

# **Development of a Portable Electroluminescence Measurement System for Photovoltaic Modules**

Final Team Review

Team Solar:

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## 1. Grade Band Recommendation

The team recommends a grade band of D-HD, specifically  $80 \pm 5$ . The team views the overall work done by the team as “Acceptable to Exemplary”, leaning more on the “Exemplary” half. This is based on the analysis of the team’s performance shown in this document. To summarise the project, the team has produced an iterated and fully functional prototype that satisfies the requirements of the project. The team achieved this through informed and timely decision-making paired with excellent teamwork, and effective internal and external communications to support the development of the project. Furthermore, throughout the duration of the project, the team has implemented a regular and systematic reflection process that promotes diverse contributions and ideas. Lastly, the team has embraced the TechLauncher opportunity and has produced an informative, easy to read, and detailed showcase poster that showcases the prototype made by the team. To summarise the assessment of the project throughout the semester, the Audit indications for each of the 3 Audits are as follows:

Audit	Indicator
1	Acceptable without reservations
2	Acceptable without reservations
3	Acceptable without reservations

The indicators given for each criterion in each audit are summarised below. The indicators have ranged from “Acceptable” to “Acceptable to Exemplary”. After reviewing all the work done by the team, the final recommendations in this document for each criterion range from “Acceptable” to “Exemplary”. This is also summarised below.

Criteria	Audit 1	Audit 2	Audit 3	Recommendation
Project Output	Acceptable (2)	Acceptable (2)	Acceptable (2)	Acceptable to Exemplary (2.5)
Decision Making	Acceptable (2)	Acceptable to Exemplary (2.5)	Acceptable to Exemplary (2.5)	Acceptable (2)
Teamwork	Acceptable (2)	Acceptable to Exemplary (2.5)	Acceptable to Exemplary (2.5)	Acceptable to Exemplary (2.5)
Communication	Acceptable (2)	Acceptable to Exemplary (2.5)	Acceptable (2)	Acceptable to Exemplary (2.5)
Reflection	NA	Acceptable to Exemplary (2.5)	Acceptable (2)	Acceptable to Exemplary (2.5)
Design Visualisation	NA	NA	Acceptable to Exemplary (2.5)	Exemplary (3)
Average	Acceptable (2)	Acceptable (2.4)	Acceptable (2.25)	<b>Acceptable to Exemplary (2.5)</b>

Scoring system to determine indicator: Baseline = 1, Acceptable = 2, Exemplary = 3

## 2. Project Output

Based on the criteria, the team views Project Output on an “Acceptable to Exemplary” level. This is because the team has [designed a technical solution](#), built a [fully functional prototype with 2 iterations](#), and [presented the prototype to the client](#). The prototype has been [tested by the team](#), consulting electrical engineer, and client (technical expert) who have [endorsed the system](#) and its outputs twice. Furthermore, the prototype will be validated against the requirements in the technical report using the [TPMs](#) but the document has not been finalised yet. Finally, the prototype surpasses the [crash goals and met half of the stretch goals](#). This is

because the solution was designed following a [systems engineering framework](#) where the system requirements (subsystem requirements encapsulated within high level requirements) were defined early, followed by design and construction to meet those requirements, and then by verifying the results against the requirements. The criteria that do not apply to the team are regarding the commercialisation, publication, grant funding, external validation report, and conference presentation. This is because the [team does not own the IP](#) to the system and therefore cannot produce any publications or commercialise the solution to receive funding, present at conferences or get external validation reports. The only criteria not met by the team is the real-world user testing and validation. This is because the team completed prototyping towards the end of the project and had no opportunity to perform real-world user testing.

