TENDER/V1.0

TENDER DOCUMENT

MSc in Digital Systems Engineering

Department of Electronics

University of York

Group Project

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Introduction *(Matt Reynolds)*

BitVia is comprised of a small team of dedicated and experienced Digital Design Engineers. Each team member brings a unique background to the business, contributing to a diverse and powerful dynamic.

The team have experience in IC design and layout, digital systems design, embedded C, and project management. Their project deliveries to date have shown competence with the Xilinx Vivado toolchain, Keil μVision, and the Cadence suite. This multiple-disciplinary skill set is well suited to projects in the embedded systems arena.

Furthermore, not only do the team possess a strong set of technical skills, they have demonstrated a capability to deliver projects on time and to requirements. Between them they have delivered multiple projects over the last five years in various sectors including: aerospace and defence, consultancy, automotive, telecommunications, and academia. This success has also been achieved across three different countries: the UK, Italy, and China.

This is a fantastic opportunity for you to invest in a fast growing team of highly capable engineers with a wealth of experience and demonstrable successes. The product they are looking to bring to market is a desirable, low-cost HiFi recording system. Marketed at amateur musicians and hobbyists, market analysis has shown the desirability for such a product amongst the target audience. Its ease of use, high quality audio, and user-interface simplicity are key selling points. It allows anyone to develop and create music in a home or studio environment.

Implemented on a Xilinx Zynq xc7z020CLG484 SoC with custom board layout and a 3D printed package, this product is set to be a financial success. Packed with high quality audio effects and dual-line input and outputs, it enters the market as a versatile and well-crafted product. You will certainly see appreciable returns on this investment.

Requirements *(Simone Ledda)*

This is the table containing the given requirements for this project.

Explicit requirements

Table 1 - Product Requirements

No.	Requirement
1	Design and construct a media player.
2	Play at least one compressed music file format.
3	Include hardware accelerate algorithms.
4	Use a Xilinx Zynq AP-SoC.

Formative requirements

This table contains requirements that were implicit but necessary for this project.

Table 2 - Formative Requirements

No.	Requirement
1F	Project must be delivered on September 1st 2020
2F	User must be able to import and export music files via a USB mass storage device.
3F	The device needs to be powered up at max with a 12VDC 3A transformer
4F	The device must to be user-friendly

Specification *(Simone Ledda)*

The following table contains a description of how requirements are met. The last column identifies for each row which requirement is satisfied in the previous requirements tables.

Table 3 - Specification

No.	Specification	Comments	Satisfies Requirement:
1	Able to record media to a compressed audio format.	FLAC	2
2	Able to play compressed audio to dual-aux output.	FLAC and MP3	1, 2
3	Able to play and record audio simultaneously, through dual-input aux and dual-output aux.	User will be able to play over audio and record the output internally.	1, 3
4	The maximum system input-output delay time is 15 ms	This time interval is the worst-case scenario for the real-time audio system. The board may function with a reduced time latency according on the hardware accelerated algorithms implemented.	3,4
5	Provide multiple hardware accelerated digital audio effects in real-time.	Perform DSP on audio input and record this whilst outputting the file to dual-out aux. Hardware acceleration algorithm of digital effects takes place in the PL of the FPGA.	3, 4
6	Able to store up to 5 pre-sets on each input channel.	Pre-sets allow the user to easily switch between effects during recording.	1
7	Support a full-colour LED screen.	Main user interface. Select and edit effects, menu-based file system.	1
8	Provide controls for fine live adjustment.	6 pushbuttons: Volume+/-, EQ+/-, Gain+/-.	3

No.	Specification	Comments	Satisfies Requirement:
9	Provide controls for high-use functions.	4 Pushbuttons: Play, Pause, Record, Loop.	3
10	Allow user the option to edit effects using the main user interface (LED screen).	Signal: DSP ratio, Effect Level, Time Delays.	1
11	Support a range of acoustic effects commonly found in recording platforms.	Distortion, Compression, Reverb, Tremolo, Auto-wah, Octave±.	3
12	Power distribution from main DC power input	Input Voltage will be filtered through Electro Magnetic Interference filters and converted to the suitable voltage level through buck converters.	3F
13	RAM availability by the SoC	The RAM available for this device is the one provided by the SoC, no further Ram will be installed.	2,3
14	The device software will have multiple sub menus	Sub-menus will be presented to the user via display. Each sub-menu shows a multiple choice selection allowing the user to change settings and choose his/her own pre-sets.	4F
15	The user can navigate the menu with pushbuttons	5 pushbuttons (up, down, enter, left, right) will take the user input and navigate through the menu.	4F
16	Provide a file system for storing and playing audio files.	The file system is responsible for saving to the USB device and renaming audio records.	2F,4F
17	Language packs	The device will come in 3 different language packs Chinese, English, Italian. English is the default language. Language can be changed in the settings	4F
18	Support two input channels (microphone and instrument). 2x ¼ inch female jack	Allow recording of both channels simultaneously, from single control.	1
19	Support two output channels for media playback (simultaneous feed).	2x ¼” female aux.	2
20	FreeRTOS implemented on processing system of SoC.	This OS will handle memory management, interrupt handling and content displayed to the user.	1,3,2F

