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Department of Mechatronics

Report

Vacation Training 1

Name of Firm	**:**	**MicroCare**
Period of Vacation Training	**:**	**First**
Branch of Study	**:**	**Nelson Mandela University**
Year of Study	**:**	**Third**
Vacation Training Start Date	**:**	**27 June 2022**
Vacation Training End Date	**:**	**22 July 2022**

Compiled by
Surname: Flanegan
Student ID: s220324085

Port Elizabeth

26 September 2022

VACATION TRAINING CERTIFICATE STUDENT'S

NAME: Kyle Flanegan

FIELD OF STUDY: BEng Mechatronics

PERIOD OF TRAINING (first/second): .....

EMPLOYER'S NAME AND ADDRESS: Microcare

15 Swartkops Street, North End, Gqeberha, 6001

DATE STARTED SERVICE: 27 June 2022

DATE LEFT SERVICE: 29 July 2022

DATES OF INTERRUPTIONS: 21 July 2022, 22 July 2022

TYPE OF WORK DONE: Embedded development, cloud based systems architecture, electronic hardware testing, microcontroller software design, hardware repair

GENERAL CONDUCT: Focused, hard-working, sharp, motivated, problem-solving ethic

REMARKS: N/A

Name of Supervisor: Pierre Stemmett

Company Designation: Research and Development Engineer

Email & Tel: pierres@microcare.co.za

Qualifications: BEng (Electronic)

Professional Affiliations: .....

Relation to student: .....

DATE: 09/11/2022

EMPLOYER'S SIGNATURE
Certifying that they have read and agree with the contents of the student's vacation training report.

MICROCARE
Co Reg No. 1995/005118/07
VAT Reg No. 4730133891
15 Swartkops Street, North End
Port Elizabeth 6001

OFFICIAL STAMP OF INSTITUTION

VACATION TRAINING REPORT MARKING SCHEME

STUDENT'S SURNAME & INITIALS: Flanegan K STUDENT No. s220324085

YEAR OF STUDY: Third (2022)

PERIOD OF TRAINING COMPLETED (fist/second): First

ASPECT	√	COMMENT
GENERAL		
Physical Appearance:		
Bound	√	
A4, Larger drawings folded to A4	√	
Drawings with CAD or sketch software	√	
Language, style, Grammar:		
English	√	
Style reflects technical document	√	
Third person	√	
Short sentences and paragraphs	√	
Clear and unambiguous	√	
Tables	√	
Drawings & Figures	√	
FRONT MATTER	√	
Cover	√	
First page: Vac. Work certif.	√	
Stamped	√	
Second Page: Mark schedule	√	
Summary	√	
What was done	√	
What was fond out	√	
Significance	√	
Table of Contents	√	
Summary	√	
Nomenclature	√	
Introduction	√	
Central chapters	√	
Discussion and Conclusion	√	
Reference	√	
Appendices	√	

ASPECT	√	COMMENT
List of figures	√	
Page numbers	√	
List of Tables	√	
Page numbers	√	
Nomenclature and Abbreviations	√	
CENTRAL CHAPTERS	√	
Introduction	√	
Name and historical background of institution	√	
Present size and location	√	
Divisions or departments	√	
Available transport and services	√	
Summary of work/project/investigation	√	
Reason why project was undertaken and its importance	√	
Descriptive part	√	
Technical	√	
Detailed description of the projects	√	
Apparatus used	√	
Non-technical	√	
Organization Management	√	
Lay-out planning	√	
Production methods	√	
Handling of Materials	√	
Quality Control	√	
Purchasing	√	
Sales	√	
Maintenance	√	
Discussion of Results, Conclusion, Recommendations	√	
Reference	√	
Appendices	√	

REMARKS:

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MARKED BY: …… DATE ……..

NOTE:

1) The first three lines of this page must be completed, and the page included in the final Vacation Training Report.
2) All students submitting the vacation training reports must complete the VACATION TRAINING REPORT MARKING SCHEME as a self-evaluation.
3) All vacation training reports must be submitted via Moodle, and the Turnitin similarity report should be attached in the appendix.
4) The maximum allowable similarity must be less than 15%.

