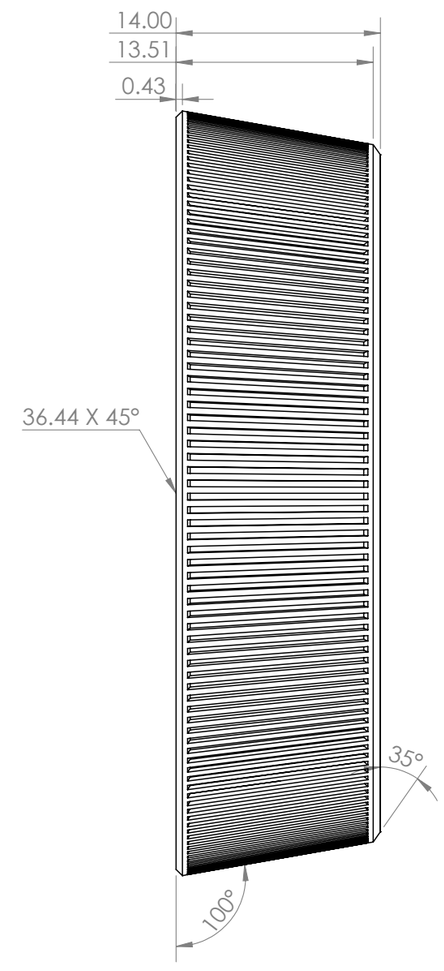


DETAIL A
SCALE 8 : 1



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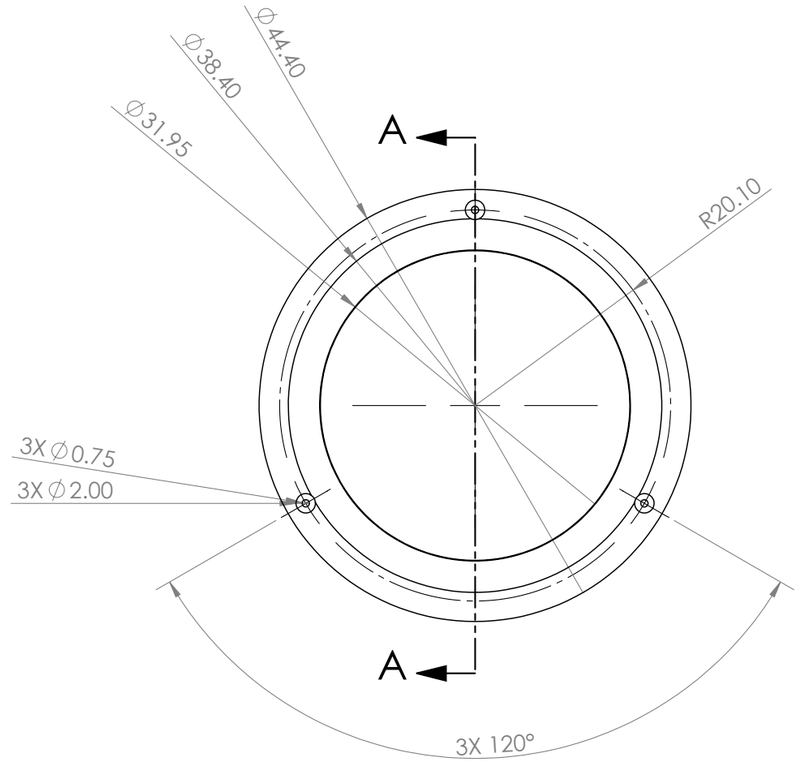

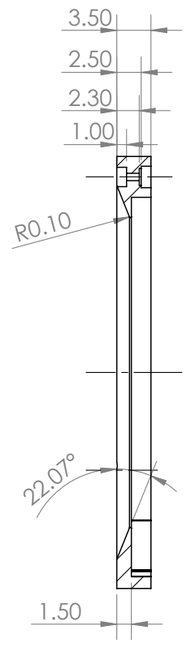

SECTION A-A

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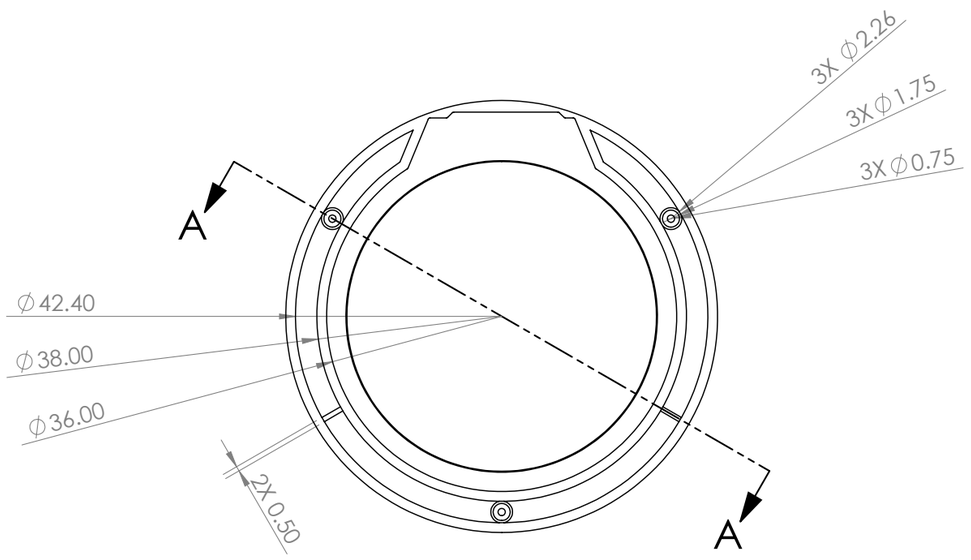

