Requirement specification

Mikael Lord

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Status

Examined		
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Project identity

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Department of Electrical Engineering
Linköping Institute of Technology

Name	Responsibility	Telephone	Email
Mikael Lord	Documentation	070 – 400 89 77	`miklo919@student.liu.se`
Anna Lindefelt	Test	073 – 623 27 22	`annli858@student.liu.se`
Mikael Johansson	Customer	070 – 207 29 90	`mikjo941@student.liu.se`
Ville Grandin	Design	070 – 150 11 59	`vilgr522@student.liu.se`
Anders Jonasson	Implementation	073 – 694 30 76	`andjo752@student.liu.se`
Chistian Lyzell	Project leader	073 – 182 04 21	`chrly059@student.liu.se`

Homepage: `http://www.cyd.liu.se/users/~andjo752/`.

Customer: DST Control
Customer contact: Jan-Erik Strömberg, 013–211080, `janerik@dst.se`
Course leader: Anders Hansson, 013–281681, `hansson@isy.liu.se`
Supervisor: Jeroen Hol, 013–282803, `hol@isy.liu.se`
Tutor: Janne Harju, 013–282804, `harju@isy.liu.se`

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Document history

Version	Date	Changes	Sign	Reviewed
0.1	060203	First draw	CL,ML,AL	AJ
0.2	060207	Small changes and corrections	CL,ML,AL	ALL
0.3	060208	Major changes and corrections	ALL	ALL
0.4	060209	Some changes and corrections	ML,MJ,CL	ML,MJ,CL
0.5	060216	2.2 Product figure added 2.6 Hardware overview figure added 2.7 Rotary switch specified 3.3 New requirement, removal and priority change 4.3 New requirement and priority change 5.3 New requirement 6.3 Requirement extended 7.3 New requirements 8.3 New requirements and removal 9 New requirements 10 Requirement change	ML,CL	ML
0.6	060222	2.7 Requirement 5: modularity added	ML,MJ,CL	ML,MJ,CL
1.0	060315	Approved as version 1.0	J. Hol	
1.1	060504	Requirement 8 has been added, as discussed with supervisor Jeroen Hol	CL	AL

1 Introduction

The *General Aviation* (GA) aircraft fleet has become very old (40+ year old aircrafts are now very common) thanks to reliable air frames and rapidly increasing prices of new light aircraft. A vast majority of these aircrafts are equipped with old-fashioned mechanical flight instruments, now reaching the end of their lifetime as the air frames become older. Instead of performing a complete upgrade of the entire instrument panel, which can result in costs often exceeding the value of the entire aircraft, one can complete the system with a much more affordable Micro EFIS. A Micro EFIS is, as the name implies, a small EFIS (*Electronic Flight Information System*), targeted for the GA market. It is intended as a backup system for the mechanical flight instruments.

In this document the project requirements will be specified. Every requirement will be stated as:

Requirement x [**P**y] Requirement description.

The priority levels are defined as follows:

P1 Highest priority. These requirements must be fulfilled before the project closure.

P2 Normal. Shall normally be fulfilled, but are negotiable.

P3 Lowest. These demands will be fulfilled if time allows it.

1.1 Parties

Customer: Jan-Erik Strömberg, DST Control, Linköping

Supervisor: Jeroen Hol, Department of Electrical Engineering, Linköping Institute of Technology

Producent: A group of six students at Linköping Institute of Technology

1.2 Goal

The goal of this project is to design a stripped down version of a Micro EFIS and to evaluate the implementation based on state-of-the art *organic graphical display*; a so called OLED display. This to ensure high endurance at extreme temperatures (down to $-30°$ C). The system shall be implemented on one single FPGA to meet the need to be *small in size* and have a *low*

cost. Since it is intented as a backup system it must have a *high reliability*, be *independent of external systems* and *simple to use.* To increase the ease of upgrading the system and to *incrementally add functions*, it shall be built in modules.

1.3   Use

The system is intented as a backup for the mechanical flight instruments and the primary use is in the case of instrument failure.

1.4   Background

This project is within the frame of the "Automatic Control Project Course, CDIO" at Linköping Institute of Technology.