Summary

Over a four-week period starting 27 June 2022 and ending 22 July 2022, different projects were worked on and observed at a company named MicroCare. MicroCare manufactures a solar electrical components for residential, commercial and agricultural use. Engineering experience was gained working alongside colleagues in the software, repairs and electrical department. In the software department, the first and main project that was worked on involved the communication of clients via IoT networks. The programming of a small inverter for residential use was undertaken. Numerous geyser controller software updates at customers' homes were performed. Individual tasks undertaken include installing a load box used for testing purposes. Less technical tasks undertaken in the repairs department involved scanning products in and out of repairs and sending them to be tested. The assembly and testing of inverters and other electrical products that are manufactured by MicroCare was observed.

A great deal of knowledge was gained after working alongside professionals and witnessing the inner workings of an engineering factory. Learning the foundational abilities necessary in electrical engineering was found to be very educational.

Table of Contents

Nomenclature and Abbreviations

AC	Alternating Current
API	Application Programming Interface
DC	Direct Current
IDE	Integrated Development Environment
IoT	Internet of Things
LCD	Liquid Crystal Display
MC	MicroCare
MCU	Microcontroller Unit
MPPT	Maximum Power Point Tracker
MQTT	Message Queue Telemetry Transport
Pub	Publish
PV	Photovoltaic
Sub	Subscribe
USB	Universal Serial Bus

Introduction

Vacation training took place over a four-week long semester break from 27 June to 22 July 2022 at a solar company called MicroCare. During this period, a variety of tasks were worked on under the supervision of two different employees. One in the software department and one in the electrical and repairs department.

Historical Background

MicroCare started as a small factory producing solar and electronic parts in Nelson Mandela Bay in August 1990 [1]. At that time electricity was inexpensive and renewable energy sources were not frequently used. They manufacture a variety of Bi-Directional Inverters, Solar Regulators (MPPTs), Solar Pump Controllers (VSDs), Solar Monitoring Devices & Accessories. This solar company believes in a greener future using locally made technology to stimulate our economy and energy future [1]. Now more than ever with altered lifestyles in South Africa following Covid-19 with increased electricity prices and load-shedding.

MicroCare has training programs available to guarantee that installations are completed in accordance with a reliable industry standard and have partnered with licensed MicroCare installers across the nation. They offer a free two-day training courses for their solar geyser and solar pumping systems. Additionally, they have teamed up with Merchant West Holdings to support installers in providing financing to the customer.

Size and Location

MicroCare is situated in Swartkops Street, North End, Gqeberha, South Africa with 52 employees working in the factory. The company exports their products worldwide with installers and distributers nationwide. With the increase in customers over the years, MicroCare exhibits significant growth potential.

Divisions or Departments

The factory is designed to be very effective during production with the different departments separated yet accessible from one another. MicroCare has three main departments namely repairs, sales and production/electrical. Production being the biggest with employees in different divisions building the necessary electrical components for the various products. These divisions include the “store” where ALL electrical components are kept, the winding of inductors and transformers, assembly, etc.

Transport and Services

MicroCare owns a company vehicle which allows for employees to travel for work purposes such as attend to clients or transport products.

Summary of Work Done

Throughout the four week period, a great deal of engineering knowledge was gained from assisting in various projects. The first and most important project focused on building a MQTT system by establishing a connection between publishing and subscribing clients via brokers. This was very important for the company as it will allow them to make changes to geyser controllers remotely with the customers permission. The second project, programming a small 600W inverter, also had high importance as customers needed an affordable home inverter to power certain electronics during power outages. Daily tasks included updating geyser controller software at clients' homes and new developments in Port Elizabeth/ Gqeberha. An installation of a load box was performed which was an important task as a load box is required for product testing. Other tasks included scanning products in and out of the repairs department. The assembly and testing of inverters was also witnessed.