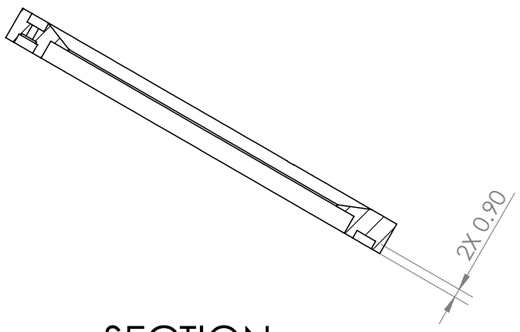

SECTION A-A

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
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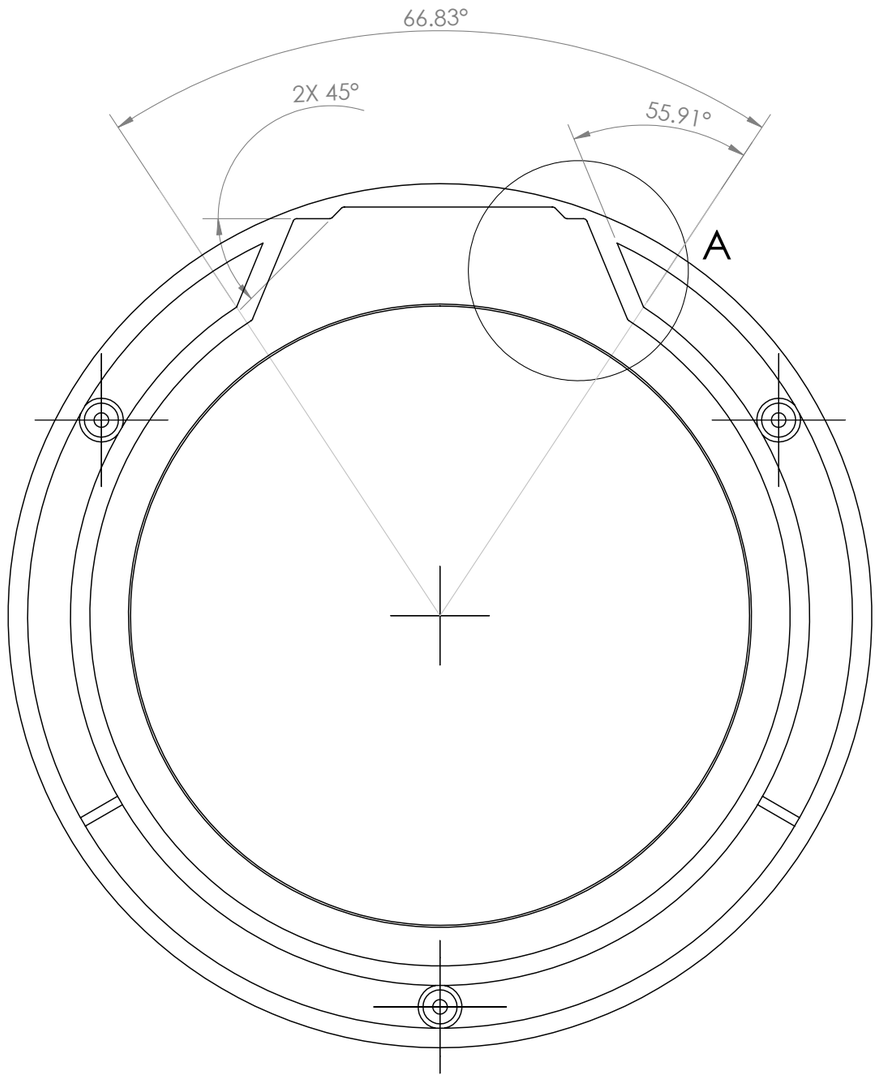