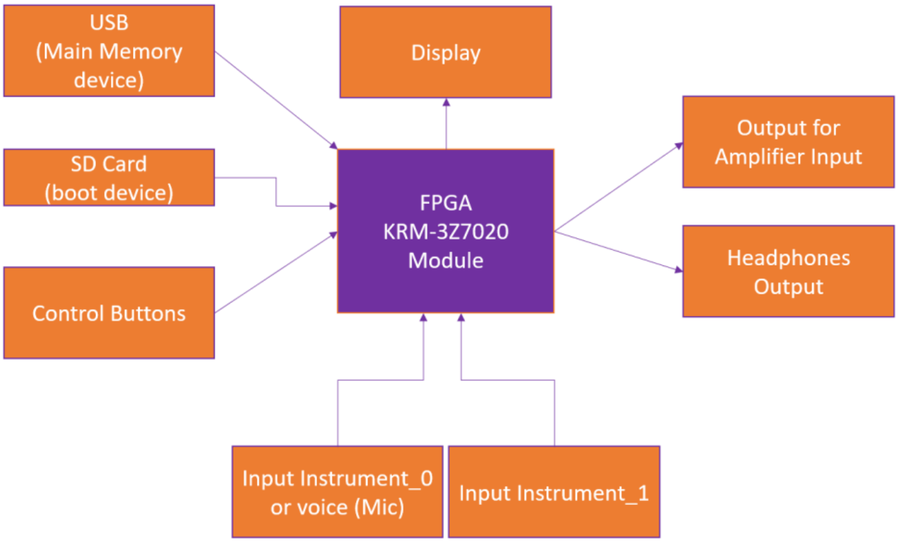

Figure 1 - Spec. Implementation Diagram

The Verification and Validation process will take place later on. This is a very delicate part of the project development and possibly the more challenging under many points of view.

Here are some definitions taken from *Verifying and validating software requirements and design specifications.* [1]

Verification is the process of determining whether or not the products of a given phase of the software development cycle fulfil the requirements established during the previous phase

Validation is he process of evaluating software at the end of the software development process to ensure compliance with software requirements.

Our main goal in this phase is to answer two questions as shown in Taylor's online slides.[2]

1- Are we building the product right? (Verification)
2- Are we building the right product? (Validation)

Our testing procedures are based upon a V&V Matrix with which we ensure to meet our requirements and specification. The matrix will be found in the final revision of the QAM for this project.

Device power up

The system will be powered by a 12VDC power supply capable of providing 3 A at peak power. The product will feature a mechanical power switch for on/off control of main current supply. When power is applied an LED indicator will display to the user the 'on' status. At power up, the user will be presented with a welcome screen featured on the LED display, following which the main menu is presented.

Working principle

At power up the user can choose between these menu options: playing a record from a USB drive, recording a new record live or changing settings. The main functions of the product can be summarised as:

- Allows music records to be recorded in FLAC.
- Supports MP3 playback from a USB drive.
- Provides two input ports for live instrument recording.

The user can plug in the output of his/her instrument, or microphone, and start recording when ready by pressing the record button. The red LED will light up and the recording mode is entered. The recording process can be stopped by pressing the record button again. When stopping, the file is automatically saved. Since the board comes with no speaker, two outputs are provided. One with a classic 3.5mm headphones jack and a ¼" instrumental jack. Both outputs share the same data line, so there is no difference in content, it's just a form factor to empower the user to plug in headphones or a jack for an amplifier.