1.5   Notation and abbreviations

The following abbreviations and notations will be used:

ADI Attitude and Direction Indicator

A/C Aircraft

DST DST Control AB: the project owner

EFIS Electronic Flight Information System: a standardised terminology used for a system of sensors, computers and displays designed to present critical flight data to the pilot

ESI Engine Status Indicator

GA General Aviation: non-commercial air traffic (including aircraft operated by companies for internal use only)

GND Ground Level

GUI Graphical User Interface

HSI Horizontal Situation Indicator

MSL Mean Sea Level

2   System overview

2.1   Product description

The product that is going to be delivered is a Micro EFIS (Electronic Flight Information System) aimed for the GA market. It is intended to be used as a backup system for the mechanical flight instruments, in case of instrument failure.

2.2   Product components

The Micro EFIS consists of an instrument casing with specific measures ($60 \times 60 \times 50$ mm), with a user interface on a single monochrome display (128×64 pixels) and one single rotary mode selector switch. A user manual and technical documentation will be included at delivery.

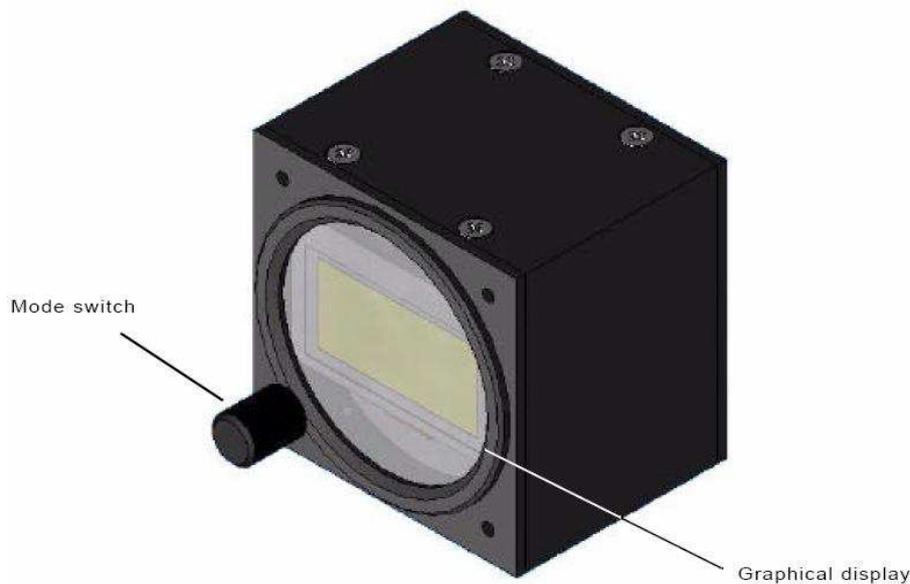Figure 1: Micro EFIS box

2.3   Dependences

The back panel consists of a number of multi-purpose connectors for future expansion. The six leftmost connectors are intended for connection of distributed sensor units, defined by the customer. The topmost connector on the right is used for power supply. The second connector in the right end is intended for upgrading the software of the Micro EFIS.

2.4   Subsystems

The system will be divided into the following subsystems: OLED unit, HSI/ADI/ESI display modes, setup mode, and a rotary switch unit.

2.5   Restrictions

The group does not supply any support after project closure. No garanties except fulfillment of the requirements will be given.

2.6   Design method

The system shall be built in modules with well defined interfaces to enable upgrading a single subsystem independent of the others. The system shall be developed with use of VHDL, if needed a softcore will be included. One single FPGA shall be used and the use of FLASH is optional.
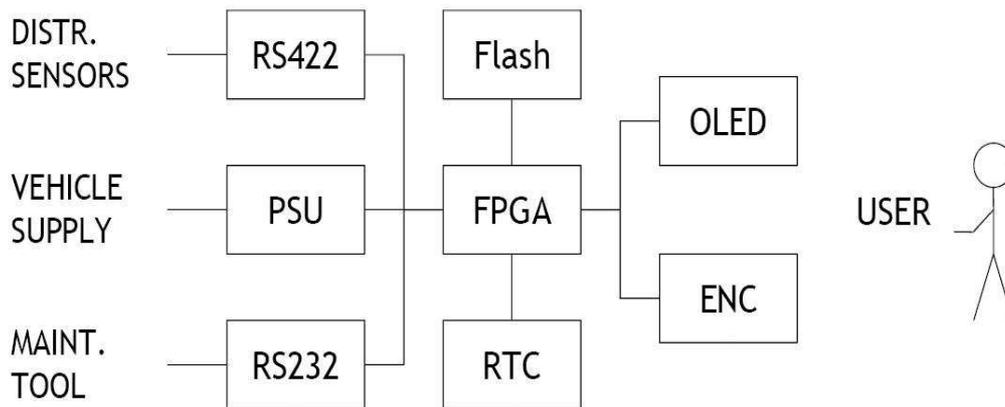
Figure 2: System hardware overview

2.7   General requirements

Requirement 1 [P1] *The system shall fit in a box with dimensions* $60 \times 60 \times 50\,mm$.

