

Power Electronics

DC-AC Inverter Project

Lessonplan

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Overview

This project is divided into two dimensions.

Dimension 1: The project targets three different objectives-

- Improve the trainees' technical knowledge about DC-AC inverters; this content is the same as for the course "Power Electronics."
- Improve trainees' knowledge and understanding of how to manage projects. Trainees are encouraged to do this project correctly by following the project management rules.
- Improve the English skills of the trainees.

Dimension 2: This project is divided into 5 phases- just like with a timeline. These phases are designed to be action-oriented training. The trainer will act as a moderator. Activities will be done mostly by the trainees. Every phase has exercises for technical knowledge, project management knowledge and English training.

- Phase 1: Understanding the project
The trainer defines and explains the project. He divides the class into working groups, so that trainees will have an orientation class to understand about the timelines. The trainer will then discuss with the trainees about the importance of DC-AC inverters. Later on trainees will have to find examples of where to use power inverters in their own life. The trainer will explain with examples how SMART terminology will be used in this project.
- Phase 2: Collecting Information about the project
Groups will be selected and remain the same throughout the project. Trainees will be working in groups of two or three. It is important to know that trainees must educate and inform themselves. This can be completed through use of journals, textbooks, internet and communication with other training organizations, etc. After that, trainees will have to select the information which is best to create the product. Assistance by the trainer will be given only if needed.
- Phase 3: Planning and designing of the product

The groups must now develop a work plan. The trainer can present an example solution at the end of the phase for groups who have weak results.

- Phase 4: Project implementation

Implementation means performing and completing the activities described in the work plan. It requires the coordination of many different activities. The product, the DC-AC inverter, is only one part of the project. Trainees will also have to deliver documentation and test boards or prototypes, week by week.

- Phase 5: Evaluation of the project

The groups present their work results. Other groups will evaluate the result. Mistakes should be analyzed and alternatives developed. "Learning from mistakes" is an important idea to understand and practice in this action-oriented project!

In this document every lesson is designed for 4 hours.

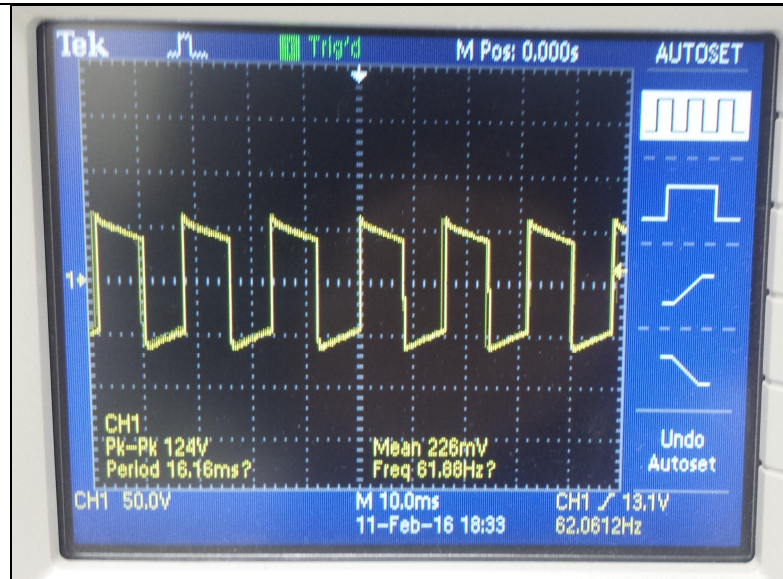
Lesson/Hours	Content
Lesson 1 40 minutes	<p>Introduction</p> <p>Improving English skills:</p> <p>The trainer distributes Task 1A that includes an overview of activities and tasks for this project. Trainees work in groups of two. Trainees have to solve Task 1A. Refer to document "Power Electronics - Task 01." After 20 minutes the trainer asks for the answers. The whole class works on the solutions.</p> <p>Phase 1: Motivation of trainees for the project</p>
70 minutes	<p>Improving technical knowledge</p> <p>Task 2: The class is divided into two groups. Each group has to create a presentation of about 10 minutes in length. Preparation time is 30 minutes</p> <p>Task Group 1:</p> <p>Refer to document "Power Electronics - Task 02 – Group 1"</p> <p>Task Group 2</p> <p>Refer to document "Power Electronics - Task 02 – Group 2"</p> <p>After preparation, each group has 20 minutes to present and have a classroom discussion; to find other examples or ask questions. The trainer evaluates the result and informs the trainees of the evaluation.</p>
30 minutes	<p>Improving technical knowledge:</p> <p>Input by trainer:</p> <ul style="list-style-type: none"> • What is a 12V DC to 230V AC power inverter? • Refer to Presentation "Power Electronics - Trainer Input 01."
20 minutes	<p>Improving English skills:</p> <p>Task 3: Trainees work in groups of two. Trainees have to solve Task 3. Refer</p>