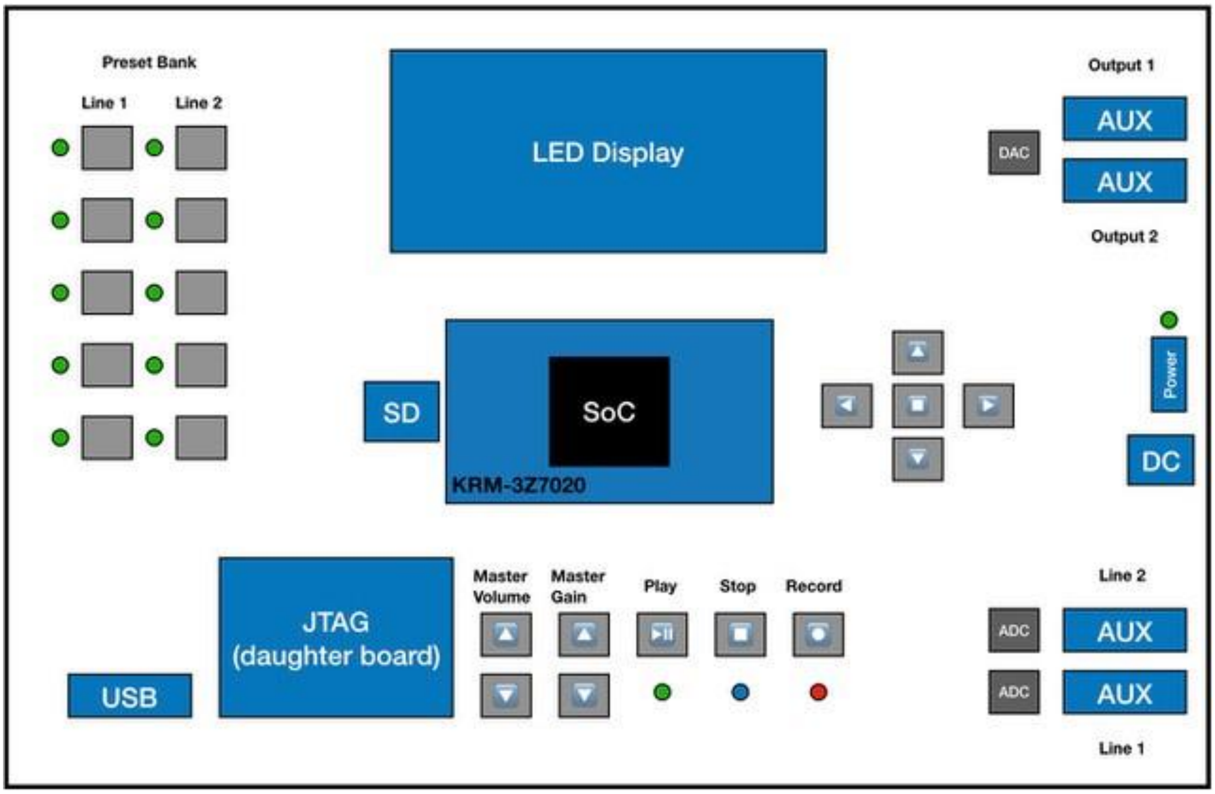

Figure 2 - High-level board layout

The board comes with a pre-fixed set of effects and functions mapped with the pushbuttons map. The user can customize the effects and save them. Effects can be enabled/disabled at any moment in time and will be added to the live input playing record. The selected pre-set will light up the corresponding LED green light. Multiple pre-sets can be called for the same recording. It is not possible to apply the effects on saved files. This feature is to keep the recording system easy for the user, i.e. if the file being played is a drumbeat for a guitar solo and the user is playing the solo live, the effects will apply only on the guitar instead of on the drum beat too. This said at the output channels the user will hear the complete melody in real time.

The pre-sets can be edited and saved via sub-menus in the software so that the user can save the pre-set configuration he/she likes the best and have it handy. There is a maximum of 10 pre-sets the user can customize, and a maximum of 5 pre-sets per input channel.

Volume and gain plus and minus arrow keys are present on the board. This allows the user to increment or decrement the volume of the track being played as with analogue or, increment or decrement the gain from the input channels. Higher gain values will result in distortion.

The micro SD card is used for booting purposes. It’s not meant to be removed by the user since the board cannot function without it. The user can plug in a USB pen drive to play/save music records.

Implementation *(Gavin Johnston)*

The device will be implemented on a custom, 4-layer PCB board with a Xilinx Zynq xc7c020CLG484 SoC. The board will boot from a removeable SD card which will also act as mass storage from recorded files. The board will feature 3.5mm jacks for input and output to allow compatibility with musical instruments and speaker amplifiers and an additional 2.5mm output jack for headphones. Each input channel will run through an Analogue to Digital Converter (ADC) to digitise the signal for processing and through a Digital to Analogue Converter (DAC) so it can be played through a speaker or headphones.

The digital effects will be encoded into the FPGA fabric on the Zynq chip. This will provide hardware acceleration to reduce the latency of the effects processing, returning the signal before the user notices the delay. This will be implemented using VHDL in the Vivado toolchain.

The UI will be solely implemented in software booting from the SD card. Here we will provide a menu to allow the user to select, configure and assign a group of effects to each button in the effects bank; load audio files from the SD card to record on top of and to handle button the compression and the saving of the audio file. This will be written in C using the Xilinx SDK for their SoC packages.

Down Selection *(Gavin Johnston)*

Originally the team set out to make a device whose main function was to decode and play MP3 players. The team decided that the market was oversaturated with these devices and could not agree on any unique selling points for this kind of device, therefore it was decided to design a recording and playing device which would satisfy the requirements, provide additional value and fill a gap in the market for hardware-based amateur recording systems.

A USB boot and mass storage drive was considered due to the prevalence and low-cost of the standard however, due to the USBs large form factor and users tendency to damage USB sockets when removing and inserting devices, it was replaced with a SD card. It was additionally noted that SD to USB converters are plentiful in the consumer market therefore clients without SD card sockets on their home PC are not excluded from access to the storage.

Additional input lines were considered, i.e. 4 inputs, to support multiple instruments musicians simultaneously, e.g. a band. This would have required a jack, an ADC and an effects bank, to be implemented on the board for each input line. This was considered too complex for the scope of the project and too many components to place and route on the board. The team has decided to implement two input lines with the ability to record on top of previously recorded audio, i.e. a backing track and drub beat, this will allow users to create an audio track with multiple instruments, recording the instruments one or two at a time.