### 3. Decision Making

Based on the criteria, the team views Decision Making on an “Acceptable” level. This is because the team has used a systematic method for recording decisions through clear and concise [meeting minutes](#). Furthermore, the team has exhibited transparent communication within the team and with [the client](#), teaching staff, and shadow by being open about the state of the project and any challenges faced such as the unexpected complexity of current regulator. The team has a [centralised group chat](#) for internal communication, with much of the external communication facilitated through the Project Coordinator. The team has also utilised systemic [document revisions](#). Furthermore, the team executed this project through the use of [a systems engineering V-model](#) that guided decision-making as decisions always related to the requirements. The team also had an inclusive [decision-making process as there was feedback in Audit 1](#) about the need for a better internal process. The team then committed to consulting with everybody before [making a decision](#) as opposed to only the sub-team focused on the task. The criteria that the team did not meet was our decision-making process aligning with relevant standards, however, the team did ensure the components used aligned with relevant standards. This is because the team had operated on a system agreed upon by the team as detailed in the [ConOps](#). The team also did not utilise a decision log and recorded decisions only in meeting minutes.

### 4. Teamwork

Based on the criteria, the team views Teamwork on an “Acceptable to Exemplary” level. This is because early on in the project, the team designated [specialist roles and defined the responsibilities by embracing the diverse skill set of each member](#). Furthermore, the team agreed that the roles were not set in stone as members would rotate around the team dependent on which area required more support. The team also defined a [conflict resolution style](#) early on but was lucky to not require it. The team began to build support around the project [from experts as early as 10<sup>th</sup> March \(Week 3\)](#). This process allowed team members to grow and develop new skills. An excellent example of this is when Balaji who has a [Mechanical background](#) had the opportunity to learn soldering from the consulting electrical engineer. As such, [Balaji ended up working primarily on the electrical component which transcends his background](#). The team faced failures during the prototyping phase. The team embraces the failures as an opportunity to learn such as when the camera algorithm was not working as intended and when the current regulator had a heating issue. The team [solved each issue as a team and through guidance from the established support network of experts](#). The only criteria not met by the team was reducing uncertainty as the team operated in two sub-teams for the prototyping process and only collaborated towards the end, increasing the risk of non-integration.

### 5. Communication

Based on the criteria, the team views Communication on an “Acceptable-Exemplary” level. This is because the team believes they have displayed [transparent, relevant, timely,](#)

[professional, respectful, and effective communication with all stakeholders](#). The team also utilises a [systems vocabulary in all documents](#) and whenever talking about the project as evident in the tutorials and in the [meeting minutes](#). For communication with stakeholders, the Project Coordinator has been tasked with facilitating the process. This enables professional communication as there is a sole person of contact which removes any confusion. Furthermore, the team utilises systematic process such as scheduled meetings with all stakeholders and through consistent modes of communication such as emails and MS Teams. From the beginning of the project, the team has created a [shared vision](#) of the project through consultation with the client. This resulted in trust being built with the most important stakeholder. The criteria not met by the team include the common mental models of practice because members operated best at their own pace and method but would come together and finalise the work as a team. Next, empowering members to engage with new audiences was also not achieved as there was no opportunity to engage with more external stakeholders.

## 6. Reflection

Based on the criteria, the team views Reflection on an “Acceptable-Exemplary” level. This is because the team has a system for reflection and acting on feedback. The team achieves this through the feedback response documents for Audit [1](#) and [2](#). In this document, the team analyses and summarises all the feedback given during the Audit process and responds to each one. The team either acts on the feedback immediately, agrees to act on the feedback, or rejects the feedback due to relevance. In this process, the team respects the viewpoints of all members as well as the shadow and teach staff who gave feedback through open discussion. Furthermore, the [team consults with the client and electrical engineer](#) for advice regarding the feedback received. This allows for mentoring and gaining external validation for how well the team is progressing. The team also actively engages with the other teams and clients during the tutorial to provide any feedback where possible through open discussions. The only criteria not met by the team is the additional review process that includes external stakeholders. The team had initially planned on iterating the prototype after conducting user testing with ANU Solarcar to determine how functional and user friendly the system is. However, the client stated that it would only be done if a functioning system was completed in time but as the prototype phase taking longer than expected, this was not achieved.

