**ELEC2205 Electronic Design**

**D4 System Design Exercise 2014**

**BOOMBASTIC:**

**Body Operated One-Man Band with Amplification, Storage and Transmission Integrated Circuits**

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**Version 1.1.5**

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# Introduction

Your job, working as a design consultancy formed of 5-6 students, is to design and build a new one-man band product in 12 days. You will be competing with 13 other teams to design the best product.

## Background

In recent years, advances in MicroElectroMechanical Systems (MEMS) have improved the cost, size, energy consumption and capability of sensors, such as accelerometers, gyroscopes, magnetometers, microphones, pressure sensors and ultrasonic sensors. This has opened the door to many new innovative applications of sensing, including vehicular, entertainment and communication devices.

In this design exercise, you will leverage recent advances in sensors to build innovate live audio performance systems. In other words, high-tech one-man band systems, which could be used by buskers or stage performers to entertain an audience.

## Requirements

Your design should comprise all of the following modules:

**Sensing** – One or more sensing devices, such as accelerometers, gyroscopes, magnetometers, microphones, pressure sensors, ultrasonic sensors, cameras, buttons, dials, etc. These should provide the means for a human performer to have real-time, live and interactive control of the system.

**Signal processing** – Entertaining audio signals should be synthesised or obtained by mixing, distorting and/or transforming pre-recorded samples (without infringing upon copyright) and/or microphone signals. This should be controlled in real-time by the human-controlled sensor readings.

**Amplification** – A built-in amplifier and speaker, with a bandwidth of at least 15 kHz. This should be capable of producing sound that is loud enough to entertain an audience of around five or six people, but should also have an adjustable volume control, so that the lab doesn’t become too noisy!

**Transmission** – Real-time low-latency wireless transmission of the audio signal to a separate device, which outputs the audio using a standard 3.5mm jack socket and a male-to-male audio cable. This audio signal should have an an output impedance of 100 Ω, it should contain no DC component and it should have an RMS voltage of 300 mV when driving a 10 kΩ load. This will allow the developed one-man band system to work with an external amplifier and speaker, when entertaining large audiences.

**Storage** – Recordings of the generated audio signals should be stored when chosen by the user. It should be possible to play these back using the system. Alternatively or additionally, the audio signals could be saved onto a standard media (such as SD card), for use on a PC. This could be done using an audio format which is native to the PC (such as .wav, .midi or .mp3) or using a custom PC application to interpret the saved data.

**Power management** – The system should be battery operated, so that it can be used in places where mains electricity is not available. The power consumption of the system should be managed, so that it can continue operating for an hour or so, without requiring excessively heavy batteries.

You can include any other additional features that you like, such as the following ideas:

**Stereo audio** – The system could include two speakers. In this case it could generate, amplify, store and transmit stereo audio.

**Loading of samples from standard media** – If your system generates audio by mixing, distorting and/or transforming pre-recorded samples, then these could be loaded in a standard format (such as .wav, .midi or .mp3) from a standard media (such as SD card).

**Apperance, mechanical operation, ruggedisation** – You could house your electronics in a box, to stop them from getting damaged easily. You may like to think about shower-proofing for those long miserable days of busking in the rain…

**Display** – You could use LEDs or an LCD display to help entertain the audience or to give feedback to the performer.

**Karaoke or “Guitar hero” mode** – The system could dispay lyrics for the performer to sing or could tell the performer which controls to operate and when, in order to reproduce a pre-recorded performance. The system could give the performer a score, depending on how accurately they can reproduce the performance.

**Pyrotechnics** – Only kidding! Although you could build a simple mechanical or electronic system for setting off party-poppers…

## Research

It would be great to see a wide variety of different system designs among the different teams. You and your team should spend some time brainstorming ideas, rather than jumping on the first idea that springs to mind. You may like to combine the best parts of the various ideas that you come up with. There are lots of places you can look for ideas:

* Literature (you should include some good references in your final report), e.g.   
  <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.74.2844&rep=rep1&type=pdf>
* Trade shows and conferences, e.g. <http://www.engadget.com/tag/namm2013/>
* Hobby websites, e.g. <http://hackaday.com/?s=audio>

Here are some ideas that could get you started:

* A boiler suit with sensors built into the arms, legs and body.
* Different instruments could be imitated using different types of sensor – e.g. a pressure sensor in a pipe could stand-in for a trumpet.
* An old acoustic guitar could be turned into a “guitar hero” machine.
* A DJ booth with sensors built into home-made turntables.
* Rather than a musical performance, the audience could be entertained by an audio system that is used as part of a magic trick…

Please note that we have provided these ideas here to illustrate the diversity of projects that we are hoping to encourage, rather than to give particular suggestions. Please only implement one of these ideas if it is genuinely your favourite of all the ideas you consider.

## Overview

The exercise has been developed to reflect commercial practice as far as possible, testing and assessing your abilities at a variety of skills, such as:

* working in groups and partitioning a large task amongst individuals;
* creativity and innovation;
* mixed-signal electronic design;
* initiative;
* costing and budgeting;
* time management;
* troubleshooting;
* technical research.

The assessment contributes approximately 50% of the ELEC2205 module, or equivalently 7.5 credits. As such each team member is expected to put in 75 hours of work in undertaking the design, development and reporting.

The exercise takes place over a four week period, with the following structure:

1. Design, investigation and simulation.
2. Prototyping and construction.
3. Final assembly, evaluation and report production.
4. Trade fair

The trade fair on 21st March is a competitive event, and a prize will be awarded to the team that impresses the judges the most with their design, presentation and demonstration/performance. Detica ESG sponsors the prize[[1]](#footnote-1) and the judging panel will consist of Matt Sacker (Detica) and Tim Forcer (ECS). Each member of the winning team will receive a cheque for £100. The winners will be announced at the trade fair on the afternoon of 21st March.

## Evaluation

Your marks for the D4 exercise are based on your technical solution, design process, team dynamics, the report that you submit, and your team’s presentation at the trade fair. In evaluating your work the following points will be considered:

* Difficulty of the problem addressed
* Entertainment value of the device
* Electronic design
* Ease of use of the device
* Creativity and innovation
* Aesthetics
* Cost
* Reliability
* Documentation

## Acknowledgements

The authors gratefully acknowledge the support of David Oakley, Jeff Hooker, David Kemmish, Mark Temple, Tim Forcer and Matt Sacker in preparing for this exercise. The remainder of this document describes the requirements of the project, the logistics, the resources available and the deliverables.

# Specification

Your team is a small electronic design consultancy, which has been contacted by a customer looking to market the next big thing in live performances. You have 12 working days to design and build a working prototype. The entrepreneur has also contacted some other design consultancies to produce competing designs. You will market your product at a trade fair held by the entrepreneur. In proposing your design you will decide on what you think is achievable with the time and resources available.