An analogue gain stage before ADC of the inputs and after the DAC of the output, were to be used to control volume of the induvial inputs and the output respectively. It was later decided that the signal processing should be purely digital to reduce the implementation complicity.

Silicone push buttons which would light up when selected was envisioned for the effect banks and rotary encoders were to be used to control the level of the active effects. These were cut from design as they are not available in the parts list provided.

A touchscreen was considered to improve users experience and simplify menu navigation. This was removed as the number of lines required to control the touchscreen module would make implementation difficult.

Future Development *(Matt Reynolds)*

Following a successful product launch and prototype, the project team would like to see several areas of future development occur. This is to introduce a comprehensive product line to an established customer base. With successive models including features such as increased memory capacity, more diverse output capability, and a higher number of inputs for extended track layering.

In addition to added hardware features for future releases, the team have conceptualised additional software features for the current release, beyond the proposed specification. Should the project be on track for completion ahead of the proposed schedule, the additional features can be implemented to increase the product's value. Since time to market is fixed with the given product release, any surplus time can be used to implement the proposed ideas, which should see a greater return on investment than releasing the product ahead of schedule.

At the time of document release the proposed additional features include:

- Media-synchronised visual effects output to the LED screen.
- A greater suite of effects with higher data throughput for increased audio quality.
  - Reverb presets (Hall, Church, Large Room, Basement, etc.).
  - Modelling presets (Fender Deluxe, Vox VC30, Marshall Valvestate, etc.).
  - Overdrive.
  - Anti-aliasing.
  - Qualitative adjustments: Warmth, Harshness, Space, Overtones.
  - Dual octave.
- Capacitive touch screen.
- Menu animations.
- Increased editing controls.

Nearly all of these additional features focus on SoC implemented developments, which means that the alterations can take place post board manufacture. This is important when considering development time and has an effect on determining when the final decision date to add them in occurs. Any additional features added will be offered to the investors for review prior to implementation. Ultimately the project team will still be responsible for delivering to the deadline agreed regardless of any extra specifications included beyond the initial project agreements.

Market Analysis *(Pengan Wang)*

Market Overview

Looking at the entire Home Recording Device market, although the profitability of portable products is somewhat reduced compared to the previous decade, it is still in the development stage of product segmentation. Our company's target markets are mainly the UK, China and Italy. Since there are many mobile apps that can help people realize the function of music production, there are few similar products on the market.[3]

From a technical perspective, many Home Recording Device vendors have made many attempts to expand the product functions in history. Ever since July 1877, Thomas Edison invented the first phonograph, then records have come into common families' lives since 1902. Behind, tape recordings were released in 1935.[4] In early 1990, the multitrack digital recorders are used by a lot of families and the studio, digital recording began to provide people with high fidelity, multi-function recording experience. Nowadays, people prefer to buy the Home Recording Device with more comprehensive functions at a lower price. Therefore, people have to choose high-priced products from high-end brands to meet their needs. For example, in the last product in Table 4, the price of 800 pounds is hard for many people to accept.[5]

In terms of appearance, Home Recording Device merchants have put a lot of effort into this. There are more and more Home Recording Devices that are stylish and easy to operate, but there are still many merchants who use the successful design solutions of other Music Maker merchants. For instance, products with the same function and effect are sold under different covers and brands.

From a price point of view, although some Home Recording Device products have undergone several rounds of price reductions. For example, the price of the Alesis ADAT recorder is £3499 in 1992, even the price of the Tascam MSR24 recorder is £8395 in 1989, although these machines are highly specialized, their price is beyond anyone's expectation. Now, decades later, with advances in materials and technology, the prices of these products have dropped to levels similar to those in Table 4.

At present, consumers have different requirements for Home Recording Devices. High-end Home Recording Devices are welcomed by professional music industries and recording artists with high purchasing power, these people required professional products and configurations, each function is professional level. In addition, some consumers with weak purchasing power, they are more hope to get an integrated multi-functional product. Our company wants to provide these families and small studios with the products they need and sell our products around the world.

Analysis of similar products

Table 4 - Similar devices to the proposed product

Product type	Product name	Price	Source
Multi FX pedals	Zoom B3n Effects and Amp Simulator Pedal	£145.	gear4music.com
	NUX MG-20 multi-effects pedal	£149.	bax-shop.co.uk
	BOSS GT-1 Guitar Effects Processor	£142.	muziker.co.uk
	BOSS GT-001 Desktop Guitar Multi FX Processor	£193.	andertons.co.uk
Multi track recorders	Tascam DP-006 Digital Recorder	£115.78.	amazon.co.uk
	BOSS BR-800 Digital Recording	£317.	gear4music.com
	Zoom R8 - 8 Track Recorder and Audio Interface	£229.	bax-shop.co.uk
	Roland R-44E 4 Channel Compact Portable Field Recorder	£799.	gear4music.com

Zoom B3n Effects and Amp Simulator Pedal.[6]

Features and Functions:

- 99 effects.
- 3 backlit LCDs.
- 50 factory preset.
- Auto Save function.
- 41 built-in rhythm patterns
- Dual output jacks for connection to amps or headphones.
- USB port for bus power and firmware updates

NUX MG-20 multi-effects pedal.[7]

Feature and Function:

- More than 60 models.
- Drum Machine and looper.
- USB for System Update.
- Different Output Modes.
- 36 factory preset.