Requirement 2 [P1] *An organic* LED *with dimensions* 128×64 *pixels shall be used to display the data.*

Requirement 3 [P1] *A single* FPGA *of type Xilink Spartan* 3 *model XC3S1000 shall be used for all calculations.*

Requirement 4 [P2] *The integrated hardware/firmware development environment* Protel/DXP *by Altium shall be used.*

Requirement 5 [P1] *The implementation will be modular and the code will be uniform, well structured, and commented.*

Requirement 6 [P1] *A rotary mode selector switch of type* EM11B *shall be used to interact with* Micro EFIS.

Requirement 7 [P2] *The communication between* FPGA *and sensors shall use* RS422 *protocol.*

Requirement 8 [P1] *If the project group has not received the hardware card at the 3rd of May 2006, then all the requirements only have to be fulfilled in simulation.*

3   OLED unit

The OLED subsystem is consisting of the graphical display module (128 × 64 pixels) and associated hardware in the FPGA.

3.1   Description

The graphical display is based on state-of-the-art organic technology; a so called OLED display. Organic materials have the benefit of operating over a wide temperature range as required by the GA market. In particular the display is guaranteed to work down to $-30°\,$C without any degradation in performance. Another important factor is long life expectancy since OLED displays are active emitting light by itself (as opposed to passive LCD displays requiring an external light source) it is ideal for operation in situations of total power failure. Unfortunately there are no colour OLED displays currently available on the market. Therefore the initial graphical user interface is limited to various intensities (16 levels) of the yellow light emitted by the selected display.

3.2   Interface

The information given by the HSI, ADI, ESI and Setup mode shall be displayed on the OLED.

3.3   Requirements

As the graphical display has no character generating hardware, all such functions will be implemented in the FPGA.

Requirement 9 [P1] *The typefaces that will be created shall be* DST *based and approved by* Liana Pop.

Requirement 10 [P2] *The display shall be able to output the characters needed by the* HSI, ADI, ESI, *and* setup mode.

Requirement 11 [P3] *Graphical objects such as circles, dynamic lines, and similar will be used to present data.*

4   HSI display mode

4.1   Description

The Horizontal Situation Indicatior, HSI, provides the basic horizontal view of the A/C heading and navigation. The system usually displays data such as: roll angle, pitch angle, slip (lateral g force), air speed, pressure altitude, true elevation, vertical speed, and outside air temperature. If the A/C is equipped with a GPS system, then ground speed and true altitude also can be given. This project aims to produce a stripped downed version of an EFIS, and will only implement the most significant parts.

4.2   Interface

The HSI communicates with the rotary switch, OLED unit, and sensors.

4.3   Requirements

Requirement 12 [P2] *The following data shall be presented in* HSI *mode: roll angle, pitch angle, slip (lateral g force), outside air temperature* (OAT), *and vertical speed* (VS).

Requirement 13 [P3] *The following data shall be presented in* HSI *mode: air speed* (AS), *pressure altitude* (PA).

5   ADI display mode

5.1   Description

ADI is an abrivation for Attitude and Direction Indicator, which is a system to present common data such as: magnetic heading, direction/track to radio beacon (if ADF or VOR receiver is provided), and outside air temperatur. If the A/C is equipped with a GPS system, then true heading and true track also can be given. This project aims to produce a stripped downed version of an EFIS, and will only implement the most significant parts.

5.2   Interface

The ADI communicates with the rotary switch, OLED, and sensors.

5.3   Requirements

Requirement 14 [P2] *The following data shall be presented in* ADI *mode: magnetic heading* (MH) *and outside air temperature* (OAT)*.*

Requirement 15 [P3] *The following data shall be presented in* ADI *mode when* GPS *is provided: true heading* (TH) *and true course* (TC)*.*

6   ESI display mode

6.1   Description

The Engine Status Indicator, ESI, provides the basic information about the A/C condition such as: battery voltage, alternator current, load current, engine RPM, engine manifold pressure, engine fuel flow, engine fuel pressure, engine oil pressure, engine oil temperature, engine cylinder head temperature, and engine exhaust gas temperatur. This project aims to produce a stripped downed version of an EFIS, and will only implement the most significant parts.