## 7. Design Visualisation

Based on the criteria, the team views Design Visualisation on an “Exemplary” level. This is because the [showcase poster](#) designed by the team clearly states the motivations for the project, the work done and results achieved, and details the opportunities for new audiences in a coherent, uncluttered, and visually pleasing manner. In the poster, the team also highlights which stakeholders the project delivers value to and complements the information with a functional physical prototype. In the poster, the team has built a story that flows from the current pains of the stakeholders to the accomplishments of the team, and to the opportunities allowed for by the designed solution. This story is told in as non-technical language as possible to appeal to a broad audience and allows for discussions to occur with the team, supplemented by physical prototypes and demonstration videos, to help build an understanding within the new audiences. Furthermore, the team [iterated on the poster](#) to produce a concise and informative poster. The criteria that do not apply to the team is the demonstrates individual contributions criterion as a techlauncher poster should focus more on the holistic work done by the team, and the acts on opportunities for new audiences as the team is able to commercialise the product due to the IP being owned by the client.

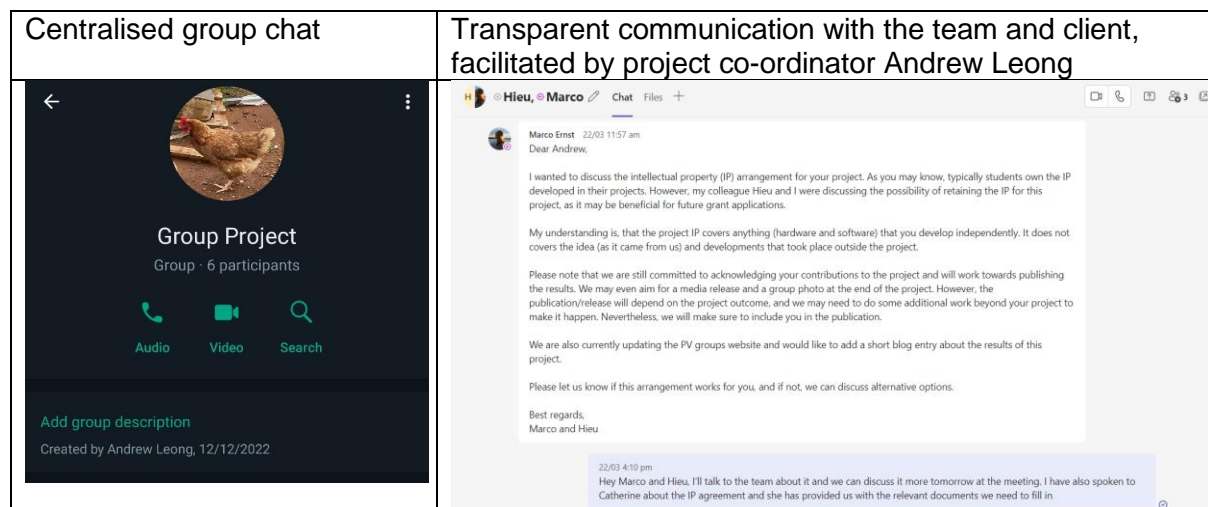
## Supporting Evidence

### Project Output

- Technical Solution: [Design Documentation](#)
- Fully functional 2 prototypes: [Results](#)
- Presented prototype 1 to client, validated by client and experts: [Meeting minutes 15\\_05\\_2023.docx](#)
- Tested by team: [Meeting minutes 14\\_05\\_2023.docx](#)
- Systems Engineering Framework: [Systems Engineering Document.docx](#)
- IP agreement: [IP Agreement](#)

### Decision Making

- Meeting minutes : [Meetings](#)