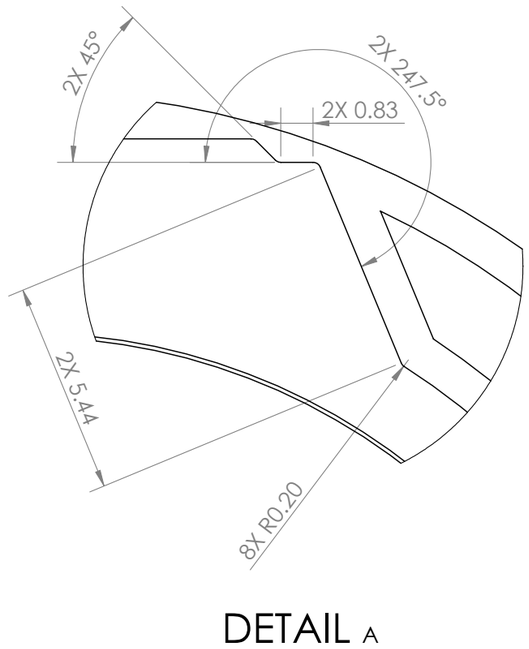

DETAIL A
SCALE 8 : 1

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Q.A				MATERIAL: ABS	DWG NO. Screen Cover		A3
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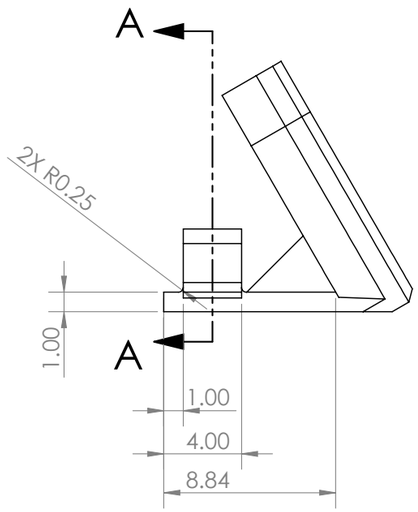
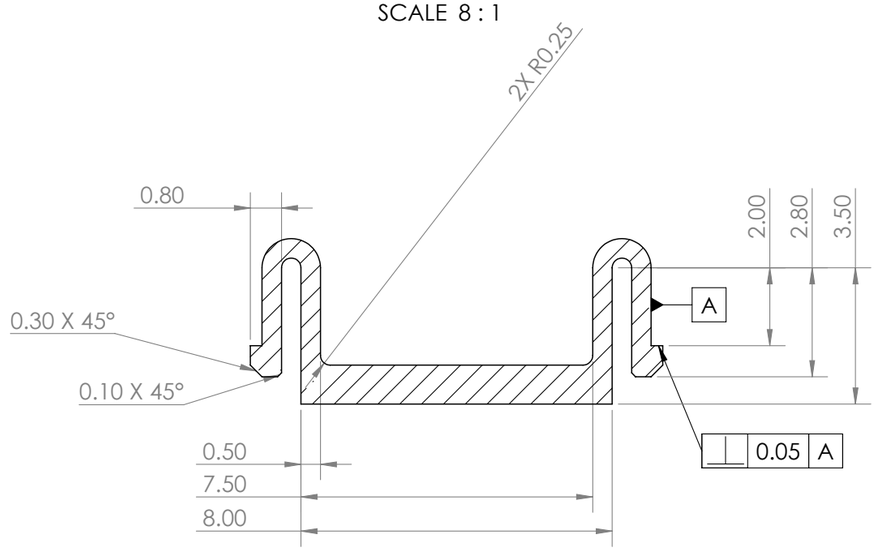
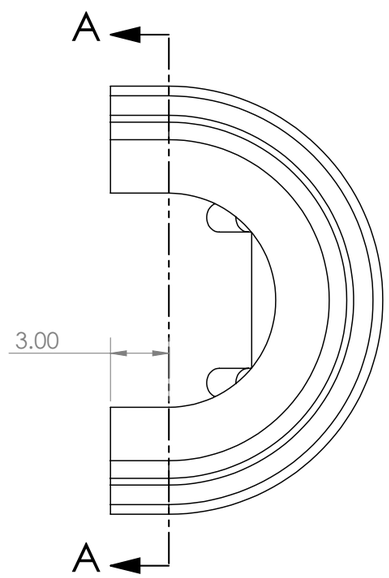
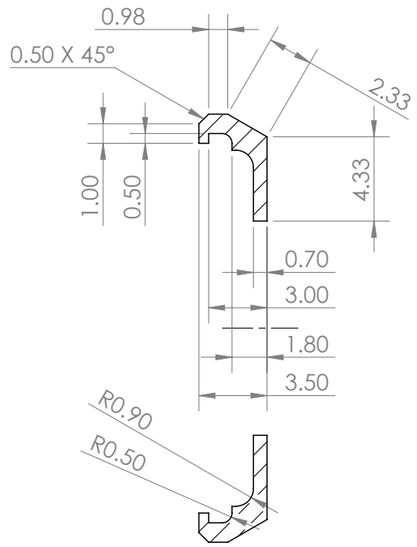


SECTION A-A
SCALE 8 : 1



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			COMPANY: CASIO	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: ABS		DWG NO. Speaker Mount	A3
						SCALE:4:1	SHEET 1 OF 3

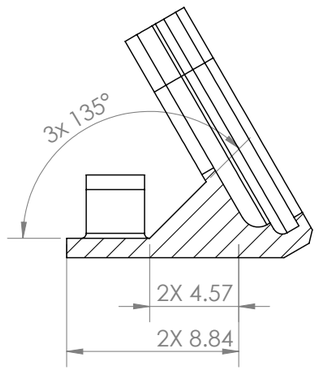




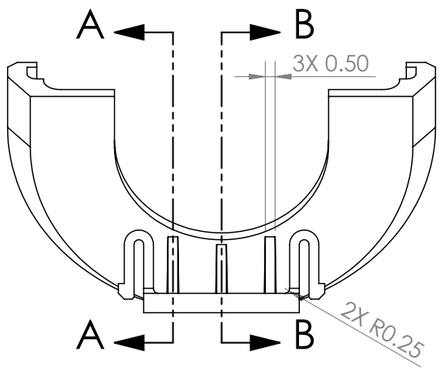
SECTION A-A

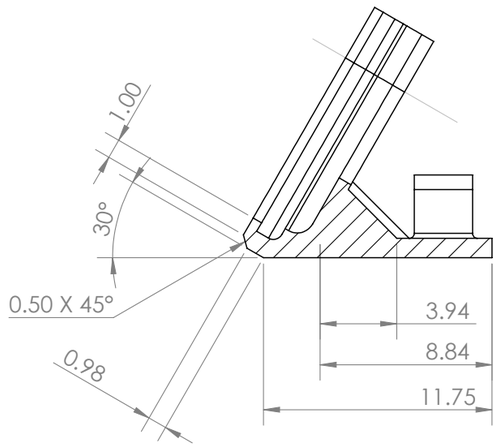
SCALE 4 : 1

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			COMPANY: CASIO	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: ABS		DWG NO. Speaker Mount	A3
						SCALE:4:1	SHEET 2 OF 3