## Design Decisions

There are always many different ways to solve a design problem. However, the most robust and elegant solutions are usually the simplest. Always ask the question: “Is there a simpler way?” Consider carefully what is best done in hardware, and what in software. You should give thought to the complexities, practicalities, suitability and benefits of all the options. Remember a stripped down system that works will be better than a more complex one that fails. Try to mitigate the risk of a failed design by concentrating on the central elements and enabling features to be scaled up when the critical part is working. Remember that components that you have used before are less likely to reveal unexpected behaviour.

Although you have lots of experience using the AVR and it is quite a powerful computer, it does have limitations; it has a small internal data memory, the program memory is not generous and the clock speed is limited to 20MHz. The Stellaris and other ARM processors are a more powerful alternative. You will need to look carefully at exactly what you can and cannot do. But remember, there is no limitation on the number of chips you may use.

## Prototyping and Construction

When working with mixed-signal systems, care must be taken in separating the analogue and digital grounds to avoid interference from the digital part affecting the sensitive analogue part. More details can be found in [The Circuit Designer's Companion](http://lib.myilibrary.com/Open.aspx?id=100939&loc=&srch=undefined&src=0)*.* Also, remember to decouple your ICs.

## Testing and Evaluation

Individual modules and milestones should be verified as you go and recorded on the design completion form of Appendix D. It is your responsibility to design tests that demonstrate and validate the capabilities of your design.

## Features

During the design phase you might like to think about how you are going to market your device at the trade fair. What is your market niche? high performance, super signal processing, low power, low cost …?

# Logistics

For this design exercise you are required to work together in a team of 5-6 students. The teams are given in Appendix C. Your team will elect a representative to be the project team leader. This team leader will be responsible for co-ordinating meetings between you all, to ensure that a successful collaborative design becomes a demonstrable reality by the end of your last day in the laboratory. You must collectively partition the work of the project evenly among the members of your team, making arrangements to ensure that the various modules of the design will interface correctly, integrating to become the overall system, and put in place a mechanism for monitoring progress and redistributing effort if part of the project is not going well. You are strongly encouraged to make use of the [ECS project management system](https://forge.ecs.soton.ac.uk/) and [ECS Source Kettle](https://devtrack.ecs.soton.ac.uk) for managing the project and maintaining source code.

## Week 0: Introduction

In week 0, you should meet with your team, allocate roles to each team member, decide on the scope of your project, research possible solutions and begin the design of these. It is a critical phase in the project since you are required to attend a design clinic on Monday 24th February with your initial design and to place your order for components by 14:00 on Tuesday 25th February. Therefore, you must work intensively in this period and will likely need to make use of your weekend.

|  |  |  |  |
| --- | --- | --- | --- |
| Day | Time | Location | Activity |
| Thur 20/2 | 11:00-12:00 | 02/1085 | Kick-off Presentation |
| Outside Lectures |  | First Team Meeting |
| Fri 21/2 | Outside Lectures |  | Initial investigation and design |

## Week 1: Design, investigation and simulation

During the first week there will be opportunities to get feedback on your design. On Monday your team will meet with Tim Forcer to get early feedback on the design approach – please bring a sketch of how you envisage your device, a 150 word abstract descrbing what it does and a legible high-level block schematic, with the primary component(s) noted on each block. At the beginning of your laboratory session on Friday a member of academic staff will review your design, and will advise you as to their impression of the likelihood of success. We believe that simple designs will stand a much higher chance of success than complex ones. We will look at your design completion form and may request that you add some more detail to this.

|  |  |  |  |
| --- | --- | --- | --- |
| Day | Time | Location | Activity |
| Mon 24/2 | Outside Lectures |  | Refine initial design, and draft first versions of software (SystemVerilog, C, …)  Collect box of bits from the Zepler Lab Support Hatch |
| Appendix G | Laboratory | Design Clinic (20 minute slot per team) |
| Tue 25/2 | Outside Lectures |  | Refine design, prepare project proposal form and draft first versions of software |
| 14:00 | Zepler Lab Support Hatch | Deadline for submission of kit & component requisition form to David Kemmish/Mark Temple and ECS Electronic Handin System. |
| Wed 26/2 | Outside Lectures |  | Refine design, prepare project proposal form and draft first versions of software |
| Thur 27/2 | Outside Lectures |  | Refine design, prepare project proposal form and draft first versions of software |
| Fri 28/2 | 10:00 | Electronic Handin System | Submit project proposal form to the ECS Electronic Handin System. |
| 10:00-13:00 | Laboratory | Teams Armstrong – Eminem initial investigations in the lab. Negotiation of design completion form with Rob, Steve or Geoff. |
| 14:00-17:00 | Laboratory | Teams Franklin – Jackson initial investigations in the lab. Negotiation of design completion form with Rob, Steve or Geoff. |

## Week 2: Prototyping and construction

This is the week where your team will be able to prototype and implement the majority of its design. Although only three formal lab slots are allocated for each team in the second year laboratory, the lab will be available to you outside of your scheduled lectures this week, and you are advised to use it. The table below shows the lab opening times, which enables you to be in the lab every day. It is a good idea to get incremental goals ticked off on the design completion form during the supervised slots in this week.

|  |  |  |  |
| --- | --- | --- | --- |
| Day | Time | Location | Activity |
| Mon 3/3 | 10:00-13:00 | Laboratory | Teams Armstrong – Eminem prototyping in the lab with supervision |
| 14:00-17:00 | Laboratory | Teams Franklin – Jackson prototyping in the lab with supervision |
| Tue 4/3 | 12:00 | Lab Support Hatch | Scheduled delivery of kit & components ordered from Onecall and Technobots |
| Outside lectures | Laboratory | All teams have an opportunity to work in lab without supervision, subject to the agreement of the lab support staff. |
| Wed 5/3 | Outside lectures | Laboratory |
| Thur 6/3 | Outside lectures | Laboratory |
| Fri 7/3 | 10:00-13:00 | Laboratory | All teams prototyping and assembling sub-systems in the lab with supervision |
| 14:00-17:00 | Laboratory |

By the end of this week you should aim to have the individual components of your design working, ready for the final integration on Monday.