Descriptive Part

Technical:

MQTT (Message Queue Telemetry Transport) System

MQTT is a client server publish/subscribe messaging transport procedure. It needed for Machine to Machine (M2M) communications, specifically their geyser controller. They wanted to provide a platform that will allow their customers to control their geyser and update their geyser controller software from anywhere in the world. This project had the highest priority as MicroCare thought it would boost geyser controller sales by a great deal. EMQX, an open source MQTT broker for IoT, was utilized to distribute information to the relevant clients. MQTT X, a program to develop and test IoT applications, was used as a client to subscribe to the topics that were created for test purposes. Arduino IDE was used to set up the connection between publishing and subscribing clients via the broker. The code written for this connection can be found in Appendix A. Colleagues had to communicate well for this project, which provided several learning opportunities.

Objective:

1. Publishing clients, such as sensors, send information (readings) to the broker.
2. The broker is responsible for distributing the information to the relevant subscribers.
3. The subscribing client (user) can subscribe to multiple topics such as “temperature”, this will allow them to receive notifications for topic “temperature” from the broker.

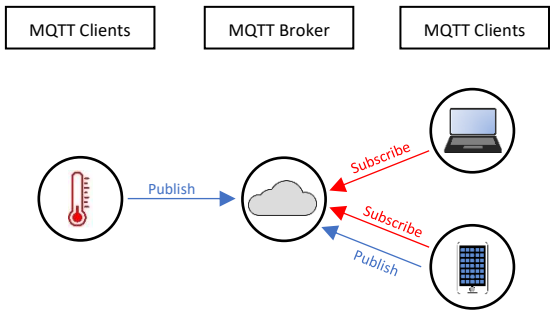


Figure 1:Communication of clients via the broker

Software used in this project:

- **EMQX:** Used to set up a broker to distribute information.
- **MQTT X:** Used as a client so subscribe to the test topics.
- **Arduino IDE:** Used to program the connection between the clients and the broker.

600W Inverter

MicroCare manufactures inverters ranging from 1kW to 15kW, all of which utilize a LCD as a user interface. Due to the power outages that South Africans had been experiencing, many people required a smaller inverter to power a few home electronics. A 600W inverter seemed appropriate as it was affordable and ideal to supply enough power to laptops and TV's etc.

Project Objectives:

1. 600W.
2. Eliminate LCD.
3. Automatically switch on when electricity turns off.

The 1kW to 15kW inverters. One of the main objectives for the 600W inverter was to eliminate the screen. The code from the 1kW inverter was used as a starting point in programming the new 600W inverter. After reading through many lines of code, adjusting the necessary variables and testing the code numerous times, a final efficiency test needed to be conducted. This was necessary to ensure that the final product would be able to withstand a maximum load of 600W.

Apparatus used for the efficiency test:

- **Battery:** 13V battery needed to power inverter.
- **Load box:** Supply a load to the inverter.
- **Light bulbs:** Seven light bulbs attached to the box for a maximum load of 700W.
- **Multimeter:** Used to measure current.
- **Voltmeter:** Used to measure voltage.

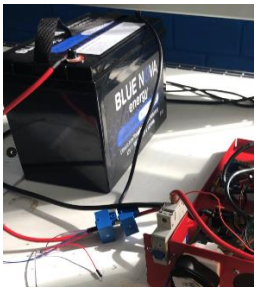


Figure 2: Blue Nova 13V Battery

Figure 3: Load box

Figure 4: Load box connected to inverter

Set-up:

1. Connected the charged 13V battery to the inverter using the red (+) and black (-) wires.
2. Attached seven light bulbs to the load box.
3. Plugged the load box into the inverter.