BOSS GT-1 Guitar Effects Processor.[8]

Feature and Function:

- Easy Select and Easy Edit functions.
- Can use four AA batteries to provide power.
- Onboard control switch and expression pedal.
- Footswitch/expression pedal jack and USB.

BOSS GT-001 Desktop Guitar Multi FX Processor.[9]

Feature and Function:

- COSM amp models and powerful MDP effects.
- Multi-channel USB audio/MIDI interface.
- Powered by USB bus or included AC adapter.
- Jack for connecting an expression pedal.
- 1/8-inch input for connecting a stereo device.
- XLR mic input.

Tascam DP-006 Digital Recorder.[10]

Feature and Function:

- 4GB SD card.
- Backup and restore songs.
- USB2.0 connection.
- Chromatic tuner and metronome.
- UNDO/REDO function.
- Direct locate function by jog-wheel.
- Repeat playback between IN/OUT point.

BOSS BR-800 Digital Recording.[11]

Feature and Function:

- SD Card.
- Powered by six AA batteries/USB/AC adaptor.
- Stereo condenser microphone.
- Drum machine with editor software.
- 4-track simultaneous recording.
- 8-track simultaneous playback.

Zoom R8 - 8 Track Recorder and Audio Interface.[12]

Feature and Function:

- 8-track playback, 2-track simultaneous recording.
- Stereo condenser microphones.
- Records to SD and SDHC cards.
- Dual balanced ¼" TRS output jacks.
- Headphone output with dedicated volume control.
- Metronome and chromatic tuner.
- Variable playback speed.
- 160 drum and percussion sounds.
- 2-in/2-out USB audio interface for PC/Mac computers.
- Powered by 4 AA batteries/USB/AC adaptor.

Roland R-44E 4 Channel Compact Portable Field Recorder.[13]

Feature and Function:

- Solid-state recording to SD & SDHC cards.

- Record 8-channels.
- Four channels recording.
- Stereo microphones and monitor speakers.
- Limiter, low-cut filter.
- Pre-Record function.
- Combo type analogue jacks.

Market demand

Transparency Market Research (TMR) reported that the global market for digital recorders could grow from $1.15bn in 2017 to $1.91bn in 2022. This is a big market, as long as our products are competitive enough to attract consumers, we can put our products on the market.

Estimate product life cycle and time to market

Our products in five years will not have quality problems with normal use. During this period, if any problems occur in the product itself, consumers can return the product to the factory for free repair.

Our company plans to bring our first-generation products to market by the end of 2020, after which we will upgrade the products according to the needs of consumers.

Product Sell Channel

We plan to sell our products in three countries: The UK, Italy and China. The UK will be our first country of sale. We will promote our products on social media and then put them on different e-commerce platforms, such as Amazon and Alibaba.

Market Analysis Summary

From the above analysis of similar products, we can see that the cost of materials alone (£314.44, see Finance Analysis) is higher than the selling price of other similar products. However, our products are not portable devices, our unique selling point is we are taking DSP functionality and merging it with recording functionality. We want to sell our products to people who want to make their own music in at home and in amateur studios.

Our Product Features:

- Play and record audio simultaneously, through dual-input aux and dual-output aux.
- Multiple hardware accelerated digital audio effects in real-time.
- A full-colour LED screen.
- The device software will have multiple sub-menus.
- Language packs: come in 3 different language packs Chinese, English, Italian.
- Two input channels (microphone and instrument).
- The pre-sets can be edited and saved via sub-menus in the software
- The micro SD card is used for booting purposes.
- The user can plug in a USB pen drive to play/save music records.

Finance Analysis *(Pengan Wang)*

Cost Estimate

Fixed costs (does not change as long as sales)

Table 5 - Estimated labour costs

Name	Work time/month(hour)	Salary(£)
Matt	80	4000
Simon	80	4000
Gavin	80	4000
Pengan	80	4000
	Total Cost	16000

Table 6 - Estimated office resource costs

Equipment type	Quantity	Brand	Cost(£)
Computer	4	Windows OS machine with Intel core I7 + 16GB RAM	1499/unit
Tables	4	Dripex	56.99./unit
Chairs	4	Dripex	59.99./unit
Software	4	Microsoft Office	135/unit
Hardware	1	Xilinx Development Kit (Zedboard + cables)	350
		Total Cost	~7355

Table 7 - Estimated operating costs

Cost type	Computing Unit	Cost(£)
Bills	Monthly	100
House rent	Monthly	500
	Total Cost	600

These cost estimates show that our initial start-up costs will be **£7355** and our combined monthly costs will be **£16600**.