## Week 3: Final assembly, evaluation, and report production

Monday is judgement day which sees final assembly of your prototype and its evaluation. At the end of the day before the lab closes your team must demonstrate your system to the supervising member of staff, who will finalise your Design Completion Form with details of the success or failure of any remaining aspects of your design. There will be no extension to the laboratory time allocated to your team. Your design will be signed off in whatever state it is at the end of the session. Moreover, all your team’s hardware must be handed in after marking on that day so that your team can be signed-off as “all items returned”.

|  |  |  |  |
| --- | --- | --- | --- |
| Day | Time | Location | Activity |
| Mon 10/3 | 10:00-13:00 | Laboratory | All teams completing final assembly and evaluation with supervision. You may like to capture some video footage and still imagery of your prototype in action. |
| 14:00-17:00 | Laboratory |
| 16:30 |  | All construction stops |
| 17:00 |  | Deadline for finalising design completion forms, handing over your prototype and returning other items to the Zepler Lab Support Hatch |
| Tue 11/3 | Outside lectures |  | Fill out the project completion form (Appendix E).  Your team should write the final report. |
| Wed 12/3 | Outside lectures |  |
| Thur 13/3 | Outside lectures |  |
| Fri 14/3 | Outside lectures |  |
| 16:00 |  | Deadline for the final report. Each member of your team should submit their individual report to the ECS Electronic Handin System. One member of your team should submit the group report to the ECS Electronic Handin System and print out the receipt. The receipt should be bound to a hard copy of your group and individual reports, which should be submitted to the Zepler reception before 4pm on Friday 14th March. |

## Week 4: Trade fair

Your hardware will be returned to you on the day of the trade fair. You must not make any further modifications or improvements to the design, but can check that it is still working as you left it.

|  |  |  |  |
| --- | --- | --- | --- |
| Day | Time | Location | Activity |
| Mon 17/3 | Outside lectures |  | Prepare trade-fair slides to detail the technical, marketing and costing aspects of your prototype. Prepare a video advert lasting no longer than one minute to showcase the features of your product to a commercial audience. |
| Tue 18/3 | Outside lectures |  |
| Wed 19/3 | Outside lectures |  |
| Thur 20/3 | Outside lectures |  |
| 16:00 | Electronic Handin System | Deadline for submitting presentation slides and advert to the ECS Electronic Handin System |
| Fri 21/3 | 10:00-13:00 | 44/1041 | All members of your team should attend the trade-fair. One member of your team should present your slides and advert. |
| 14:00-14:30 | Laboratory | One member of your team should attend to setup your hardware, ready for demonstration to the judges. |
| 14:30-17:00 | Laboratory | One member of your team should attend to demonstrate your hardware to the judges. |
| 17:00-18:00 | Laboratory | All members of your team should attend the closing ceremony. Teams with working prototypes are invited to give a quick live performance and prizes will be awarded by the judges. |

# Resources

As this exercise is about initiative, you may choose to use any technology or solutions. However, you are not allowed to use purpose built solutions, and your plan for the final delivered prototype must not contain any protoboards.

## Research

In developing your design you may wish to use elements of hardware or software of other designs you may be able to find. Note that this is only acceptable provided you follow the [standard procedures for academic integrity](https://secure.ecs.soton.ac.uk/kb/entry/35/). Simply copying large parts of another design will result in a low mark for the exercise. However, re-using and referencing an element from another design because you understand it and think it is good is fine. Ultimately, the balance between your own ideas and those of others will moderate the marking of your design. Furthermore, make good use of software libraries where they exist.

## Kit & Components

To help you with the design we will provide you with a “box of bits” containing some components which may be useful[[2]](#footnote-2) (see Appendix F). You are required to submit a list of any additional items you require to David Kemmish/Mark Temple using the form in Appendix B, not later than 14:00 on Tuesday 25th February. Items you may request include:

* Altera FPGA board with cables (maximum one per team)
* MSP430 boards and programmers (there are limited numbers of these in stores, so there is a maximum of one per team and they will be offered on a “first come, first served” basis). We have [this](http://onecall.farnell.com/jsp/search/browse.jsp;jsessionid=NEDM0AGBPCWTUCQLCIRJPQQ?N=411&Ntk=gensearch&Ntt=MSPEXP430&Ntx=mode+matchallpartial&exposeLevel2Refinement=true&suggestions=false&ref=globalsearch&_requestid=283612), [this](http://onecall.farnell.com/texas-instruments/msp-exp430f5529lp/msp430f5529-usb-launchpad-eval/dp/2357895), [this](http://onecall.farnell.com/jsp/search/browse.jsp;jsessionid=NEDM0AGBPCWTUCQLCIRJPQQ?N=411&Ntk=gensearch&Ntt=MSP-FET430UIF&Ntx=mode+matchallpartial&exposeLevel2Refinement=true&suggestions=false&ref=globalsearch&_requestid=284528) and [this](http://onecall.farnell.com/texas-instruments/ez430-f2013/msp430f2013-usb-stick-dev-tool/dp/1172234?Ntt=117-2234).
* Stellaris ARM processor development board (maximum one per team)
* ISP programming adaptor for PLDs (maximum one per team)
* ispGAL22V10 PLDs
* FTD USB interface modules
* Photodiodes
* Anything available from the lab component drawers
* Standard components stocked by Lab Stores
* Connectors or cables that you might need for testing or to connect modules or boards together.
* SD Card reader (<https://secure.ecs.soton.ac.uk/notes/ellabs/databook/equip/SD_card_types.pdf>)
* Soldering irons, solder, solder suckers and solderwick.
* Surface mount solder stations.
* protoboards,
* DMMs
* sets of digital scope probes
* Micro arcana kits – Il Matto, Il Bagatto, La Papessa, L'Imperatrice
* [Accelerometers](https://www.sparkfun.com/products/11770)
* [OV7670 FIFO camera module](http://emartee.com/product/42043/OV7670%20AL422%20FIFO%20Camera%20Module) ([Source code for AVR](https://devtrack.ecs.soton.ac.uk/project/OV7670_Test))
* [2.2” TFT QVGA Display](https://secure.ecs.soton.ac.uk/notes/elec2032/D4/Micro%20Arcana/)

Your team has a budget of £50 for purchasing components (from [Onecall](http://onecall.farnell.com/) or [Technobots](http://www.technobotsonline.com/)[[3]](#footnote-3)) that are not available from Lab Stores or in your Box-of-bits. You may also obtain components from Maplin (or anywhere else) if you wish provided: (a) you pay for them yourselves, (b) you collect them yourselves, (c) you have made a sufficiently good case for their need in your project proposal form and (d) you do not expect to get them back at the end of the project.

Bonus marks will be awarded to teams that step out of their comfort zone and use components that they have not had experience with before – being able to pick up new kit and run with it is an important skill for an Electronic Engineer. Of course, there is a risk associated with using unfamiliar equipment and so you should plan and manage your project to mitigate this.

All of the above items must be ordered in advance and must be handed back by 17:00 Monday 10th March, and signed off by a member of staff or by someone in stores. The technical staff have absolute authority to refuse your order without appeal if they are not satisfied. Should this happen you must contact Dave Oakley or Geoff Merrett (by email in the first instance) as soon as possible to rectify the matter. Please note that any self-purchased items must also be handed in, and will not be returned after the exercise. You may negotiate with technical staff about their return, after the exercise has been fully marked, in June.