Procedure:

1. Switched one light bulb (100W) on.
2. Using an ammeter, AC current was measured (blue and brown wires coming from the load box).
3. Using a voltmeter, AC voltage coming into the inverter was measured.
4. AC power was calculated using $P_{AC} = VI$.
5. DC current was measured (red and black wires leading into the battery).
6. DC voltage was measured (voltage across the battery).
7. DC power was calculated using $P_{DC} = VI$.
8. Efficiency at 100W was calculated using $eff = \frac{P_{AC}}{P_{DC}}$.
9. Process was repeated to get power measurements up to 600W buy switching on an additional light bulb and taking readings for each one.

The efficiency test yielded the following results:

Table 1: Efficiency test results for 600W inverter

LOAD	DC Power	AC Power	Efficiency
$0\ W$			
$100\ W$	$125\ W$	$91\ W$	73%
$200\ W$	$238\ W$	$180\ W$	75%
$300\ W$	$359\ W$	$271\ W$	75%
$400\ W$	$498\ W$	$373\ W$	75%
$500\ W$	$642\ W$	$462\ W$	72%
$600\ W$	--	--	--

Conclusion:

The test's results demonstrated that the 600W inverter's efficiency requirements were met. In addition to achieving all of the project's goals, a lot was learned about programming and testing inverters.

Controller Updates

One of the most popular electrical components manufactured by MicroCare is their geyser controller. This device uses an API as an interface which allows the user to set their geyser temperature, turn their geyser on/off, switch between PV (solar energy) and AC, set daily timers to switch from PV to AC . Geyser controllers with older software versions require updates. Many geyser controller updates at customers' homes were witnessed.

Apparatus used to update controller:

- **Laptop:** This was required to use an IDE.
- **Microchip Studio (IDE) :** This was used to program the microchip with the latest software version.
- **PICkit 3:** This debugging tool was used to connect the IDE on the laptop the microchip in the geyser controller.

Figure 5: Geyser Controller

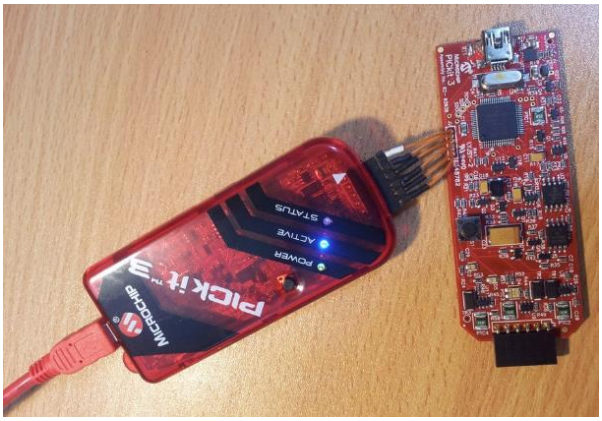


Figure 6: PICkit 3

Load Box

Load boxes are used to test the products after assembly and after repairs to ensure they are in working condition. Load boxes vary in resistance and are located at certain testing stations depending on the product being tested. They provide the resistance required to test the product under maximum load capacity. A new load box needed to be installed in the repairs department. The wiring of electrical components inside the box was witnessed. After the installation, the connection between the box and the power source was undertaken.

Apparatus used to install load box:

- **Tape measure:** Used to measure distances for the holes.
- **Drill:** Used to drill holes through the metal bars.
- **Socket spanner:** This was used to tighten the nuts and bolts.
- **Spirit level:** Used to make sure the box is horizontal (level).
- **Wire cutters:** Used to trim rubbers to expose the wire.
- **Screwdriver:** Used to tighten screws to secure wires.