SECTION A-A
SCALE 4 : 1





SECTION B-B
SCALE 4 : 1

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			COMPANY: CASIO	
DRAWN							
CHK'D							
APPV'D							
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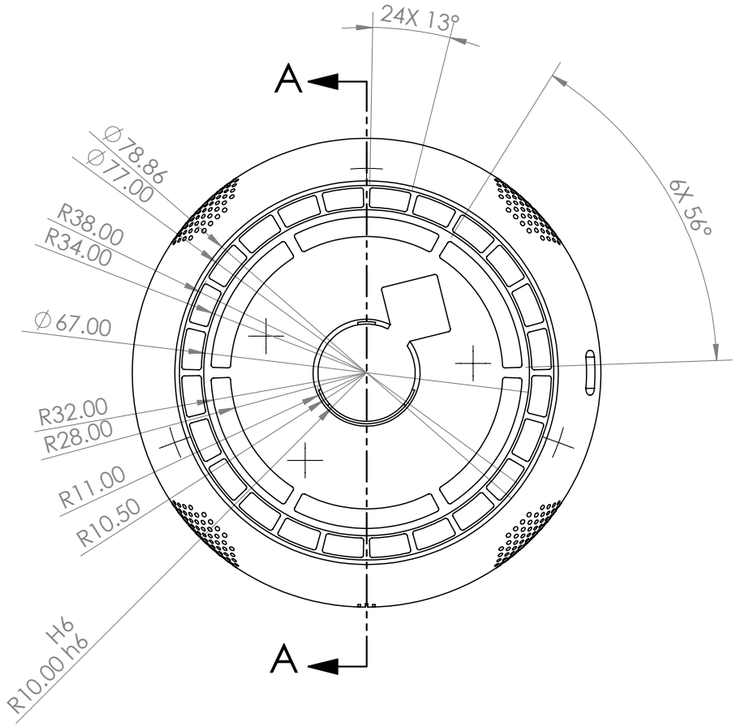
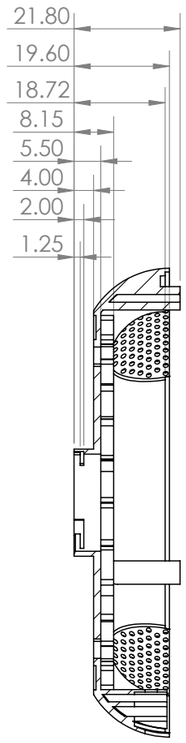
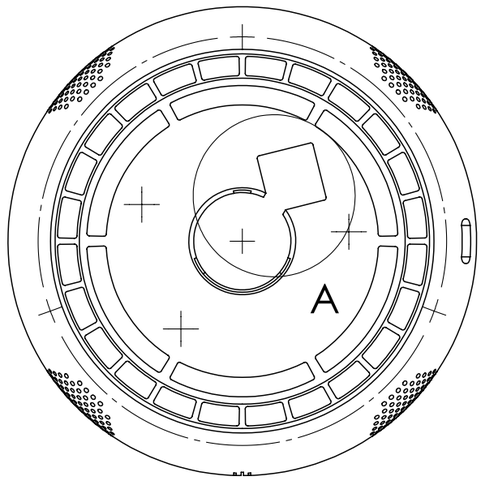
Q.A				MATERIAL: ABS		DWG NO. Speaker Mount	A3
						SCALE 4:1	SHEET 3 OF 3

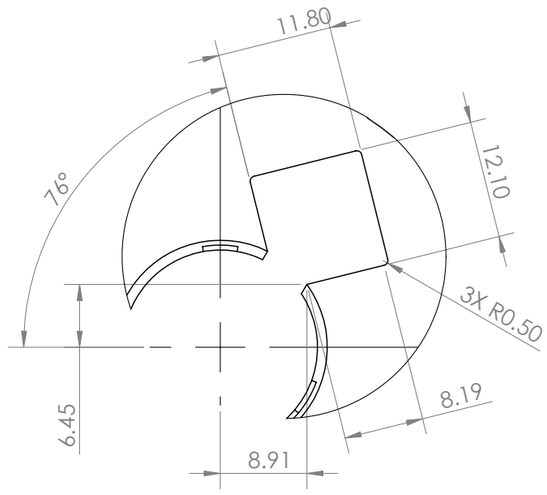




SECTION A-A

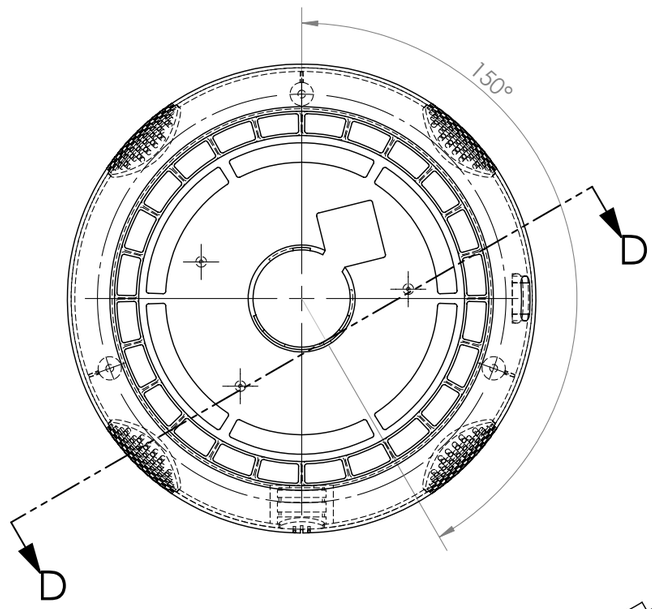
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING		DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			COMPANY: CASIO	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: ABS		DWG NO. Top Casing	A3
						SCALE:1:1	SHEET 1 OF 7