Remember – Keep it Simple

A shot-gun approach, i.e. let’s have lots of everything at the beginning, is usually the sign of a poor design.

## Prototyping and Construction

Protoboard some elements first to quickly identify issues. Read the datasheets – they contain a lot of useful information. Remember, the idea is to identify any unexpected behaviour or misconceptions/complications in your design. Your plan for the device you will submit must not contain any protoboards. You may choose to construct using any of a variety of approaches such as tri-pad, strip-board, wire-wrap, or dead bug. Remember to request anything you need on the Kit & Component Requisition form (Appendix B). Think carefully about the choice of packaging of all components. If you do decide to use any surface-mount components consult with the members of your team who have been trained in basic surface-mount technology to decide on which packages are realistic to work with. We can provide some DIL adaptors for surface mount components.

## Laboratory Resources

Your team will be allocated a number of benches in the Electronics laboratory for the sole use of your team throughout the duration of the prototyping and construction phase of the exercise (28th February to 10th March). During this period there are no other part I or part II laboratories and you may leave materials on these benches overnight. The allocation is shown in Appendix H. Additionally, 22 computers have been block-booked for your use on Friday 28th February and Monday 3rd March for simulation. These are the computers in the quiet zone at the end of the big computing laboratory on level 3 of Zepler.

## Costing

The development and manufacture of your design incurs many costs, which the customer hopes to recover (along with some profit!) through selling your product. Your report should include a detailed and justified breakdown of these costs. There are two types of costs:

1. Fixed costs, which do not depend on how many units you build. These include:

* Hardware and software development costs. Your report should specify how many person-hours your team spent on D4 up until the prototype was handed over. Each of these person-hours incurs a cost of £75.
* Development component costs. Your report should include a detailed costing of all the components you acquired for D4 (whether you used them or not), including any items from the box of bits. Use the Onecall, or Technobot websites to obtain prices; you should **\*not\*** use quantity discount figures from these sites where available for the development cost. You should not include the cost of PCs, bench power supplies, test equipment and device programmers; these are all accounted for in the depreciation part of the manufacture overheads.
* Conformance testing, to obtain a CE mark. This is £2000.
* Development and manufacture overheads incurred, including rent, service bills, depreciation, repair of equipment, etc. This incurs a cost of £100k.

1. Variable costs, which are proportional to the number of units you build. These include:

* Manufacture component costs. Your report should include a detailed costing of all components required to build your product, including any items from the box of bits. Use the Onecall, or Technobot websites to obtain prices; you may use quantity discount figures from these sites where available for the manufacture cost. You should not include the cost of PCs, bench power supplies, test equipment and device programmers. These are all accounted for in the depreciation part of the manufacture overheads.
* Assembly costs. Your report should include a detailed and justified estimate of how many person-hours it would take to assemble each unit on a production line. This should include the time it takes to collect the components, solder them together, flash the ROMs, manually adjust the trimmers, house the components in a case, package the completed unit, etc. You pay your skilled work force £10 per hour.

Your report should specify and justify a recommended retail price for your product, excluding shipping, but including VAT at 20%. You should state how many units will need to be built and sold (considering a less than 100% production yield) for you to turn a profit.

# Deliverables

You will be assessed by a number of deliverables. The weighting of the deliverables is approximately:

5/100 Project Proposal Form,

15/100 Constructed Prototype & Design Completion Form,

5/100 Project Presentation,

10/100 Team Report,

65/100 Individual Report (detailed below)

The weighting of marks for the individual Report is approximately:

20/65 Technical Approach

15/65 Achievement and Results

10/65 Reporting Writing and Structure

10/65 Team Working, Planning and Progress

10/65 Evaluation and Reflection

At the end of the project, your team will have to agree on the effort contributed by each team member. This will be used as an indication of how team marks should be allocated across the team.

## Project Proposal Form

The environment of the design exercise is supposed to reflect commercial practice as far is possible. For this reason, your team will be required to submit a completed Project Proposal Form (you may edit the electronic version from appendix A). This form requires you to explain in broad terms what your proposed designs are, for both the hardware and the software, and to provide cost estimates for producing your prototype implementation. These estimates will include software development and manpower estimates. A percentage of the mark is allocated to the proposal form. Failure to submit this form by the deadline will automatically disqualify each member of the team from receiving that portion of the marks.

The project proposal form consists of four items:

1. A copy of the form from Appendix A, with the responsibilities/overall design summary, multiple module design proposals (there should be one for each module of the whole project), the cost estimates, the prototyping/construction and the planned activities sections.
2. An annotated circuit diagram of all the circuitry you expect to build (output from a CAD application or diagramming application is preferable, otherwise neat hand-drawn diagrams are acceptable provided they are scanned in for electronic submission). Depending on the state of your design process, you may choose to supply full schematics or block schematics or a mixture.
3. Initial listings of any software (C, SystemVerilog, …); these do not have to be fully functional, but software should compile correctly and circuits should make sense. This is not just a bureaucratic requirement. Experience has shown that to finish the design exercise you must start construction of the software and circuitry early in order to have time for debugging, integration and testing. Pseudo-code is acceptable where algorithms and high-level structuring are being defined.
4. An edited Design completion form from Appendix D specifying 10-15 milestones in your project which can be signed off as you progress.

The project proposal form is to be submitted electronically to the hand-in system by 10:00 Friday 28th Februart. Additionally, you should bring a paper copy of all items to your laboratory session on Friday 28th February.

## Constructed Prototype

You are required to produce a working prototype of your design. During development you are able to get working elements verified and recorded on the design completion form by a supervisor. The final prototype must be handed over no later than 17:00 Monday 10th March and should contain no protoboards.

## Project Presentation

You are required to give a six minute presentation of your final design at the trade-fair on the 21st March, to the customer and your classmates. This presentation should include a video (max duration 1 minute) and a series of slides to advertise the features of your prototype (max duration 5 minutes). The slides should describe the problem you solved, your target market, the costing of your device, your design, the problems you encountered and the performance of the final prototype. Do not try to put in too much material and compensate by talking like [John Moschitta](http://en.wikipedia.org/wiki/John_Moschitta,_Jr.); practice the talk and time it; think how you might make it stand-out from the others. An electronic copy of your slides and advert should be submitted to the ECS Electronic Handin System by 16:00, 20th March. You should include no more than 10 slides and these should be contained in a single ppt, pptx or pdf file. Your advert should be a standalone file that will play in [VLC](http://www.videolan.org/vlc/). You may also like to try embedding the advert into your presentation, but experience shows that this doesn’t always work properly. Your files will be transferred onto the presentation computer, and you must elect one team member to give the presentation.