Figure 7: Load Box

Figure 8: Load box installed

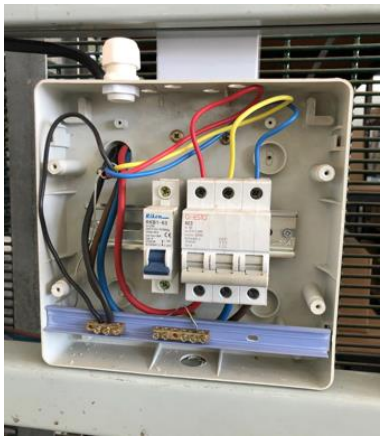


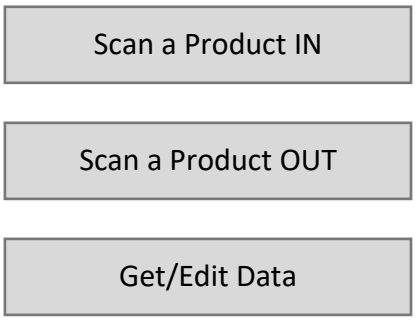
Figure 9: Breaker connection

Repairs Scanning

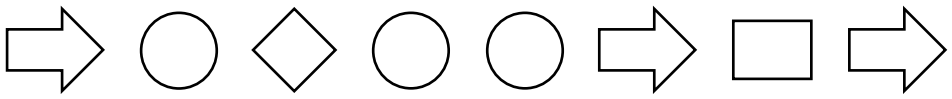
MicroCare uses a highly effective internal system to track the movement of products across departments in the production. To track each product's journey inside the factory, a barcode tag is placed on every item that is brought in for repair. Although this duty required less technical expertise, it formed a crucial part of the production. While working in the repairs section, the following duties were done.

- A product arrives for repairs and receives a repair sheet, which is filled out by an employee. An MPPT repair sheet is shown in Appendix B.
- The system generates a barcode for the product.
- The barcode is placed on the repair sheet and represents a serial number linked to that unit which is scanned when the product enters or exits a department.

The system can perform three operations:



Operational sequence diagram representing the repairing process:



1. A product enters repairs.
2. Perform repair assessment on the product.
3. Identify faults and decide on the necessary repairs.
4. Repair the faults.
5. Perform the necessary tests.
6. Transport product to inspection.
7. Final inspection performed.
8. Repairs complete, product can be sent back to the customer.

Inverter Assembly and Testing

Workers are provided with schematic diagrams and pictures to use as a reference when assembling the various inverters. Only the assembling of electrical components takes place in this department; all the electrical components are manufactured before this step takes place. A lot was learnt while observing the assembly process.

Apparatus used for assembling inverters:

- **Socket spanner:** Used to tighten the nuts and bolts.
- **Glue gun:** Glue wires and electrical components together.
- **Screwdriver:** Used to tighten screws to secure components.
- **Pliers:** Used for to tighten and grip components.

Testing is the last and most crucial step in the production process. Once the inverters have been assembled, they are attached to a mini grid system. The inverters are monitored to ensure they are in perfect working condition. The installation of the three phase mini grid system shown below was observed.

Figure 10: Three phase mini grid system

Non-technical:

Organization and Management

At MicroCare, each employee is given responsibility for their own area and desk. They are responsible for keeping their assigned area tidy, organized and clean. Tools, equipment and machinery are stored in specific places and are expected to be returned each day to ensure that they don't go missing.

Controlling parts within a factory is crucial as they are very expensive. Only authorized people are allowed access to the "store," which houses the electrical components needed to manufacture products. They are expected to sign for any parts they receive from the store.

The parts store, repairs department, and electrical department all have factory supervisors. Each departmental supervisor keeps a close eye on the workers in their charge to make sure they are carrying out their duties correctly.

Lay-out and Planning

The different departments and offices were carefully laid out to ensure efficiency withing the factory. To make it simple for clients to access, the main entrance and offices are situated in the front of the building. These offices handle design, sales, and human resource management. The main entrance has a lounge, coffee station, and reception desk. The factory has a variety of other offices for each department to guarantee that the supervisors can easily reach their division and are not separated from their staff.

The location of the delivery entrance on the building's side makes it simple for vehicles to deliver and pick up products. Since the repair department is located right next to this entrance, retrieving the products that have been brought in for repair is simple. The store is close to repairs and opens onto a station where motherboards are made, allowing for simple access to components.

The electrical department includes the manufacturing of parts, assembly and testing of and is located at the back of the building as the noise would naturally be the loudest. The software department can be found alongside the electrical department as these employees work closely with the electrical department during testing.