Variable costs (which are related to sales)

Quantity	Description	Manufacturer	Cost	Sum Cost
var	Resistor	Multicomp	£25	£25
var	Capacitor	Multicomp		
var	Ferrite Bead 600 ohm SMT 0805 [2012]	TDK	£0.10	£0.10
1	KRM-3Z7020 Module	XILINX	£155.64	£155.64
1	USB2.0 FS TO BASIC UART, SMT	FTDI	£1.67	£1.67
3	Audio Codec, low power stereo 96kps	Analog Devices	£5.12 / unit	£15.36
1	LDO Linear Regulator 2.5-5.5V input Fixed 3.3V 300mA Output	Microchip	£0.09	£0.09
16	LED - GREEN 50mcd 570nm, SMT	Kingbright	£0.12 /unit	£1.92
1	LED - RED 20mcd 625nm, SMT	Kingbright	£0.13	£1.65
1	LED - BLUE 80mcd 470nm, SMT	Kingbright	£0.30	£1.50
1	LOW VOLTAGE SOCKET, 12V 5A, 2.00mm TIP	Multicomp	£0.60	£3.00
1	micro SD carrier	Amphenol	£0.90	£0.90
1	MINI USB 2.0 TYPE B, RECEPTACLE, SMT	FCI	£0.57	£0.57
1	3.5mm surface mount stereo jack socket	Switchcraft	£0.91	£0.91
3	¼” female aux	RSPRO	£2.34 / unit	£7.02
15	MOSFET N-CHANNEL 50V 200mA, SMT	On Semiconductor	£0.13 / unit	£1.95
1	MULTIFUSE 3A/6A 6V PTC RESETTABLE	Bourns	£0.52	£0.52
2	DC/DC Converter 3A	MuRata	£4.80	£9.60
1	Switching Voltage Regulators 4.5-V to 17-V input, 10-A step-down converter	Texas Instruments	£3.6	£3.6
1	High Resolution TFT Display	Pimoroni	£35.4	£35.4
1	JTAG PROGRAMMING MODULE (200-251)	Digilent	£37.93	£37.93
1	CRYSTAL 25MHz 18pF 50ppm, SMT 7mm x 5mm	Abracon	£0.65	£0.65
22	Pushbuttons	Alps	£0.43	£9.46
			Total Cost	**£314.44**

Set price at £499.

Total cost (one year) = Fixed costs + Variable costs ≈ £206 555

Profit estimate

Breakeven point

Total cost = Fixed costs + Total variable costs = Sales unit*Price

The sales must be greater than breakeven point so that business can stay in operating.

Set the price of our Product at £499.

If breakeven, the company needs to sell 1,120 units of products at £499 a year.

Consider the tax

Profit = (Revenue – Total cost)*(1 – Tax rate 20%)

If breakeven, the company needs to sell 2437 units of products at £499 a year.

To make the company profitable, the company needs to sell more products than it needs to breakeven.

Cost-reduction opportunities

Economies of scale

As long as the scale of business growth the fixed costs would reduce. As time goes on, our company will recruit more technicians and expand the scale of production to reduce the cost.

Material cost

With the increase in market demand, the production of our company will also increase. At the same time, the raw material company will sell the components to our company at a lower price, thus achieving the purpose of reducing the cost.

Production cost

Our company plans to update its products on the market every year, which means introducing a new generation of products with more features and features to consumers. At the same time, our company will optimise product design to reduce production costs.

Sources of finance

- Venture Capital(Angel investment): A financing method that supports venture companies and acquires shares in the company. Our company product function is complete, and the target consumer is clear so that we can achieve profitability in the short term. Therefore, give up a part of the equity to start the company quickly is a very good choice.
- Business Loan: A bank loan is a good choice for a new company like our company. It is a safe and reliable source of finance, our company only needs to bear a low risk. To get this source of finance, our company has to pay some interest. In addition, the government will have beneficial loan terms for students to start businesses,
- Asset Finance: Asset financing can meet short and medium to long term funding needs with small and medium enterprises' own assets. Our company is a student start-up company and does not have the asset credit to attract this kind of financing. Therefore, our company is not suitable for this source of finance.

Financial management mechanisms

The company's financial management mechanism is very important for the company's operation and development. Therefore, our company has drawn up the following plan to manage the company's financial.

- Set up the financial department, hire professional financial management personnel to record the company's income and expenses.
- Set up a financial supervision group, by the company vote elected financial supervisors to supervise the company's finances.
- Maintain the company's financial security through external supervision. For example, an audit firm is entrusted to audit the company's financial affairs every year.