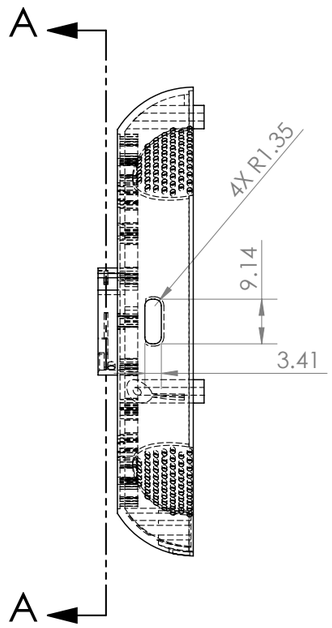


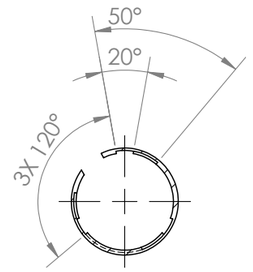


DETAIL A
SCALE 2 : 1

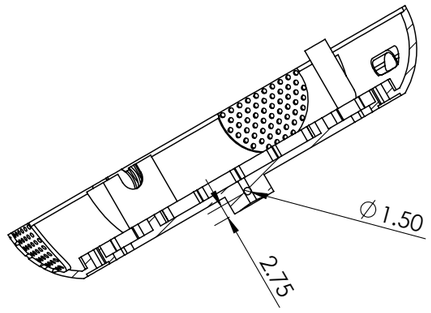
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			COMPANY: CASIO	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: ABS		DWG NO. Top Casing	A3
						SCALE:1:1	SHEET 2 OF 7





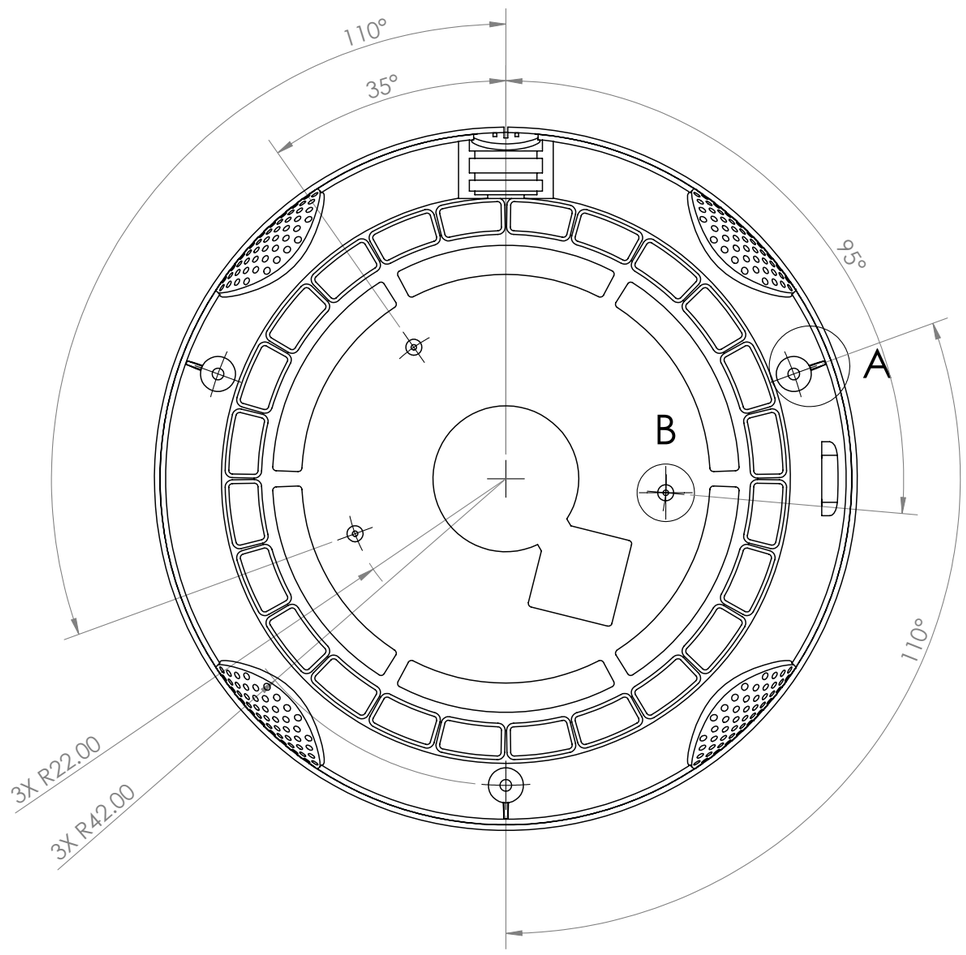


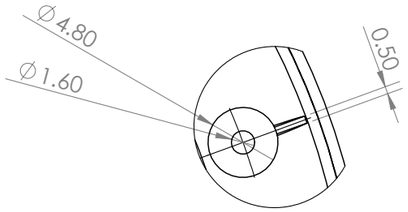
SECTION A-A



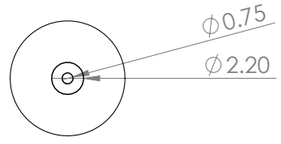
SECTION D-D

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			COMPANY: CASIO	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: ABS		DWG NO. Top Casing	A3
						SCALE:1:1	SHEET 3 OF 7