Production Methods

Design

If a customer requested a quote, employees would draw up a design for a system to satisfy the customer requirements. If they are happy with the proposal, the system specifications are sent to the electrical department.

Electrical

The motherboards, transformers and other electrical components are built by employees inside the factory and sent to the assembly department. These electrical components are assembled and prepared for testing. Testing takes place once the inverters have been programmed with the relevant software. The units are installed onto the mini grid testing system and monitored with a close eye.

Programming

After being assembled in the electrical department, inverters are programmed. Using Microchip Studio, the appropriate software is flashed onto the microchip found inside the inverter. Once this procedure is completed, testing is conducted.

Handling of Materials

Heavy materials and products are transported between department using a scissor lift. The company owns three scissor lifts and utilizes them each day. Employees are responsible for looking after the materials and equipment they use.

Quality Control

Before a product is delivered to a client, it is thoroughly tested. A final quality inspection is conducted at the end of production. Smaller tests include checking the connections between components and occur after each process in the production line.

MicroCare has check sheets for each department for employees to fill out when testing the unit. These tests are crucial to perform before sending the unit to the next step in the production process.

Purchasing

Standard components required for production are ordered regularly by the store manager to ensure that the factories inventory does not run low. Having the necessary components in the factory eliminates the risk of slowing down the production process.

All inventory is delivered to the factory, where it is checked to make sure it was delivered correctly and without any damage. Once this check is completed, the parts are kept in the store for employees to collect for their tasks.

Sales

The sales managers are responsible for selling to and communicating with clients. MicroCare has numerous regular clients, as well as walk in customers who are looking for a standard solution/system. The company has built a good reputation over the years of its operation and therefore has a large client base which ensures consistency in sales.

Furthermore, they have a servicing division, which is just as crucial as initial sales. Here, they carry out repairs on products that they manufactured.

Maintenance

Factory

Employees are responsible for maintaining a tidy workplace. Each day the factory floors and tables in each department are cleaned by their respective workers.

Equipment

Equipment is cleaned regularly to ensure its proper function. Maintenance on machinery is done every 5 years and broken machinery is replaced immediately.

Products

As mentioned before, MicroCare services and maintains the products that they manufacture. They suggest upgrades to their clients' systems on a regular basis.

Discussion of the Results

Organization and Management

Having the employees in charge of maintaining a tidy workplace is a good method to keep the factory well organised. Equipment does not go missing due to each employees returning the tools that they used.

MicroCare has a good system in place to control their components. The store is convenient for employees to retrieve the necessary components to complete their tasks.

The organisation and management within the company is excellent which leads to efficient production.

Lay-out and Planning

The factory's layout was carefully planned. Separating the factory from the offices reduces noise levels within the office. The entrance is very inviting with a nice environment to engage with customers and employees.

The location of the delivery entrance creates efficiency for the logistics of the company. It is convenient and easy for delivery vehicles to drop off and collect products. The layout of the factory creates a great flow for production and is highly efficient.

Production Methods

The production methods utilised by MicroCare are very efficient and successful. Mostly, the manufacturing process runs smoothly and is completed within the required time. However, due to the large involvement of people in the production process, there is room for error. Wires may break or components may not fit correctly from time to time. This wastes time and materials which could slow down production.

The production methods cannot be automated to reduce these mistakes, which means there will always be human error. Duties could be carried out with precaution and care to reduce the amount of errors.

The programming of inverters is meant to be a quick process. It was noted that there was a shortage in working debugging equipment. The PICkit 3, which is used to program the inverters, often gave issues causing a delay in this department.

Handling of Materials

The use of equipment to help handle materials is effective and all safety standards are adhered to.

Quality Control

In every factory, product quality control is crucial. The safeguards put in place by MicroCare are thought to be adequate for guaranteeing top quality in each of their products. Through this process, the company ensures the quality of every product it sends out.

Purchasing

The purchasing process is professional and works very sufficiently. The factory's inventory is always up to standard, and a shortage of parts hardly occurs.