<p>40 minutes</p>	<p>to document "Power Electronics - Task 03." After 10 minutes, the trainer asks for the answer. The whole class works on the solution.</p> <p>Improving English skills:</p> <p>Trainees have to solve Task 4. Refer to document "Power Electronics - Task 04." Trainees work in groups of two.</p> <p>The trainer provides the movie, available in the appendix or from the web https://www.youtube.com/watch?v=VDi_uFSr3w0</p> <p>Trainees can download the movie to their cellphone, a tablet or even to a computer, whatever is available.</p> <p><u>Notes for the trainer:</u></p> <ul style="list-style-type: none"> · Make sure the trainees understand all the vocabulary / technical terms · Play the video clip twice before giving the trainees this activity. · Have the trainees read through the questions · Stop after each question to give the trainees time to write · Give the trainees 10 minutes to finish their task and ask for the answer. The whole class works on the solution.
<p>40 minutes</p>	<p>Improving project management knowledge:</p> <p>Input by trainer:</p> <ul style="list-style-type: none"> · What is project management? · What is a project? · Why do projects fail? · Why do projects succeed? · What are the project phases? <p>· Refer to Presentation "Power Electronics - Trainer Input 02."</p> <p>Homework - Improving Project Management Knowledge</p> <p>The trainer distributes Task 5: Every trainee works alone. Refer to document</p>

60 minutes	<p>Task 6: Trainees work in groups of two. Trainees have to solve Task 6. Refer to document "Power Electronics - Task 06." Check to see if your former project descriptions follow SMART terminology. If they do not follow this terminology, formulate a new description.</p> <p>After 15 minutes the trainer is asking for answers. The whole class discusses these solutions.</p> <p>Improving project management knowledge:</p> <p>All together: The class formulates the project goal utilizing SMART terminology to produce DC-AC inverters.</p> <p>Here is an example:</p> <p>The team (a group of selected trainees) produces one 12V DC to 230V AC inverter for a minimum output power of 15W. The device is usable, when it works a minimum of 30 minutes with a load of 10W. The device must be ready 2 weeks before the trimesters end. Together with the device the team has to provide documentation including project goal, circuit diagram, circuit description, material list, PCB layout, assembling steps and test report.</p> <p>Phase 2: Collect Information about the project</p>
90 minutes	<p>Improving technical knowledge:</p> <p>Groups search on the internet for YouTube videos with content about 12V to 230V inverters. They analyze the content and prepare a presentation that is 5 minutes in length. The presentation should contain description of functionality, advantages and disadvantages of their selected movie.</p> <p>Designated groups of trainees present and discuss their results to the whole class.</p>

	<p><u>Notes for the trainer:</u></p> <ol style="list-style-type: none"> 1. Some examples of these movies are available in the appendix. If trainees are not able to find appropriate movies, the trainer can distribute those movies. 2. Focusing during the presentation to advantages, disadvantages, cost, effort and difficulty. <p>Homework:</p> <p>Trainees must search on internet for related circuit diagrams. They should analyze them and prepare a short presentation including features, advantages, disadvantages and estimating cost.</p>
<p>Lesson 3 60 minutes</p>	<p>Checking Homework</p> <p>Designated groups, chosen by trainer, present and discuss their results to the whole class.</p> <p><u>Notes for the trainer:</u></p> <ol style="list-style-type: none"> 1. Check the presentations before so that results with a variety of concepts are presented, for example: <ul style="list-style-type: none"> • Inverters with Transistors of same type (pairs of NPN or PNP) • Inverters with Power Mosfets • Inverters with one NPN and one PNP Transistor • Different driving circuits for the 50/60 Hz oscillator (timer) 2. The trainer may have to guide the trainees to this decision: The easiest, most efficient and cheapest design is with Power Mosfets. An example documentation that uses Power Mosfets is available in appendix "Power Electronics - Tutorial DC-AC inverter."