Project Development *(Matt Reynolds)*

High-Level Project Gantt Chart:

WBS	TASK	START	END	DAYS	Weeks	% DONE	WORK DAYS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	Requirements Analysis	13/01/2020	11/02/2020	30	4	50%	22									
2	System Design	20/03/2020	02/04/2020	14	2	0%	10									
3	Architecture Design	06/04/2020	19/04/2020	14	2	0%	10									
4	Module Design	20/04/2020	10/05/2020	21	3	0%	15									
5	Coding	11/05/2020	21/06/2020	42	6	0%	30									
6	Unit Testing	11/05/2020	05/07/2020	56	8	0%	40									
7	Integration Testing	22/06/2020	19/07/2020	28	4	0%	20									
8	System Testing	20/07/2020	24/08/2020	36	5	0%	26									
9	Acceptance Testing	24/08/2020	30/08/2020	7	1	0%	5									
10	Final Delivery	01/09/2020	01/09/2020	1	0	0%	1									

The Gantt Chart provided within this section is a high-level time schedule based on the V-Model that the project team are implementing. This is to provide an easily viewable overview of the tasking required to carry out the project. However, a more detailed work breakdown structure is available upon request. Work days are defined as days which fall on a weekday (Monday – Friday) and contribute to single-person hours. i.e. Providing equal skillsets are maintained, two staff members may complete a 4 working days task in 2 days. However, given the small size of the project team it is likely that the project plan will accurately reflect the number of work days with regards to single-person hours, as there will unlikely be sufficient resource to further breakdown tasks.

Estimations based on previous project experience have been provided to determine the length of certain tasks. There is a small gap of work between mid-February and mid-March, as the project team will be focussed on other deadlines at this time. Although small tasks may be able to be carried out during this period should the project require.

Milestones such as document submission, board manufacture, and working prototypes will be added to the detailed version of the plan.

Each stage of the project development follows the V-Model process and can be summarised as:

- Requirements analysis – Documenting explicit and implicit requirements, agreeing them with the customer, and developing a product specification that meets these requirements.
- System design – Defining the system level components, interface protocols, and system test strategies.
- Architecture designs – High level design that defines what aspects of the product will be implemented in software and hardware.
- Module design – Low level component design, documenting intra-SoC communications between PL and PS, defining packet structures, clock speeds, and flow of operations. Component level testing strategy developed.
- Coding – Implementation of the design stages.

- Unit testing – Execution of the component testing strategy, followed by iterative redesign of any failures or optimisations required.
- Integration testing – Test for communication and cooperation between the programmable logic and the processing system. Sees that peripherals are functioning as specified and meets the design requirements.
- System testing – Tests SoC interfaces with all other board level components. Full hardware test and product power-on.
- Acceptance testing – Performing test vectors on final prototype product, similar to Beta testing. Preparing product to ship and identifying any unidentified faults in user operation.
- Final delivery – Delivery of the product to the customer.

Quality Assurance *(Gavin Johnston)*

Quality Assurance is important to BitVia, we therefore have several methods to ensure that the device is developed to a high standard and quality can be proven.

We are following the V-Model methodology of development which allows testing and verification against specification at every level of abstraction of the device allowing us to verify functionality and correctness quickly and efficiently.

Each manager has identified Quality Assurance Metrics in our Quality Assurance Manual. We will use these metrics to evaluate the quality of our product and identify areas which require more work. Examples of these metrics include the number of test reports produced compared to number of reports expected, device maximum operating frequency and deadlines met verses deadlines missed.

Standardised document formats will be provided to managers for compilation reports, test reports and other common reports, standardised formats ensure all important data is captured and aids readability.

Review meetings will be held with all managers to discuss the status of the project on a regular basis and at certain milestones. Here any progress or shortcomings within development will be discussed and staff may be reassigned to assist of slow development areas.

Risk Management *(Pengan Wang)*

Risk management is the activity of identifying and analysing project risks and taking countermeasures.

Risk Identification

For the BitVia company, We can clearly identify the risks in the software and hardware design, testing, integration and market entry phases and find solutions in time.

For this reason, the company has set up a risk management team to identify and solve the risks in each stage of product production and sales.

Risk Evaluation

“Home Recording Device” is the project that the company needs to do risk management. For the risks in the product development and sales phase, the company has set up Software Manager, Hardware Manager, Design & Specification Manager, Testing & Integration Manager, Finance Manager and Marketing Manager to evaluate the risks in each phase. A quality assurance team was set up to ensure the overall quality of the project.

Risk Control

To control the risk, each manager of the company will formulate risk coping strategies for the risks that may arise in the stage for which he is responsible, and take countermeasures when or after the risks are about to occur, so as to ensure that the overall development of the project will not be affected.

Risk Monitoring

During the project of "Home Recording Device", project managers need to monitor all risks. No matter whether this risk occurs or not, the project managers need to ensure that they can deal with the risks in the first time. The group leader needs to monitor the risks of the whole project.

Risk Analysis

Table 8 - Risk Analysis

Source of Risk	Risk Impact	Severity	Risk Handler
Design & Specification development period	The whole project will not work, and the subsequent development will be in the wrong direction.	10	Design & Specification Manager
Software development period	The function of the product can not achieve the desired effect.	8	Software Manager
Hardware development period	The producted product can not perform the functions designed by software .	8	Hardware Manager
Testing & Integration development period	Determines whether the product can be put into production.	7	Testing & Integration Manager
Market management period	Products can not survive in the market. Lack of market competitiveness.	6	Marketing Manager
Financial management period	The company's balance sheet is fuzzy, and even continue loss.	6	Finance Manager

**1 represents the lowest risk severity,10 represents the highest risk severity. Priority should be given to those with high-risk severity.*

In addition, the Group Leader needs to divide responsibility for the risks occurring in the whole project and supervise the risk management of the whole team.