Sales

MicroCare has grown to become the oldest company in South Africa to produce this range of products. They have done so by maintaining good relationships with clients. The sales managers are very friendly and professional when carrying out their duties. The growth and expansion over the years is due to their consistency in sales.

Maintenance

Although the factory's equipment is kept in good condition, some of the furniture and workspace's can be updated. These factors are not crucial to the production of the products, but they do have an impact on the workers and the aesthetic attractiveness of the company, given that potential customers frequently visit the factory workshop to see the products in action.

Conclusion

MicroCare's employees are very friendly and have built a connection as a team over the years. The products that they manufacture are trusted by many companies and organisations. Quality, service and efficiency are the core values of the company. The different departments run smoothly with supervisors watching over the workers. A few recommendations for the company are as follows:

- Walls and tables could be painted or updated to enhance the overall look of the company.
- Workers could take precautionary measures to reduce the risk of damaging components or products.
- Update debugging equipment to eliminate the delay when programming the products.

References

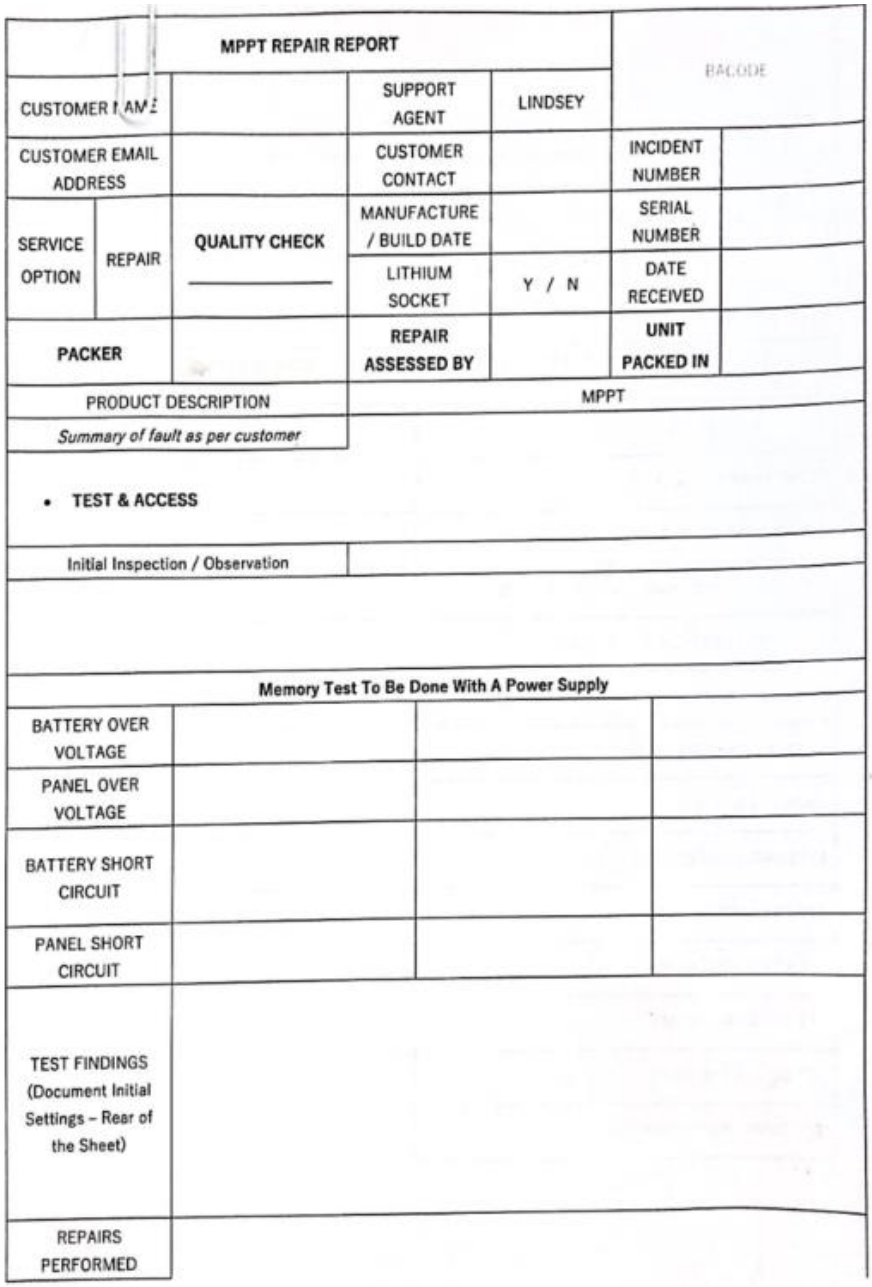
[1] MicroCare, “MicroCare,” MicroCare, [Online]. Available: https://microcare.co.za/. [Accessed 20 08 2022].