## Team Project Report

The team report should be edited by all members of the team to summarise the overall design, system integration, team working practices and costing/marketing aspects. The report should follow the following structure:

* 1. Challenge Solution Statement
* Describe the specific challenge(s) that your Solution Concept addresses
* What is the performer and audience experience?
  1. System Design
* How did you meet the requirements?
* Why did you choose a particular architecture?
  1. Evaluation

- How does your product match up against the criteria of difficulty, impact, design, ease of use, power management, …

* 1. Team Working
* How did you decide to partition the work?
* What tactics did you employ in your project working?
* How did you respond to unexpected events?
  1. Costing, Marketing and Conformance marking

- Detail these aspects.

* 1. Final Product
* A picture of the final product
* Describe how it works
* Discuss further extensions that could be made.

References

Appendix A: Design Completion Form

Appendix B: Project Completion Form

Appendix C: Circuit Diagrams

Appendix D: Software Listings

Appendix E: Project Meeting Agendas & Minutes

Each section can be up to 500 words long, and hence a maximum word count of 3000 words if all sections are fully populated; figures, diagrams, tables and appendices are not included in this count. The team report should contain only things that don’t make sense to include in one of the individual reports. If a module was developed by a particular team member, then it should be discussed in the corresponding individual report. However, the team report may discuss its interface with another team member’s module, for example.

## Individual Report

Each member of the team is also required to submit an individual report focussing on their contributions to the project and reflecting on the project as a whole. The report should follow the following structure:

* + 1. Contribution

- Identify exactly what you were tasked to do and what you did.

* + 1. Design & Simulation

- Describe in detail the parts that you were responsible for.

* + 1. Testing & Results

- Detail the testing that you undertook on your modules. In particular, discuss the testing of each module’s interface with the rest of the system.

* + 1. Management/Team Working

- Describe any management roles and team working practices

* + 1. Critical Evaluation & Reflection

- A candid description of what worked and what failed.

Appendix A: …

The individual report has a maximum word count of 3000 words and it is expected that the majority of this will be in sections 2 and 3; figures, diagrams, tables and appendices are not included in this count. You do not need to duplicate material from the appendices in the team report – simply make a reference to it. Your report should acknowledge all sources in the reference section.

A zip file containing copies of all software and CAD files (C, SystemVerilog, schematics, etc), source files and binary executable must be submitted via the hand-in system along with the report.

Listings should be printed with line numbers, in a non-proportional font, so that all references to code may be made by file name and line number. Avoid duplicating material that is available elsewhere, such as the supplied datasheets; simply reference them. One of the criteria we will use in the assessment is our ability to replicate your work from the details of the submitted material. It is mandatory that all the reports be bound together. Spiral binders and covers are available from Lab Stores or the Zepler Reception at a nominal cost. Which word processing tool you use to write the report is your choice. If you decide to use Latex you can find further details [here](https://secure.ecs.soton.ac.uk/support/textools/), and you can use ECS Forge to keep up to date versions of the different components and bring the report together more coherently.

The team and individual reports must be submitted electronically to the ECS Electronic Handin System and on paper to the Zepler Reception by 16:00 Friday 14th March*.* Failure to submit the formal report on time will result in [the university's standard penalty.](http://www.soton.ac.uk/quality/docs/Extensions_and_Late_Submission_Penalties.doc)

# Hints and Tips

In this section you will find some suggestions and guidelines on how to carry out this project successfully.

## Project Management

1. Appoint a team manager, not to act as a tyrant but to provide a co-ordination function. A good team manager will do slightly less hands-on design, development and construction than the rest of you, but will know what everybody is doing, how far along you are, and if there are any problems. The team manager is responsible for coordinating the activities of the team, and ensuring that deadlines are met. He, or she, should be empowered to make decisions on the priority of different tasks and to alter the team’s activities accordingly. If a team is seen to have bad management the leader will receive fewer marks than the others in the team. Alternatively, a well-managed team will earn its leader extra marks.
2. If the team is not getting along contact the academic staff as soon as possible.
3. Have regular meetings, particularly at the start to thrash out the design strategy. Try to make meetings efficient by jointly putting together an agenda so that everyone understands the purpose of the meeting and can come prepared. Let everyone make a contribution; we all have something to contribute. Identify someone to record minutes of the meeting so that a summary can be promptly circulated afterwards to record what you agreed (or disagreed!) to do.
4. Break up the work, each to his or her best skills. You will need to work as individuals as there are too many sub-sections for working in pairs. Use a skills audit to divide up the tasks.
5. Look at the sub-systems you need and assign people according to their skills.
6. Identify the minimum requirements to get the system working and use this to prioritise tasks. Keep it simple to start with. Make sure you reach the minimum goal early in the main laboratory week. Also consider whether you can put together a working but more limited system should any one of your modules fail. Take a rapid prototyping, or spiral model, to identify risks early.
7. Use a backup and versioning tool such as ECS Forge or Source Kettle to collect your source code, schematics, results etc in a single place, that everybody has access to.
8. Find a good balance between your ambition, the novelty of your project and the challenge that you take on. It is better to be under-ambitious to begin with then add more complexity later.

## Design

1. Remember that simulation is a useful tool, and it can let you do things that are impossible otherwise.
2. Reconfigurable designs that can be extended from simple systems by means of software or firmware upgrades are easier to adapt to changing requirements.
3. Assume that your design will not work first time and think carefully about how you will test and fault-find the modules independently – if you cannot, troubleshooting will become more difficult.
4. What inputs and outputs will each team member's module need, in order to interoperate with everybody else's? This interface definition will need to be continually updated and monitored, as things rarely go exactly to plan. Begin on integrating your modules as early as possible. We find that integration is make or break in D4 – teams that succeed are the ones that start integrating their modules together early.

## Troubleshooting

1. Take care of your equipment; remember ICs can be damaged by static electricity.
2. A complex circuit that does not work does not need to have a complex cause.
3. Many problems of designs failing to work are associated with power supply problems, e.g. poor decoupling, no power applied, wrong voltage applied, or wrong polarity; always use the current limiter.

## Reporting

1. Use a camera, the oscilloscope’s waveform capture and the PC’s screen-grab facility, to obtain visual records of progress and achievement.
2. When you have something working get this recordedon your Design Completion Form.
3. You should aim to complete the team component of the final report soon after the build has been completed, so that you can focus on the individual components in the run up to submission.