Contact Details *(Matt Reynolds)*

To contact the project team please visit their website: https://dsebale.wordpress.com

Alternatively, they can be contacted via:

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York
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Technical Overview *(Simone Ledda)*

The following table is a draft of the necessary components for this project.

Item #	Quantity	Category	Description	Manufacturer	Manufacturer Part No.
1	var	Resistor	Resistor	Multicomp	MCWR06XvvvvFTL
2	var	Capacitor	Capacitor	Multicomp	
3	var	Ferrite	Ferrite Bead 600 ohm SMT 0805 [2012]	TDK	MPZ2012S601AT
4	1	FPGA	KRM-3Z7020 Module	XILINX	KRM-3Z7020
5	1	IC	USB2.0 FS TO BASIC UART, SMT	FTDI	FT230XS
6	3	IC	Audio Codec, low power stereo 96kps	Analog Devices	SSM2603CPZ
7	1	IC	LDO Linear Regulator 2.5-5.5V input Fixed 3.3V 300mA Output	Microchip	MIC5504-3.3YM5-TR
8	16	LED	LED - GREEN 50mcd 570nm, SMT	Kingbright	KPHCM-2012CGCK
9	1	LED	LED - RED 20mcd 625nm, SMT	Kingbright	KPHCM-2012EC-T
10	1	LED	LED - BLUE 80mcd 470nm, SMT	Kingbright	KPHCM-2012PBC-A
11	1	Connector	LOW VOLTAGE SOCKET, 12V 5A, 2.00mm TIP	Multicomp	MJ-179PH
12	1	Connector	micro SD carrier	Amphenol	114-00841-68
13	1	Connector	MINI USB 2.0 TYPE B, RECEPTACLE, SMT	FCI	10033526-N3212MLF
14	1	Connector	3.5mm surface mount stereo jack socket	Switchcraft	35RASMT4BHNTRX
15	3	Connector	¼” female aux	RSPRO	M223-RS
16	15	Transistor	MOSFET N-CHANNEL 50V 200mA, SMT	On Semiconductor	BSS138LT1G

Item #	Quantity	Category	Description	Manufacturer	Manufacturer Part No.
17	1	Miscellaneous	MULTIFUSE 3A/6A 6V PTC RESETTABLE	Bourns	MF-SM300-2
18	2	Miscellaneous	DC/DC Converter 3A	MuRata	OKY-T/3-W5N-C
19	1	Miscellaneous	Switching Voltage Regulators 4.5-V to 17-V input, 10-A step-down converter	Texas Instruments	TPS54A24RTWR
20	1	Miscellaneous	High Resolution TFT Display	Pimoroni	PIM369
21	1	Miscellaneous	JTAG PROGRAMMING MODULE (200-251)	Digilent	JTAG-SMT2
22	1	Miscellaneous	CRYSTAL 25MHz 18pF 50ppm, SMT 7mm x 5mm	Abracon	ABMM-25.000MHZ-B2-T
23	22	Miscellaneous	Pushbuttons	Alps	SKQGABE010

Power Distribution Network

The board is meant to be powerful and fast. These two concepts are in contrast with small power consumption. The maximum power the KRM-3Z7020 module can draw is 6A @ 3.3V = 20W.
Assuming 20 LEDs on at the same time and each one of them consuming a current of 50mA circa the total power consumption related to LED is 1-2W circa.
Other IC on the board have limited power consumption, therefore we can confidently margin their contribution with 10W.
The total power draw is therefore 32W circa. The suitable power supply for this device should be a 12V 3A supplier.
The power coming from the transformer is converted through a buck converter from Texas Instruments down to 5V.
5V are fed into the 2 MuRata DC/DC converter to step the voltage down to 3.3V. Each MuRata DC/DC converter provides a maximum current output of 3A, for this reason we are using 2. This power source will be responsible for the power supply of the KRM-3Z7020 Module.
The LDO converter takes the 5V input and provides the power supply for the LED display.

SoC Functional Description

Among the SoC required in this project there is of course the FPGA (KRM-3Z7020 Module). The FPGA comes as a daughterboard with two ram banks already available on top of it. The main elements for its functioning are already in place such as the quartz crystal and the capacitors.

Another interesting and useful module required is the JTAG programming interface. This device is necessary for debugging and programming. The user can discard its functioning.

ADC/DAC are IC extremely necessary for the job. ADC allow the board to sample at a high sampling rate allowing the user to enjoy high quality audio files. DAC on the other hand allow the user to enjoy the fruit of his/her creativity by reproducing the music record stored in memory.

Signal Integrity

Signal integrity is a critical issue to consider when routing the PCB. We take in high consideration eventual EMC issues and to reduce them as much as we can we decided to route the input /feedback/output lines as short as possible. We spent particular care on choosing the right position for the connectors as well in order to ease this job. We cannot assure there will be no EMC issues, but we can state confidently that the user can discard their effect.

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