Appendices

Appendix A: MQTT Arduino IDE Code

```
#include <ESP8266WiFi.h>
#include <PubSubClient.h>

// Setting up WiFi
const char *ssid = "HUAWEI-A409"; // Enter your WiFi name
const char *password = "01704635";  // Enter WiFi password

// Setting up MQTT Broker
const char *mqtt_broker = "broker.emqx.io";
const char *topic = "topic1";
const char *mqtt_username = "test";
const char *mqtt_password = "test";
const int mqtt_port = 1883;

WiFiClient espClient;
PubSubClient client(espClient);

void setup() {
  Serial.begin(115200);// Set software serial baud to 115200;
  WiFi.begin(ssid, password);// connecting to a WiFi network
  while (WiFi.status() != WL_CONNECTED) {
      delay(500);
      Serial.println("Connecting to WiFi..");
  }
  Serial.println("Connected to the WiFi network");
  client.setServer(mqtt_broker, mqtt_port);//connecting to a mqtt broker
  client.setCallback(callback);
  while (!client.connected()) {
      String client_id = "mqttx_eab8b357";
      client_id += String(WiFi.macAddress());
      Serial.printf("\nThe client %s connects to the public mqtt broker\n", client_id.c_str());
      if (client.connect(client_id.c_str(), mqtt_username, mqtt_password)) {
          Serial.println("Public emqx mqtt broker connected");
      }
      else {
          Serial.print("failed with state ");
          Serial.print(client.state());
          delay(2000);
      }
  }
  client.publish(topic, "hello emqx"); // publish and subscribe message
  client.subscribe(topic);
}
void callback(char *topic, byte *payload, unsigned int length) {
  Serial.println("-----------------------");
  Serial.print("Message arrived in topic: ");
  Serial.println(topic);
  Serial.print("Message: ");
  for (int i = 0; i < length; i++) {
      Serial.print((char) payload[i]);
  }
  Serial.println("-----------------------");
}
void loop() {
  client.loop();
}
```

Appendix B: MPPT Repair Report



MPPT REPAIR REPORT				BACODE	
CUSTOMER NAME		SUPPORT AGENT	LINDSEY		
CUSTOMER EMAIL ADDRESS		CUSTOMER CONTACT		INCIDENT NUMBER	
SERVICE OPTION / REPAIR	QUALITY CHECK _____	MANUFACTURE / BUILD DATE		SERIAL NUMBER	
		LITHIUM SOCKET	Y / N	DATE RECEIVED	
PACKER		**REPAIR ASSESSED BY**		**UNIT PACKED IN**	
PRODUCT DESCRIPTION		MPPT			
Summary of fault as per customer					
• **TEST & ACCESS**					
Initial Inspection / Observation					
Memory Test To Be Done With A Power Supply					
BATTERY OVER VOLTAGE					
PANEL OVER VOLTAGE					
BATTERY SHORT CIRCUIT					
PANEL SHORT CIRCUIT					
TEST FINDINGS (Document Initial Settings – Rear of the Sheet)					
REPAIRS PERFORMED					

Appendix C: Factory Floor Plan