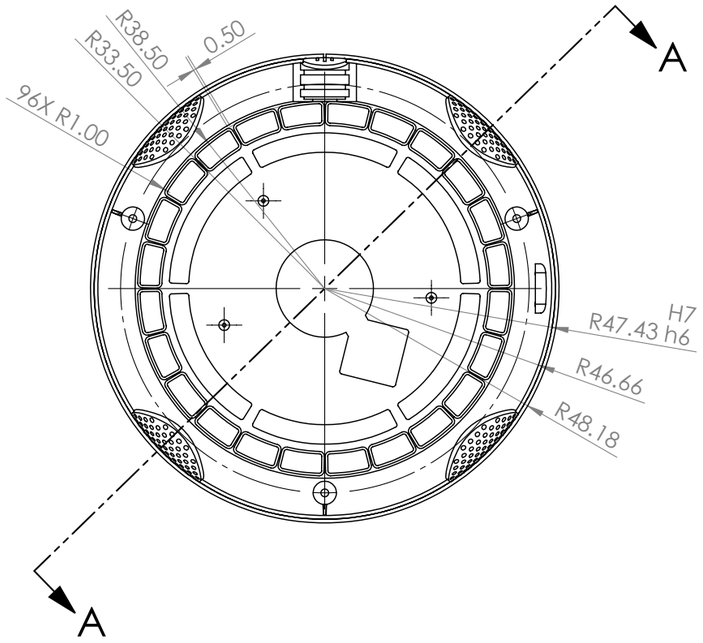


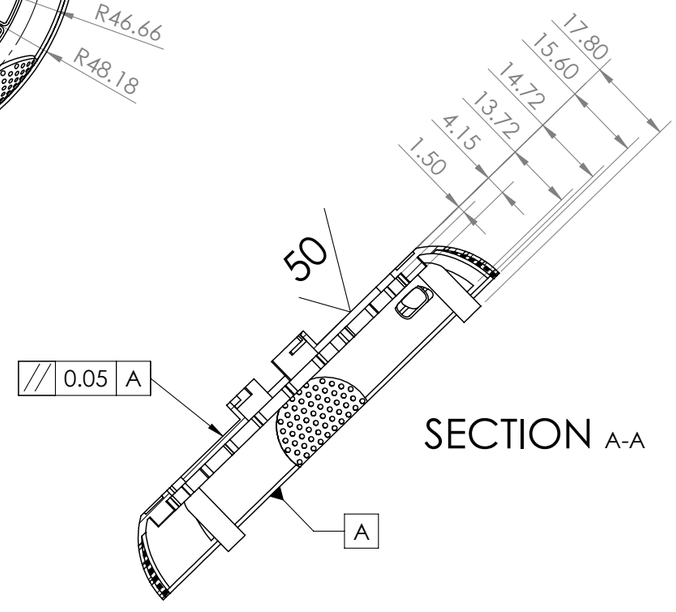
DETAIL A
SCALE 3 : 1



DETAIL B
SCALE 3 : 1

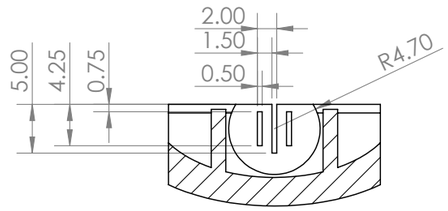
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING				DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING / REVISION
	NAME	SIGNATURE	DATE				COMPANY: CASIO
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: ABS			DWG NO. Top Casing / A3
							SCALE:3:2 / SHEET 4 OF 7



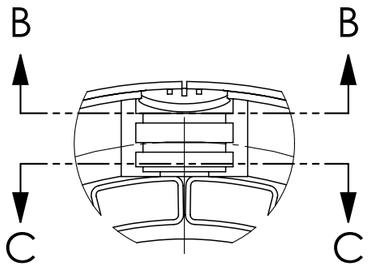


SECTION A-A

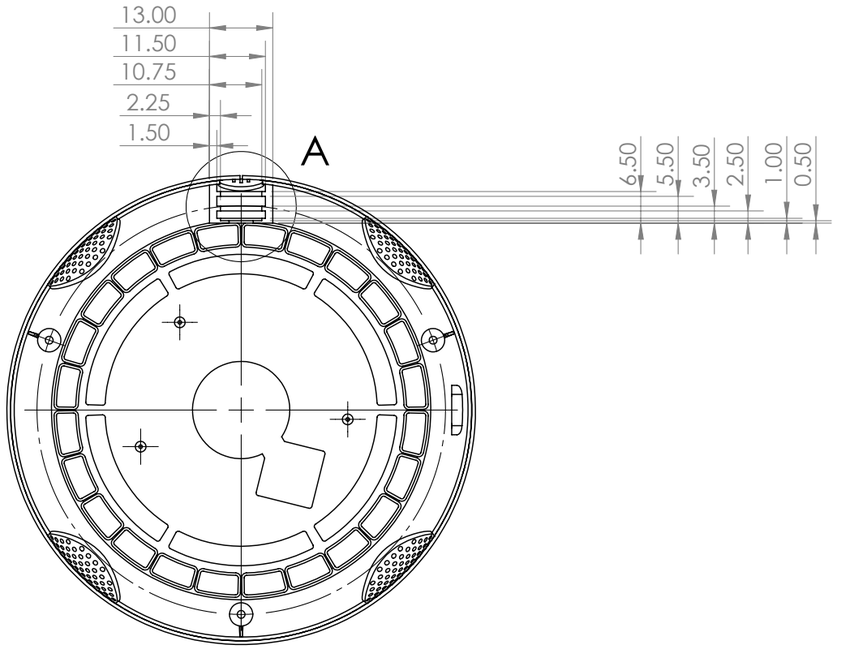
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			COMPANY: CASIO	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: ABS		DWG NO. Top Casing	A3
						SCALE:1:1	SHEET 5 of 7