30 minutes	<p>Phase 3: Planning and designing the product</p> <p>Improving project management knowledge:</p> <p>Trainer input:</p> <ul style="list-style-type: none"> • Why is planning a very important phase? • How to organize the project <ul style="list-style-type: none"> a) Note the tasks b) Scheduling - timeline c) Assignment of tasks to persons • Refer to Presentation "Power Electronics - Trainer Input 04."
30 minutes	<p>Improving project management knowledge:</p> <p>Task 7: Trainees work in same group like before. Trainees have to solve the Task 7. Refer to document "Power Electronics – Task 07." Develop a project plan. Note the tasks, schedule the tasks and assign the tasks to team members.</p> <p>After 20 minutes the trainer asks for answers. Designated groups present their results. The whole class discusses these solutions.</p>
120 minutes	<p>Phase 4: Project implementation</p> <p>Improving technical knowledge:</p> <p>The Trainer distributes the circuit and components for the oscillator/timer of the inverter circuit. Trainees can determine R and C for the circuit, regarding the needed frequency. They can start to assemble the electronic components on a test board.</p> <p>If the circuit is running, trainees have to measure the output frequency with an oscilloscope. The result should be similar to the picture below.</p>



Picture: Measuring the frequency of the oscillator with an oscilloscope

Homework - Improving project management knowledge:

1. Each group of trainees creates a material list for the project and estimates the cost.
2. Each group finishes developing their project plan (Task 07.) The Trainer will check the results next lesson.

Homework - Improving English skills:

The trainer distributes Task 08 where trainees must match the words on the left with the definition on the right. Trainees work alone. Refer to document "Power Electronics - Task 08." The trainer will collect and evaluate this homework next lesson.

Lesson 4	
30 minutes	Checking homework - Improving project management knowledge: Selected groups of trainees present and discuss their developed material list

30 minutes	<p>to the whole class. Trainees must show the project plan to the trainer.</p> <p>Checking homework - Improving English skills:</p> <p>Selected trainees present their result of Task 8 to the whole class. The trainer announces a quiz for the next lesson.</p>
40 minutes	<p>Improving English skills:</p> <p>Task 9: For this task alone, new groups will be selected to share experience between the groups. Trainees have to solve the Task 9, refer to document "Power Electronics - task 09." After 25 minutes, the trainer asks for answers. The whole class discusses these solutions.</p>
140 minutes	<p>Improving technical knowledge</p> <p>Trainer distributes the circuit diagram and electronic components (Mosfets and transformer) for the power unit of the inverter. Trainees start to assemble the power unit on a test board and use their timer circuit from last lesson to drive it. If the unit is running, trainees have to measure the output voltage.</p> <p>Homework:</p> <p>Trainees proceed to produce a prototype of their DC-AC inverter on a test board.</p>
Lesson 5 90 minutes	<p>Checking Homework</p> <p>Trainees have to show the prototype of their DC-AC inverter to the trainer and the class. Trainees with weak results now have the chance to discuss with other groups how to improve their own product. The entire class is</p>

10 minutes	<p>doing improvement on the prototype.</p> <p>Quiz 1</p> <p>The trainer distributes Quiz 01 where trainees must match the words on the left with the definition on the right. Trainees work alone. Refer to document "Power Electronics – Quiz 01." The trainer will collect and evaluate this quiz.</p>
140 minutes	<p>Improving technical knowledge</p> <p>Trainer input PCB layout:</p> <p>The trainer presents an introduction on how to design boards (PCB) for electrical circuits on a computer. The free software tool EAGLE is a good option to design simple boards. Later on, trainees have to design the PCB layout of the DC-AC inverter. The trainer can show examples referring to document in appendix "Power Electronics – Tutorial DC-AC inverter."</p> <p><u>Notes for the trainer:</u></p> <ol style="list-style-type: none"> 1. Trainees have to plan the size of the PCB. Before they start to design the layout by software, they have to arrange all components on paper and check what space is needed. Trainees have to draw on paper a first draft. 2. Trainees should not forget to add the heat sink on the board. 3. Trainees should not forget to implement connectors for 12V DC input and 230V AC output. 4. Trainees have to select a proper box, which is big enough for all components. Trainees should not forget to add holes to the PCB, where later they will attach the board into the box. 5. For trainees with weak results, the trainer can hand over the example PCB layout from the DC-AC tutorial. 6. Trainees who are ready with the layout can start to etch and drill the boards.