6.2   Interface

The ESI communicates with the rotary switch, OLED, and sensors.

6.3   Requirements

Requirement 16 [P2] *The following data shall be presented in* ESI *mode: date and time.*

Requirement 17 [P3] *The following data shall be presented in* ESI *mode: battery voltage, alternator current, load current, engine oil pressure, and engine oil temperature.*

7   Setup mode

7.1   Description

The purpose of the setup mode is that the user can set parameters, as seen in the requirements below.

7.2   Interface

The manual setup is done by using the rotary switch and a GUI on the OLED.

7.3   Requirements

Requirement 18 [P2] *The real-time clock shall be programmable in setup mode.*

Requirement 19 [P3] *The static pressure, given by air traffic control, shall be programmable in setup mode.*

Requirement 20 [P3] *Some information displayed in the main modes (HSI, ADI) can be turned off.*

Requirement 21 [P3] *The light intensity of the* OLED *shall be changeable by an external digital input.*

Requirement 22 [P3] *There shall be two light intensity modes: normal and dimmed. The intensity levels in each mode will be adjustable.*

8   Rotary switch unit

8.1   Description

The rotary mode switch has the function of switching between the different graphical modes as described above. It utilizes a button integrated with a rotary switch.

8.2   Interface

The rotary switch sends its signals to the FPGA.

8.3   Requirements

Requirement 23 [P1] *The rotary switch shall be robust and "bounce free".*

Requirement 24 [P2] *The rotary switch shall handle turns and single tap.*

Requirement 25 [P3] *The rotary switch shall handle long and double taps*

9   Upgrade requirements

There shall be a way to upgrade the Micro EFIS with new future functions.

Requirement 26 [P1] *Software upgrades will be downloaded via serial protocol* RS232.

Requirement 27 [P3] *A version number system will be developed to ease version control at upgrades.*

Requirement 28 [P3] *An upgrading software for* Windows *will be developed.*

10   Reliability

The most important property of the system is not that it is fast and effective but that it works every time. I.e. it is more important that the system is robust than it having high performance, although high performance is desired.

Requirement 29 [P2] *The system shall be able to run for several hours without failure.*

11   Economy

The total number of working hours should be about 1200.

Requirement 30 [P1] *The number of tutor hours available is* 40.

12   Deliveries and subdeliveries

The list below specifies the *decision points* (DP) at which the deliveries shall be made. The date for the DP1 is set to 2006-02-16 and DP2 2006-03-01. The final decision point DP6 is set to 2006-05-19. For remaining DP, see the project plan.

Requirement 31 [P1] *The* requirement specification *shall be delivered at* DP1.

Requirement 32 [P1] *The* system outline *shall be delivered at* DP2.

Requirement 33 [P1] *The* project plan *shall be delivered at* DP2.

Requirement 34 [P1] *The* time plan *shall be delivered at* DP2.

Requirement 35 [P1] *The* design specification *shall be delivered at* DP3.

Requirement 36 [P1] *The* test plan *shall be delivered at* DP3.

Requirement 37 [P1] *The* test results *shall be delivered at* DP5

Requirement 38 [P1] *The* user manual *shall be delivered at* DP5

Requirement 39 [P1] *The final product shall be delivered att* DP5 *and be presented to show that the* requirement specification *is fulfilled*

Requirement 40 [P1] Technical documentation *shall be delivered at* DP6

Requirement 41 [P1] *The* project homepage *shall be delivered at* DP6

13   Documentation

The purpose of the documentation is to inform the customer about the product, to be a tool to structurize the project, make it efficient/effective and to capture the experience for future work.

Requirement 42 [P1] *The documents of the project will be written in LaTeX and use the ©LIPS document structure.*

The following documents shall be produced according to ©LIPS:

- Requirement specification

- System outline

- Project plan including list of activities

- Time plan

- Design plan

- Test plan

- Test results

- Time report including status report

- Technical documentation

- Reflection

- User manual

14   Education

Education in fields such as LIPS-model, OLED and FPGA will be given if needed by ISY and DST Control.

References

[1] Tomas Svensson & Christian Krysander, *Projektmodellen Lips*, kompendium, Linköpings Tekniska Högskola, Version 1.2.

[2] George Grätzer, *Math into LaTeX*, Birkhäuser, 1996.

[3] Jan-Erik Strömberg, *Requirement specification – Micro EFIS*, DST Control, MEFIS/Doc/Spec/R0543S01.fm, version 1.0.0.