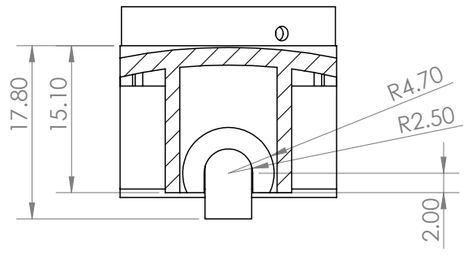


SECTION B-B
SCALE 2 : 1



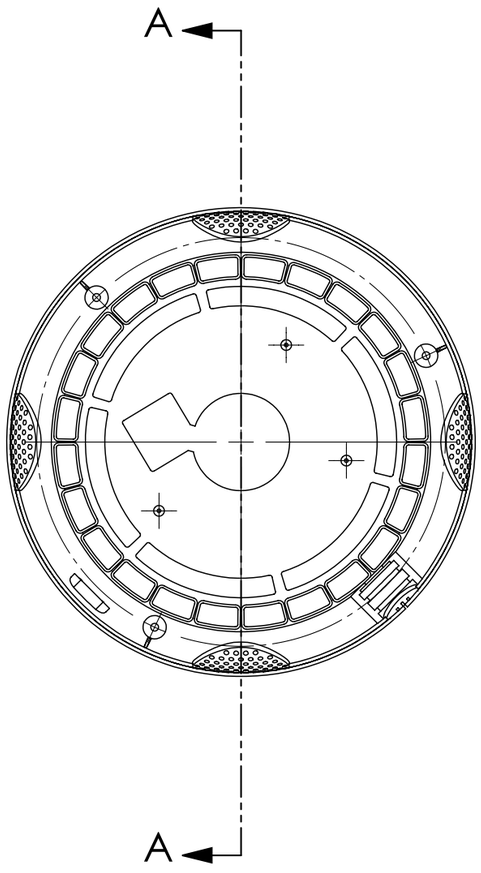
DETAIL A
SCALE 2 : 1



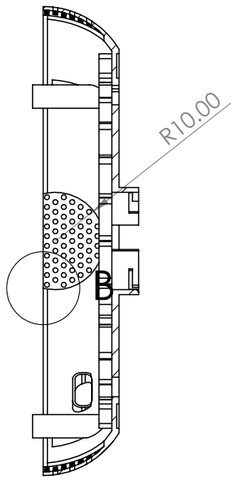


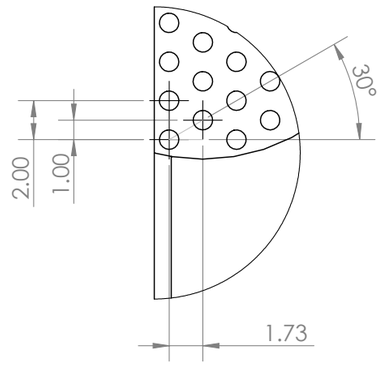
SECTION C-C
SCALE 2 : 1

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			COMPANY: CASIO	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: ABS		DWG NO. Top Casing	A3
						SCALE:1:1	SHEET 6 OF 7



SECTION A-A





DETAIL B
SCALE 4 : 1

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: SELF-FINISHING TOLERANCES: LINEAR: Class M - ISO 2786-1 ANGULAR: Class M - ISO 2786-1		FINISH: SELF-FINISHING			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			COMPANY: CASIO	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL ABS:		DWG NO. Top Casing	A3
						SCALE:1:1	SHEET 7 OF 7

APPENDIX EVIDENCE OF EMAIL CORRESPONDANCE

CASIO

CASIO COMPLIANCE

On 28 May 2020, at 13:16, Sales Mailbox <Sales@casio.co.uk> wrote:

Hi Seidler,

Thank you for your email.

We have forwarded your email to the Casio Divisions. Yes I can confirm that CASIO UK comply with all relevant EU directives and standards. All products can be exchanged by us to be safely disposed of to meet WEEE.

Kind Regards,

Minal

Casio Sales

How did I do?

Click on a face to provide feedback on my performance!

Casio Electronics Co. Ltd. Harp View, 12 Priestley Way, London, NW2 7JD

t: +44 (0)20 8208 9567 I e: sales@casio.co.uk I w: www.casio.co.uk

Opening Hours: Monday - Friday 9.00am - 5.00pm (excluding Bank Holidays)

Price and Availability are correct at the time of quote but subject to change without notice. This does not affect your statutory rights.

Please don't print this email unless you really need to.

COMPONENT PRICING CHECK

From: "BuyDisplay" <sales@buydisplay.com>
Subject: **RE: Contact Form**
Date: 13 June 2020 at 02:10:43 BST
To: <f.seidler@btinternet.com>
Reply-To: <sales@buydisplay.com>

Dear Frederick

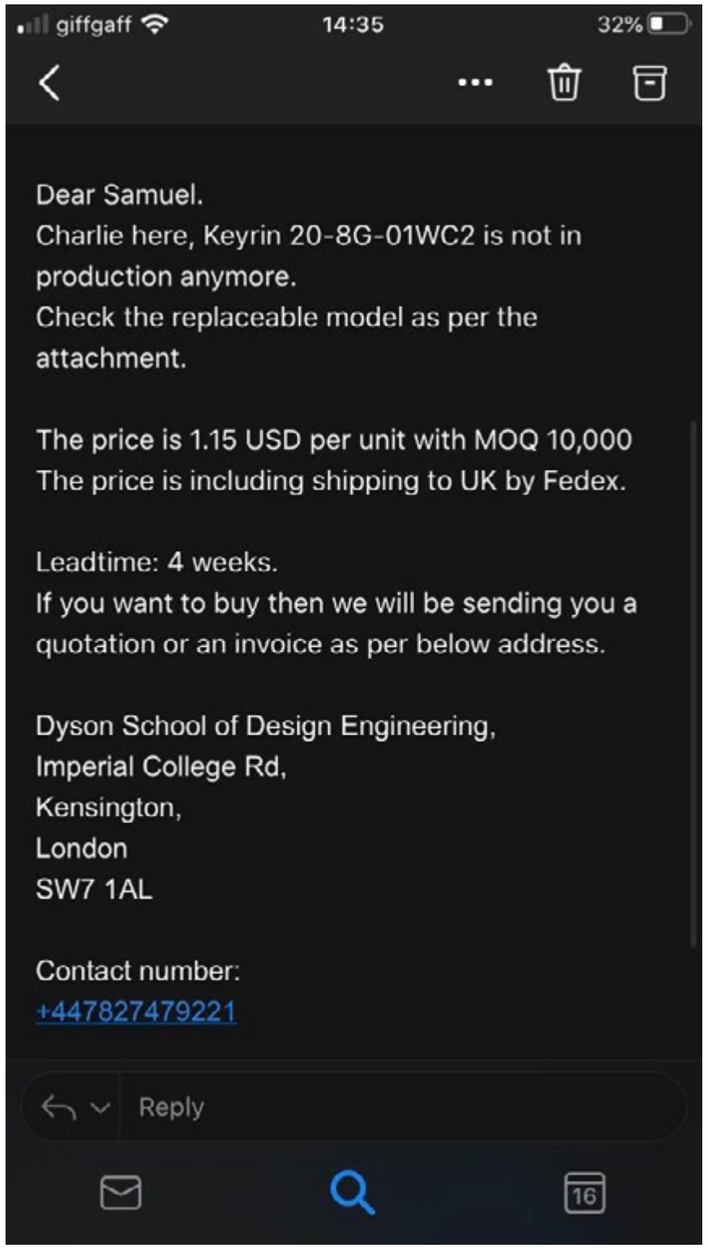
Nice to receive your email.Pls see the quotation below,the lead time for mass order is about 4~6 weeks.Pls offer the orders in advance.