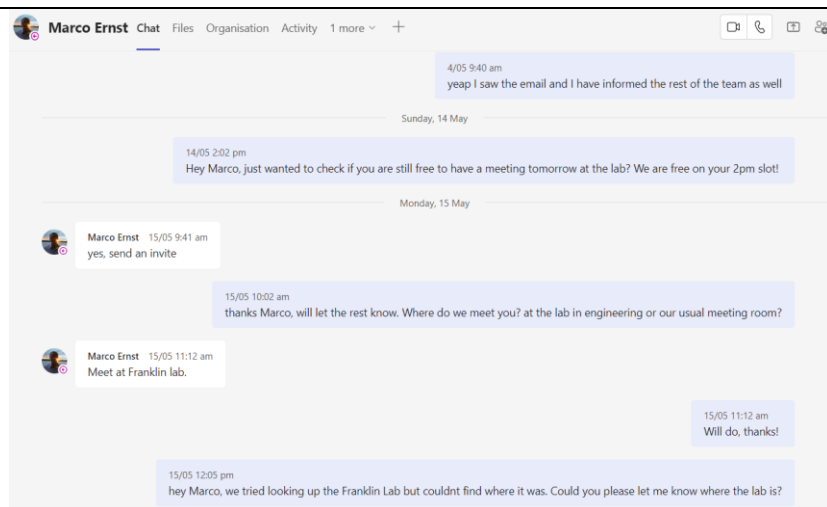
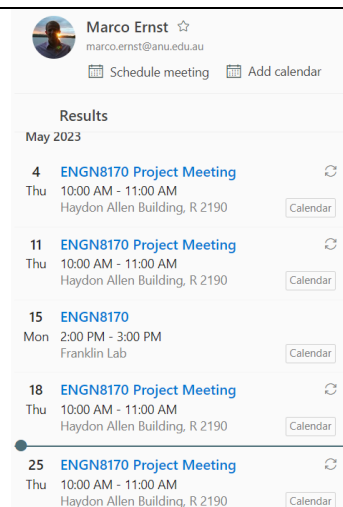
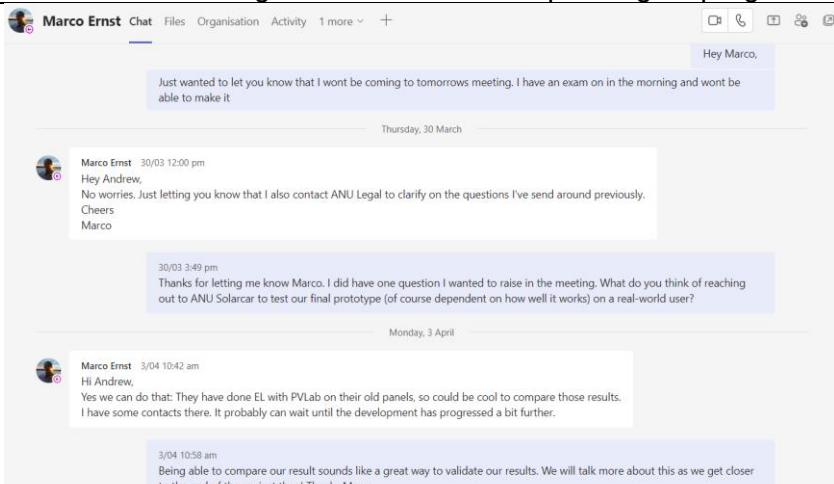
- Document revision: [Archives](#)
- System engineering V-Model: [Systems Engineering Document.docx](#)
- Decision making process for feedback audit 1: [Team Solar Audit 1 Feedback Response.xlsx](#)
- Making a decision: [Team meetings](#)
- ConOps: [Concept of Operations\\_V2.docx](#)

### Teamwork

- Specialist roles and defined the responsibilities by embracing the diverse skill set of each member: [Concept of Operations\\_V2.docx](#)
- Conflict resolution style: [Concept of Operations\\_V2.docx](#)
- From experts as early as 10<sup>th</sup> March (Week 3): [Meeting Note 10\\_03\\_2023.docx](#)
- Mechanical Background: [Landing page](#)
- Balaji ended up working primarily on the electrical component which transcends his background: [Meeting Note 03\\_05\\_2023.docx](#)
- Solved each issue as a team and through guidance from the established support network of experts: [Meeting Note 10\\_05\\_2023.docx](#)

### Communication

- Effective communication with all stakeholders: [Meetings](#)
- Systems vocabulary in all documents: [Documents](#)