# Contacts

If you have any queries or problems, please contact:

|  |  |
| --- | --- |
| Management Problems | Rob Maunder ([rm@ecs.soton.ac.uk](mailto:rm@ecs.soton.ac.uk))  David Oakley ([do@ecs.soton.ac.uk](mailto:do@ecs.soton.ac.uk)) |
| Technical queries | Steve Gunn ([srg@ecs.soton.ac.uk](mailto:srg@ecs.soton.ac.uk))  Rob Maunder ([rm@ecs.soton.ac.uk](mailto:rm@ecs.soton.ac.uk))  Geoff Merrett ([gvm@ecs.soton.ac.uk](mailto:gvm@ecs.soton.ac.uk)) |
| Kit & Components | David Kemmish ([dk@ecs.soton.ac.uk](mailto:dk@ecs.soton.ac.uk))  Geoff Merrett ([gvm@ecs.soton.ac.uk](mailto:gvm@ecs.soton.ac.uk))  Mark Temple ([mst@ecs.soton.ac.uk](mailto:mst@ecs.soton.ac.uk)) |
| Equipment problems | Jeff Hooker ([jh1@ecs.soton.ac.uk](mailto:jh1@ecs.soton.ac.uk)) |
| Construction issues | Jeff Hooker ([jh1@ecs.soton.ac.uk](mailto:jh1@ecs.soton.ac.uk)) |

Mark all messages “D4 Query” to ensure a prompt reply.

# Appendix A: Project Proposal Form

|  |  |  |  |
| --- | --- | --- | --- |
| Team letter: |  | Name of person elected as team leader: |  |

## Responsibilities

*List the responsibilities of each team member.*

|  |  |  |
| --- | --- | --- |
| Lab pair no. | Name | Design responsibility |
|  |  |  |
|  |  |
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## Overall Design Summary

*Give a summary of your design.* *Please make explicit exactly what you intend to build. Remember, a working design with more features would always obtain better marks. Be aware that you will be marked against what you declare in this document. YOU are setting the standard, YOU choose your goals and what you want to achieve.*

## Module Design Proposals

*Please give details of each module of your overall design. In particular, give interfacing details between your module and other parts of the system. Complete one of these pages for each module of the design (continue on an additional sheet if necessary).*

|  |  |
| --- | --- |
| Names of people involved: |  |
| Title of Module: |  |

## Cost Estimates

*Please give detailed calculations and estimates of the overall cost of your proposed design below. Take care to include person-hour estimates for your software, board production and debugging, as well as your components and consumables. You should also estimate the production cost of your final unit (you may assume a large quantity are to be produced), the market price and determine how many need to be sold to be profitable.*

## Prototyping and Construction Method

*Briefly describe your proposed method(s) of prototyping and construction, including whether you will use any surface mount packages.*

## Planned Project Activities

*Please list the activities that you intend taking place during your laboratory time, and indicate when they should occur, and who will do them.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Activity | Initials | Fri  am | Fri  pm | Mon  am | Mon  pm | Tue | Wed | Thu | Fri  am | Fri  pm | Mon  am | Mon  pm |
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# Appendix B: Kit & Component Requisition Form

You have a budget of £50 and can source additional components from the two suppliers listed below. This is over and above anything that you can obtain from within ECS. The additional suppliers have been selected due to their stock catalogue and delivery lead-time.

* Onecall (Farnell) <http://onecall.farnell.com/>
* Technobots <http://www.technobotsonline.com/> (based in Southampton!)

The requisition form can be found in Requisitions.xlsx from the D4 pack. If you wish to order components from both suppliers you need to complete a separate requisition form for each supplier. You should also complete a separate Requisitions form for anything that you require from ECS stock. You will be required to hand in a hard copy of the component requisition form to David Kemmish or Mark Temple at the Lab Support Hatch by **14:00 Tuesday 25th February.** An electronic copy is also required and this should be sent to [mst@ecs.soton.ac.uk](mailto:mst@ecs.soton.ac.uk), and submitted on the ECS Electronic Handin System. *Supply of components is subject to approval of the budget holder (Geoff Merrett).*

Any use of LiPo batteries, voltages/currents in excess of the standard Risk Assessment limits must be covered by a supplementary Risk Assessment procedure ***before*** relevant components are used.

Below are example copies of the three component requisition forms. Please ensure that you complete all of the required fields as failure to do so can result in late/non delivery of the components. Make the description as brief as possible and supply all prices exclusive of VAT (you do not need to supply prices for components sourced from within ECS, but you should include estimates of these when you do the costing part of the project).

Most important of all is to check that the component is available and in stock.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Group:** Z | | **Project leader:** Brian Griffin | **Supplier:** Onecall | | |
| **Quantity** | **Suppliers stock code** | **Description** | **Unit price (ex. VAT)** | **Total price (ex. VAT)** | **In stock** |
| 1 | SC11597 | Blue LED | 0.52 | 0.52 | Yes |
| 3 | 3815699 | 10 way IDC socket | 1.01 | 3.03 | Yes |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Group:** Z | | **Project leader:** Brian Griffin | **Supplier:** Technobots | | |
| **Quantity** | **Suppliers stock code** | **Description** | **Unit price (ex. VAT)** | **Total price (ex. VAT)** | **In stock** |
| 1 | 3801-204 | ACS709 Current Sensor | 7.40 | 7.40 | Yes |
| 1 | 3802-020 | Wearable Keypad | 10.06 | 10.06 | Yes |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Group:** Z | | **Project leader:** Brian Griffin | **Supplier:** ECS | | |
| **Quantity** | **Suppliers stock code** | **Description** | **Unit price (ex. VAT)** | **Total price (ex. VAT)** | **In stock** |
| 1 |  | Stellaris Development board |  |  |  |
| ? |  | Various E12 resistors |  |  |  |
| 1 |  | Altera FPGA board + cables |  |  |  |
| 1 |  | Soldering iron |  |  |  |

# Appendix C: Class list

|  |  |
| --- | --- |
| Armstrong | Ojuroye,Olivia |
| Turner,Benjamin William |
| Gupta,Mohit |
| Kiranov,Momchil Krasimirov |
| Jones,Matthew |
| Marshall,Charles Henry |
|  |  |
| Bowie | Safdar,Abdullah |
| Taylor,Elliot |
| Shi,Lu |
| Zhu,Xinyi |
| Zheng,Lu |
| Fu,Yongda |
|  |  |
| Cobain | Chien,Samuel Haozart |
| Daramola,Phillips |
| Cheng,Xiaoyu |
| Mohd Shafie,Mohammad Sharhan |
| D'Cruz,Praveen |
| Jesurajah,Samuel Anton Prabath |
|  |  |
| Dylan | Chen,Shufeng |
| Hoh,Kwang Chern |
| Liu,Dantong |
| Ma,Jingxuan |
| Pasat,Calin |
| Volkovas,Rokas |
|  |  |
| Eminem | Boyle,James Andrew |
| Corrigan,Andrew |
| Roberts,Michael James |
| Hamlin,Peter |
| Igwe,Evarista Ugonwa |
| Prasmusinto,Alyssa Primandaru |
|  |  |
| Franklin | Wheeldon,Adrian |
| Williams,Reece |
| Cottee‐Gillbe,Thomas |
| Jellard,Samuel Christopher Jack |
| Betts,Andrew |
| Oldfield,Joshua Charles |
|  |  |
| Gallagher | Ladyman,Thomas Paul |
| Marwaha,Jasvinder Singh |
| Gryko,Adam |
| Temperton,Frederick |
| Song, Yang |
| Hadiwidjana,Albertus Satria |
|  |  |
| Hendrix | Jain,Karneet |
| Mistry,Kiran Prakash |
| Bright,William |
| Wood,Joshua |
| You,Han |
| Wang,Xuekun |
|  |  |
| Ice-T | Barfoot,Theodore James |
| Chapman,Matthew |
| Gana,Mohammed El Amine |
| Yan,Hongyu |
| Abualnaja,Faris |
| Verykios,Theodoros |
|  |  |
| Jackson | Laine,Jean‐Pierre |
| Webster,Merlin |
| Aw,Wei You |
| Liu,Shaoyang |
| Hamilton,Hector Geoffrey |
| Katostaras,Theoharis |

# Appendix D: Design Completion Form

*To be completed by the lab supervisor during the time in the lab to record milestones. It will be finalised by 17:00, Monday 10th March. This form is an example and you should edit it to identify your own milestones (10-15) that you will attempt to meet during the progression of your design.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Component of system | Supervisor | Time/Date | Comments (all/part/none working; protoboard/constructed) | | | |
| Digital accelerometers interfaced with processor |  |  |  | | | |
| Processor regularly sampling digital accelerometers |  |  | Sampling rate \_\_\_\_\_ Hz | | | |
| Processor synthesising PWM signal |  |  | Pulse rate \_\_\_\_\_ kHz | | | |
| Sinusoidal input to amplifier 1 can drive 8 Ω load |  |  | Gain \_\_\_\_\_ Bandwidth \_\_\_\_\_ Hz -> \_\_\_\_\_ kHz | | | |
| Amplifier 1 driving speaker with volume control |  |  |  | | | |
| Sinusoidal input to amplifier 2 can drive 10 kΩ load |  |  | Gain \_\_\_\_\_ Bandwidth \_\_\_\_\_ Hz -> \_\_\_\_\_ kHz | | | |
| CMOS square wave input to amplifier 2 can drive 10 kΩ load |  |  | Output impedance \_\_\_\_\_ RMS voltage \_\_\_\_\_ | | | |
| Amplifiers 1 and 2 driven by PWM signals from processors |  |  |  | | | |
| Wireless modules communicating with each other |  |  |  | | | |
| Wireless modules interfaced with processors |  |  |  | | | |
| Processors communicating wirelessly |  |  |  | | | |
| Real-time wireless streaming of audio between processors |  |  |  | | | |
| SD card interfaced with processor |  |  |  | | | |
| Processor can write FAT formatted files to SD card |  |  |  | | | |
| Processor can write audio information to SD card |  |  |  | | | |
| Device 1 is battery powered |  |  | \_\_\_\_\_ mA , at \_\_\_\_\_ V. | | | |
| Device 2 is battery powered |  |  | \_\_\_\_\_ mA , at \_\_\_\_\_ V. | | | |
| Final integration |  |  |  | | | |
| Milestones finalised by supervisor: | ……………………………………………… Signed ………………………………………………………… Date | | |  |  |
| Prototype hardware handed over to: | ……………………………………………… Signed ………………………………………………………… Date | | |  |  |
| Other items returned to Lab support hatch and checked by: | ……………………………………………… Signed ………………………………………………………… Date | | |  |  |

# Appendix E: Project Completion Form

## Cost Estimates

*Please give detailed calculations and estimates of the overall cost of your actual design below. Take care to include person-hour estimates for your software, board production and debugging, as well as your components and consumables. You should also estimate the production cost of your final unit (you may assume a large quantity are to be produced), the market price and determine how many need to be sold to be profitable. Account for any differences between the actual values and the values given in your original project proposal form.*

## Design Changes

*Briefly summarise any design changes your team had to make to the original design proposal, in order to get your system to work. Do not go into vast detail, as it is anticipated that this will be done by the individuals responsible for these components of the design in the formal report.*

## Actual Project Activities

*Please list the activities that took place during your laboratory time, and indicate when they occurred, and who did them.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Activity | Initials | Fri  am | Fri  pm | Mon  am | Mon  pm | Tue | Wed | Thu | Fri  am | Fri  pm | Mon  am | Mon  pm |
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## Discrepancy in Project Activities

*Comment on any major differences between the planned and actual project activities.*

## Assessment of Effort

*The table below will be used as an indication how team marks should be allocated across the team.*

|  |  |  |
| --- | --- | --- |
| Name | Signature | % of effort |
|  |  |  |
|  |  |  |
|  |  |  |
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|  |  |  |

*If the breakdown is not equal please provide a short explanation below:*

# Appendix F: Box of Bits

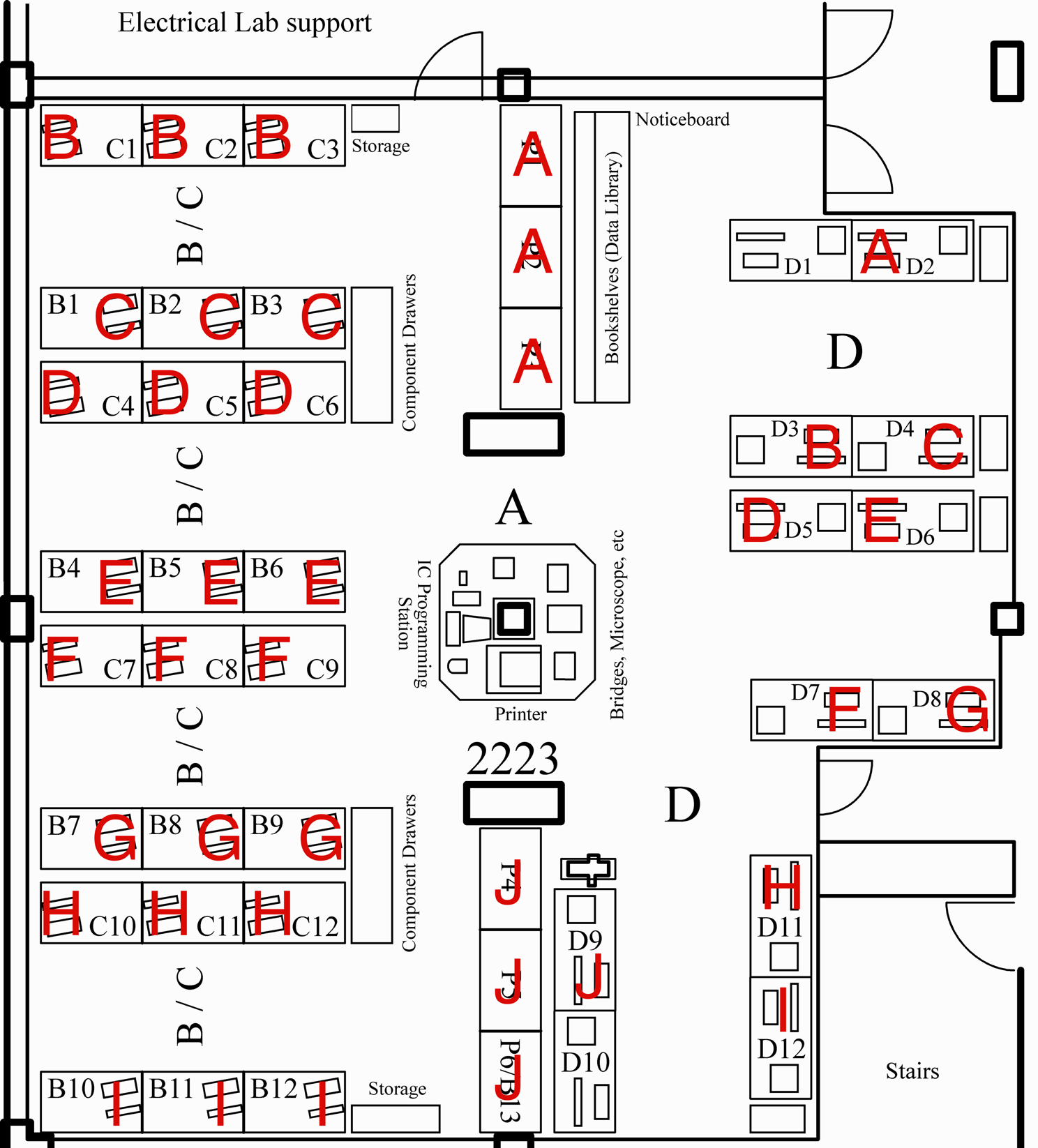
|  |  |
| --- | --- |
| Qty | Item |
| 2 | [Il Matto AVR prototyping board](https://secure.ecs.soton.ac.uk/notes/ellabs/1/x2/) kit |
| 1 | Il Matto SD card adaptor |
| 1 | [SD card](http://onecall.farnell.com/transcend/ts2gsdc/card-sd-2gb/dp/2290235) |
| 1 | [Il Bagatto CPLD prototyping board](https://secure.ecs.soton.ac.uk/notes/ellabs/1/d1/notes.html) kit |
| 1 | [AVR Dragon](http://www.atmel.com/dyn/products/tools_card.asp?tool_id=3891) |
| 1 | [10 way JTAG program/debug cable](http://onecall.farnell.com/molex/92321-1020/cable-assembly-ribbon-10way-20cm/dp/1012209) |
| 2 | [Paired X-Bee Modules](https://secure.ecs.soton.ac.uk/notes/elec2032/D4/XBee/) |
|  | Connectors and cables |

# Appendix G: Design Clinic Schedule

The schedule for the clinic on Monday 24th February is given below. Each slot is only for 20 minutes, so come prepared. Please arrive promptly and wait outside the electronic laboratory until your slot. Tim Forcer will be holding the clinic and he will be in the D area of the laboratory.

|  |  |
| --- | --- |
| Team | Time |
| Armstrong | 1100:1120 |
| Bowie | 1125:1145 |
| Cobain | 1150:1210 |
| Dylan | 1215:1235 |
| Eminem | 1240:1300 |
| Franklin | 1400:1420 |
| Gallagher | 1425:1445 |
| Hendrix | 1450:1510 |
| Ice-T | 1515:1535 |
| Jackson | 1540:1600 |

# Appendix H: Bench Allocation



# Appendix I: Check List

## Week 0: Introduction

|  |  |
| --- | --- |
|  | Attend Kick-off presentation (Thursday 20th February) |
|  | Team Meeting and appoint Team Leader (Thursday 20th February) |
|  | Read this document (Thursday 20th February) |
|  | Meet to discuss and prepare initial design (Friday 21st February) |

## Week 1: Design, investigation and simulation

|  |  |
| --- | --- |
|  | Collect Box of Bits from the Lab Support Hatch (Monday 24th February) |
|  | Attend Design Clinic (Monday 24th February) |
|  | Prepare Detailed design (Monday – Thursday) |
|  | Submit Kit & Component Requisition From (Deadline: 14:00, Tuesday 25th February) |
|  | Submit Project Proposal Form (Deadline: 10:00, Friday 28th February) |
|  | First 3 hour lab session for feedback, simulation and prototyping (Friday 28th February) |
|  | Negotiate Design Completion Form with Rob, Steve or Geoff. |

## Week 2: Prototyping and construction

|  |  |
| --- | --- |
|  | Second 3 hour lab session for feedback, simulation and prototyping (Monday 3rd March) |
|  | Lab open for some time each day, but no supervision - limited support (Tuesday – Thursday) |
|  | 6 hours in lab (Friday 7th March) |

## Week 3: Final assembly, evaluation, presentation and report production

|  |  |
| --- | --- |
|  | 6 hours in lab - complete system integration and final testing (Deadline for construction: 16:30, Monday 10th March) |
|  | Capture still imagery and video footage of your prototype in action (Monday) |
|  | Finalise Design Completion Form (Deadline: 17:00, Monday 10th March) |
|  | Complete Project Completion Form |
|  | Complete team component of final report |
|  | Write individual reports |
|  | Combine & Submit Final Report (Deadline: 16:00, Friday 14th March) |

## Week 4: Trade fair

|  |  |
| --- | --- |
|  | Prepare presentation slides and video advert |
|  | Submit presentation and video advert (Deadline: 12:00, Thursday 20th March) |
|  | Everybody attends Trade Fair (44/1041, Friday 21st March, 10:00 – 13:00) |
|  | One team member presents at the Trade Fair |
|  | One team member attends demonstrations (Lab, Friday 21st March, 14:00 – 17:00) |
|  | Everybody attends Closing Ceremony (Lab, Friday 21st March, 17:00 – 18:00) |

1. ***Detica's Electronic Systems Group delivers practical solutions to challenging problems.***

   Detica ESG have the expertise and domain knowledge to design, build and support custom-made software and hardware. The way they help clients solve their problems ranges from delivering standardised products such as high-speed network equipment through to completely one-off developments, where they conceive, prove and deliver a unique technology solution to the customer's individual requirements. To find out more visit <http://www.deticaesg.com/> [↑](#footnote-ref-1)
2. There is no obligation to use any of the items in the “box of bits”. [↑](#footnote-ref-2)
3. We will endeavour to acquire these as soon as possible, but remember that this will depend on the suppliers’ stock and the external and internal postal services. You should plan to receive your kit at midday on Tuesday 4th of March. [↑](#footnote-ref-3)