	<p>Homework:</p> <p>The groups finish and improve the existing work plan, circuit diagram, functional description and component list. The trainer will collect the documents for the next lesson to evaluate the results.</p>
<p>Lesson 6</p> <p>60 minutes</p>	<p>Checking Homework</p> <p>The trainer will collect the documents for evaluation. Trainer chosen groups of trainees present their results to the class. Trainees with weak results have now the chance to discuss with other groups how to improve their own product.</p>
<p>180 minutes</p>	<p>Moving on project implementation:</p> <p>The entire class is moving on to the PCB layout design. Then they etch, drill and start to solder the board. Example assembling steps on how to do it are mentioned in the DC-AC inverter tutorial.</p>
<p>Lesson 7</p> <p>230 minutes</p>	<p>Continuing on project implementation:</p> <p>The whole class is moving on for the project.</p>
<p>10 minutes</p>	<p>Homework - Improving technical knowledge:</p> <p>The trainer distributes task 10, frequency of astable Multivibrators. Refer to document "Power Electronics - Task 10."</p>
<p>Lesson 8</p> <p>30 minutes</p>	<p>Checking Homework</p> <p>The trainer will check the task 10. Trainer chosen trainees present their results to the class.</p>

210 minutes	<p>Continuing on project implementation:</p> <p>The whole class is moving on for the project.</p>
<p>Lesson 9</p> <p>240 minutes</p>	<p>Continuing on project implementation:</p> <p>The whole class is moving on for the project.</p> <p>Homework:</p> <ol style="list-style-type: none"> 1. Trainees have to improve their project documentation. This documentation includes: <ul style="list-style-type: none"> ○ Project description ○ Project goal using SMART terminology ○ Circuit diagram ○ Description of circuit functionality ○ Material list ○ PCB layout ○ Assembling steps ○ Test report 2. Trainees have to start developing a final presentation of about 15 minutes in length. The final presentation should be an extract of the project documentation, together with information about the challenges during the project.
<p>Lesson 10</p> <p>30 minutes</p>	<p>Checking Homework</p> <p>The trainer will check the project documentation. Trainer chosen groups of trainees present their results to the class.</p>
200 minutes	<p>Continuing on project implementation:</p>

<p>10 minutes</p>	<p>The whole class is moving on for the project. Trainees should now finish the project implementation phase. Trainees must start a running test, as is defined in the project goal. For the test they have to produce a test protocol including</p> <ul style="list-style-type: none"> · Test circuit · Test environment · Test duration · Test result <p>Homework:</p> <ol style="list-style-type: none"> 3. Trainees have to conclude their final product and the project documentation. 4. Trainees have to conclude a final presentation of about 15 minutes in length. 5. The trainer announces the final exam for the next lesson. The content will be technical and project management questions. <ul style="list-style-type: none"> ○ Frequency of a astable multivibrator ○ Output power, output voltage and efficiency of inverters ○ Project management planning ○ Project management risk ○ SMART terminology
<p>Lesson 11 20 minutes</p> <p>70 minutes</p>	<p>Checking Homework</p> <p>Selected groups of trainees present their final product and discuss with the whole class about possible improvement.</p> <p>Final exam</p> <p>The trainer distributes the final exam. Trainees work alone. Refer to</p>

<p>30 minutes</p>	<p>document "Power Electronics – Final Exam." The trainer will collect and evaluate this final exam.</p> <p>Planning the close out phase</p> <p>The trainer discusses with the trainees how to finish the project. To do the closeout phase, the teams have to organize a small celebration. They discuss who to invite to this event. This can be other trainers, management, external experts or other trainees. For the final evaluation during Phase 5, these visitors form a committee.</p>
<p>120 minutes</p>	<p>Finishing project implementation:</p> <p>The whole class should come to finish the project implementation. Groups who are not finished yet must finish now the running test, as is defined in the project goal. Good trainees can do final improvements on their product.</p> <p>Homework:</p> <p>Trainees continue to improve their final presentation and complete the project documentation. The project documentation includes:</p> <ul style="list-style-type: none"> • Project description • Project goal using SMART terminology • Circuit diagram • Description of circuit functionality • Material list • PCB layout • Assembling steps

	<ul style="list-style-type: none">• Challenges faced during the project• Which activities need to be completed?
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