Project Coordinator, Andrew, displaying professional communication with client:	Scheduled regular meetings with client:
 <p>Marco Ernst Chat Files Organisation Activity 1 more +</p> <p>4/05 9:40 am yeah I saw the email and I have informed the rest of the team as well</p> <p>Sunday, 14 May</p> <p>14/05 2:02 pm Hey Marco, just wanted to check if you are still free to have a meeting tomorrow at the lab? We are free on your 2pm slot!</p> <p>Monday, 15 May</p> <p>Marco Ernst 15/05 9:41 am yes, send an invite</p> <p>15/05 10:02 am thanks Marco, will let the rest know. Where do we meet you? at the lab in engineering or our usual meeting room?</p> <p>Marco Ernst 15/05 11:12 am Meet at Franklin lab.</p> <p>15/05 11:12 am Will do, thanks!</p> <p>15/05 12:05 pm hey Marco, we tried looking up the Franklin Lab but couldnt find where it was. Could you please let me know where the lab is?</p>	 <p>Marco Ernst ☆ marco.ernst@anu.edu.au</p> <p>Schedule meeting Add calendar</p> <p>Results</p> <p>May 2023</p> <p>4 <b>ENGN8170 Project Meeting</b> Thu 10:00 AM - 11:00 AM Haydon Allen Building, R 2190</p> <p>11 <b>ENGN8170 Project Meeting</b> Thu 10:00 AM - 11:00 AM Haydon Allen Building, R 2190</p> <p>15 <b>ENGN8170</b> Mon 2:00 PM - 3:00 PM Franklin Lab</p> <p>18 <b>ENGN8170 Project Meeting</b> Thu 10:00 AM - 11:00 AM Haydon Allen Building, R 2190</p> <p>25 <b>ENGN8170 Project Meeting</b> Thu 10:00 AM - 11:00 AM Haydon Allen Building, R 2190</p>
<p><b>Plan for contacting ANU Solarcar but depending on progress</b></p>  <p>Marco Ernst Chat Files Organisation Activity 1 more +</p> <p>Hey Marco,</p> <p>Just wanted to let you know that I wont be coming to tomorrows meeting. I have an exam on in the morning and wont be able to make it</p> <p>Thursday, 30 March</p> <p>Marco Ernst 30/03 12:00 pm Hey Andrew, No worries. Just letting you know that I also contact ANU Legal to clarify on the questions I've send around previously. Cheers Marco</p> <p>30/03 3:49 pm Thanks for letting me know Marco. I did have one question I wanted to raise in the meeting. What do you think of reaching out to ANU Solarcar to test our final prototype (of course dependent on how well it works) on a real-world user?</p> <p>Monday, 3 April</p> <p>Marco Ernst 3/04 10:42 am Hi Andrew, Yes we can do that: They have done EL with PVLab on their old panels, so could be cool to compare those results. I have some contacts there. It probably can wait until the development has progressed a bit further.</p> <p>3/04 10:58 am Being able to compare our result sounds like a great way to validate our results. We will talk more about this as we get closer to the end of the project then! Thanks Marco</p>	

- Shared vision of the project from early on: [Meeting 08\\_02\\_2023 Powerpoint .pptx](#)

## Reflection

- Audit 1 Feedback Response: [Team Solar Audit 1 Feedback Response.xlsx](#)
- Audit 2 Feedback Response: [Team Solar Audit 2 Feedback Response.xlsx](#)
- Team consults clients and experts: [Client meetings](#)

## Design Visualisation

- Showcase Poster: [\(Submitted to TechLauncher\) Final edit.pdf](#)
- Poster iteration process:  
[https://www.canva.com/design/DAFi8uVkguM/3pyQNzxX5gXxXdlzKEhu\\_g/edit?utm\\_content=DAFi8uVkguM&utm\\_campaign=designshare&utm\\_medium=link2&utm\\_source=sharebutton](https://www.canva.com/design/DAFi8uVkguM/3pyQNzxX5gXxXdlzKEhu_g/edit?utm_content=DAFi8uVkguM&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton)