Active Ankle Foot Orthosis

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**Functional System Requirements**

**subsystem if needed**

REVISION – Draft

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Functional System Requirements

for

Active Ankle Foot Orthosis

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# Introduction

## Purpose and Scope

The Active Ankle Foot Orthosis will be used to aid in the movement for patients with an impaired muscular control or asymmetric condition. This will be accomplished by processing the electrical signals from muscles and sensors to initiate motors to aid in the movement of the ankle joint. The AAFO shall operate from 30 minutes to one hour. The movement generated shall have the user’s intent behind it by sensing this movement from a human signal. The AAFO shall be able to adjust to fit 90% of the population. The AAFO shall be able to generate sufficient torque to flex or extend the ankle joint during walking without any assistance from the ankle extensor/flexor muscle. The AAFO shall function using two signal modes, these modes being EMG (human) signals and sensor (mechanical) signals. These modes should work separately and then may be incorporated into one another. The Active Ankle Foot Orthosis is a proof of concept project.

This specification defines the technical requirements for the development items and support subsystems delivered to the client for the project. Figure 1 shows a representative integration of the project in the proposed CONOPS. The verification requirements for the project are contained in a separate Verification and Validation Plan.



Figure 1. Your Project Conceptual Image

The following definitions differentiate between requirements and other statements.

Shall: This is the only verb used for the binding requirements.

Should/May: These verbs are used for stating non-mandatory goals.

Will: This verb is used for stating facts or declaration of purpose.

## Responsibility and Change Authority

Briefly describe who has the responsibility in making sure the requirements are met (i.e. team leader) and who has the authority to make the changes (i.e. client and team leader).

# Applicable and Reference Documents

## Applicable Documents

The following documents, of the exact issue and revision shown, form a part of this specification to the extent specified herein:

NOTE: examples below, make sure what you use really is what you want to follow!!!! I really would not call out MIL-STD-810 for your project!

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## Reference Documents

The following documents are reference documents utilized in the development of this specification. These documents do not form a part of this specification, and are not controlled by their reference herein.

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| **Document Number** | **Revision/Release Date** | **Document Title** |
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## Order of Precedence

In the event of a conflict between the text of this specification and an applicable document cited herein, the text of this specification takes precedence without any exceptions.

All specifications, standards, exhibits, drawings or other documents that are invoked as “applicable” in this specification are incorporated as cited. All documents that are referred to within an applicable document are considered to be for guidance and information only, with the exception of ICDs that have their applicable documents considered to be incorporated as cited.

# Requirements

This section defines the minimum requirements that the development item(s) must meet. The requirements and constraints that apply to performance, design, interoperability, reliability, etc., of the system are covered.

## System Definition

Provide brief overview of project, and then describe some of the main sub-systems of your proposed solution.

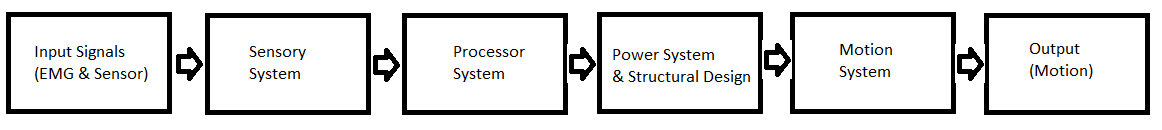


Figure 2. Block Diagram of System

The system will take in either a human EMG signal or mechanical sensor signal which will then be sensed by the Sensory System. The Sensory System will focus on the detection and processing of human nerve impulses through EMG sensors. These signals will be the inputs to our microcontroller. The microcontroller is held within the Processor System which will focus on receiving sensor data, processing, and outputting a signal to the Power System to enable movement. The Power System will focus on the delivery and supply system of power to the motor and will act as the interface in which the Processor and Motor systems will interact. Once receiving power, the Motor System will emulate natural muscle motion to generate a movement for the patient.

Describe the block diagram, what are the subsystems, how do they interconnect. Someone reading this section should get a general idea of what you are building, why, and how it will solve the problem you are solving.

## Characteristics

### Functional / Performance Requirements

#### Operational Time

The AAFO will be able to operate in 30 minutes to one hour sessions.

This is where you list functional requirements such as meeting the “big picture.” For example for a search and rescue system you would the following few functional requirements… Also, units of measure should be consistent with your audience. In the examples below there are a fix of English units and SI units that is because the target customer understands and expects to see those units.

Also, if possible give rationale to the requirement. This way you know why this requirement was specified.

#### User Intended Movement

The movement of the AAFO needs to have the users intent behind it by sensing a human signal.

Rationale: This is the core system performance requirement. Base 1 conditions originate from the environment measured at National Data Buoy Center (NDBC) station 42035, located 22 nm off the coast of Galveston, Texas at (29.232, -94.413), the designated location for system tests.

#### Adjustable Fitting

The Search and Rescue System shall support a search altitude from ### ft to ### ft AGL.

Rationale: The Search and Rescue System has a XXX° FOV and operates with a ### ft to ### ft search altitude for an operational search sweep width from ### ft (~#### NM) to #### ft (~### NM) for a range of targets such as a XXXXX and XXXX respectively.

#### Torque Generation

The Search and Rescue System shall support a search altitude from ### ft to ### ft AGL.

Rationale: The Search and Rescue System has a XXX° FOV and operates with a ### ft to ### ft search altitude for an operational search sweep width from ### ft (~#### NM) to #### ft (~### NM) for a range of targets such as a XXXXX and XXXX respectively

#### Signal Modes

The Search and Rescue System shall support a search altitude from ### ft to ### ft AGL.

Rationale: The Search and Rescue System has a XXX° FOV and operates with a ### ft to ### ft search altitude for an operational search sweep width from ### ft (~#### NM) to #### ft (~### NM) for a range of targets such as a XXXXX and XXXX respectively

### Physical Characteristics

This is the area where you will specify any requirements regarding the physical characteristics of your system. Does it need to not have a mass greater than X, etc. Examples below…

#### Mass

The mass of the Search and Rescue System shall be less than or equal to ### kilograms.

Rationale: This is a requirements specified by our customer due to constraints of their system in which the Search and Rescue System is integrating.

#### Volume Envelope

The volume envelope of the Search and Rescue System shall be less than or equal to ### inches in height, ### inches in width, and ### inches in length.

Rationale: This is a requirements specified by our customer due to constraints of their system in which the Search and Rescue System is integrating.

#### Mounting

The mounting information for the Search and Rescue System shall be captured in the Search and Rescue System ICD.

Rationale: As the Search and Rescue System mounts to platform system, the interface between the two includes mechanical, electrical and thermal details.

### Electrical Characteristics

#### Inputs

1. The presence or absence of any combination of the input signals in accordance with ICD specifications applied in any sequence shall not damage the Search and Rescue System, reduce its life expectancy, or cause any malfunction, either when the unit is powered or when it is not.
2. No sequence of command shall damage the Search and Rescue System, reduce its life expectancy, or cause any malfunction.

Rationale: By design, should limit the chance of damage or malfunction by user/technician error.

##### Power Consumption

1. The maximum peak power for the system shall not exceed ### watts.

Rationale: This is a requirements specified by our customer due to constraints of their system in which the Search and Rescue System is integrating.

##### Input Voltage Level

The input voltage level for the Search and Rescue System shall be +22 VDC to +29 VDC.

Rationale: Aircraft bus specification compatibility, MIL-STD-704F

##### Input Noise and Ripple

The input noise and ripple for the Search and Rescue System shall operate while in the presence of a 1.5 Volt RMS ripple superimposed on the steady-state voltage over the frequency range of 0 Hz to AC.

Rationale: Aircraft bus specification compatibility, MIL-STD-704F

##### External Commands

The Search and Rescue System shall document all external commands in the appropriate ICD.

Rationale: The ICD will capture all interface details from the low level electrical to the high level packet format.

#### Outputs

##### Data Output

The Search and Rescue System shall include a interface compatible with the data system.

Rationale: The Search and Rescue information passes directly to the customer’s system.

##### Diagnostic Output

The Search and Rescue System shall include a diagnostic interface for control and data logging.

Rationale: Provides the ability to manually control things for debugging and a way to view/download the node map with associated potential targets.

##### Raw Video Output

The Search and Rescue System main unit shall include a raw video interface to support external recording.

Rationale: Too much data to store internally. Would be used for diagnostics.

#### Connectors

The Search and Rescue System shall use external connectors in accordance with MIL-DTL-38999.

Rationale: This is a requirements specified by our customer due to constraints of their system in which the Search and Rescue System is integrating.

#### Wiring

The Search and Rescue System shall following the guidelines set forth in MIL-HDBK-5400 paragraph 4.3.35 Wire and cable.

Rationale: Conform to aircraft standard.

### Environmental Requirements

The Search and Rescue System shall be designed to withstand and operate in the environments and laboratory tests specified in the following section.

Rationale: This is a requirements specified by our customer due to constraints of their system in which the Search and Rescue System is integrating.

#### Pressure (Altitude)

#### Thermal

#### External Contamination

#### Rain

#### Humidity

etc….you get the idea

### Failure Propagation

The Search and Rescue System shall not allow propagation of faults beyond the Search and Rescue System interface.

#### Failure Detection, Isolation, and Recover (FDIR)

##### Built In Test (BIT)

The Search and Rescue System shall have an internal subsystem that will generate test signals and evaluate the Search and Rescue System responses and determine if there is a failure.

###### BIT Critical Fault Detection

The BIT shall be able to detect a critical fault on the Search and Rescue System 95 percent of the time.

Rationale: This is a requirements specified by our customer due to constraints of their system in which the Search and Rescue System is integrating.

###### BIT False Alarms

The BIT shall have a false alarm rate of less than 5 percent.

Rationale: This is a requirements specified by our customer due to constraints of their system in which the Search and Rescue System is integrating.

###### BIT Log

The BIT shall save the results of each test to a log that shall be stored in the Search and Rescue System for retrieval and clearing by maintenance personnel.

Rationale: This is a requirements specified by our customer due to constraints of their system in which the Search and Rescue System is integrating.

##### Isolation and Recovery

The Search and Rescue System should provide for fault isolation and recovery by enabling subsystems to be reset or disabled based upon the result of the BIT.

Rationale: This is a requirements specified by our customer due to constraints of their system in which the Search and Rescue System is integrating.

# Support Requirements

Provide details of provided support or requirements for the customer such as the fact that the system requires a laptop with listed requirements. What will you provide with the system? Any requirements for support such as tech support service or warranty? How will you resolve issues in the field? This section may be long or may not be needed at all depending upon the project and customer requirements.

# Appendix A Acronyms and Abbreviations

Below is a list of typical acronyms and abbreviations, please update based upon your project….

BIT Built-In Test

CCA Circuit Card Assembly

EMC Electromagnetic Compatibility

EMI Electromagnetic Interference

EO/IR Electro-optical Infrared

FOR Field of Regard

FOV Field of View

GPS Global Positioning System

GUI Graphical User Interface

Hz Hertz

ICD Interface Control Document

kHz Kilohertz (1,000 Hz)

LCD Liquid Crystal Display

LED Light-emitting Diode

mA Milliamp

MHz Megahertz (1,000,000 Hz)

MTBF Mean Time Between Failure

MTTR Mean Time To Repair

mW Milliwatt

PCB Printed Circuit Board

RMS Root Mean Square

TBD To Be Determined

TTL Transistor-Transistor Logic

USB Universal Serial Bus

VME VERSA-Module Europe

# Appendix B Definition of Terms

Specify anything that needs definition….

# Appendix C Interface Control Documents

Attach ICD for system….