The qty under 500pcs can be purchased on the website directly.You could pick up the goods to your shopping cart to check the price and shipping cost.

The samples and small orders would be shipped within 3 working days.Any other questions pls send me email.Thanks!!

Part Number	ER-TFT1.28-1		
1-499pcs	Please check the product link for price under 500pcs.		
500-999pcs	US$6.61	1K-1999pcs	US$6.39
2K-3999pcs	US$6.18	4K-4999pcs	US$5.97
5K-7999pcs	US$5.75	8K-10Kpcs	US$5.54

COMPONENT PRICING CHECK



REFERENCES

COMPLIANCE / BRAND / MATERIAL COSTS / PART COSTS

CASIO

BRAND RESEARCH

www.ultimateears.com/en-gb
www.logitech.com/en-gb
www.bang-olufsen.com/en
fabrikbrands.com/distinctively-danish-brands-bang-and-olufsen-story
wattintegration.com/bo-history
www.bang-olufsen.com/en/story/94-years-of-magic
world.casio.com/corporate/history/chronology
web.casio.com/emi/40th/history/ct-201.html
www.b2bmarketing.net/en-gb/resources/news/branding-news-casios-new-brand-positioning-may-shock-says-marketing-director
web.casio.com/file/csr/pdf/special05.pdf
www.a1-termpaper.com/topics/essay/brand-audit/8853965
music.casio.co.uk/blog/px-s1000-wins-2020-if-design-award-for-excellence
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world.casio.com/corporate/principle/charter
www.casio-music.com/euro/digitalpianos/grandhybrid/gp-510
world.casio.com/value

COMPLIANCE RESEARCH

www.rohsguide.com/rohs-faq.htm
ec.europa.eu/environment/waste/batteries
europa.eu/youreurope/business/product-requirements/labels-markings/ce-marking/index_en.htm
ec.europa.eu/growth/single-market/goods/building-blocks/conformity-assessment
eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:l21207
instrktiv.com/en/radio-equipment-directive
ec.europa.eu/growth/sectors/electrical-engineering/lvd-directive_en
www.sunfiretesting.com/CE-RED-Testing-Requirements
ec.europa.eu/growth/single-market/european-standards/harmonised-standards_en
bb.imperial.ac.uk/bbcswebdav/pid-1778377-dt-content-rid-6379053_1/courses/11037.201910/Shayan_GuestLecture_June20.pdf (*only accessible with an Imperial Blackboard account*)
world.casio.com/csr/environment/compliance
world.casio.com/media/csr/file/env_laws_regulations_2019_en.pdf
world.casio.com/csr/environment/plan_result

MATERIAL COSTS

https://www.apsx.com/product-p/apsx_pellet_nylon_blk.htm
https://www.sheetplastics.co.uk/2mm-clear-acrylic-sheet-cut-to-size.html
https://www.apsx.com/product-p/apsx_pellet_abs.htm

All links have been checked and are correct as of 15/06/20

COMPONENTS AND COMPONENT RESEARCH

www.buydisplay.com/1-28-inch-tft-lcd-display-240x240-round-circle-screen-for-smart-watch
www.buydisplay.com/1-28-inch-tft-lcd-display-240x240-round-circle-screen-for-smart-watch
uk.rs-online.com/web/p/miniature-speakers/1797441/
docs.rs-online.com/673f/0900766b8168e0df.pdf
www.mouser.co.uk/ProductDetail/PUI-Audio/AOM-6545L-R?qs=%252BDOaWfEBs1PWH8%2FoA11TG-g%3D%3D
www.hzhongyu.com/index.asp
www.alibaba.com/product-detail/with-a-push-switch-incremental-reel_60383580944.html?spm=a2700.details.deiletai6.1.11141f24eWAJBC
www.mouser.co.uk/ProductDetail/Microchip-Technology/RN4871-V-RM140?qs=BJlw7L4Cy79E5xvNxQ-64Jg==&vip=1&gclid=EAIaIQobChMIkvTyh8Lg6QIVxrTtCh3RgQc9EAYYAiABEgLxZ_D_BwE
www.tme.eu/gb/details/of-smd3528w/smd-white-leds/optoflash/
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www.mouser.co.uk/ProductDetail/CK/PTS526-SKG15-SMTR2-LFS?qs=UXgszm6BlbEc7nn5s4cd2Q%3D%3D
www.mouser.co.uk/datasheet/2/60/pts526-1651200.pdf
www.springmasters.com/product-category/compression-springs/wire-dia-015mm-5mm/
www.sourcingmap.com/100pcs-m2-8mm-stainless-steel-phillips-pan-round-head-self-tapping-screws-p-931485.html
uk.farnell.com/molex/105450-0101/usb-conn-3-1-usb-type-c-rcpt-surface/dp
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