ODTÜ Very Light Aircraft Project

Preliminary Design Report

ABSTRACT: This report covers the conceptual and preliminary design and trade-off studies of VLA project.

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CONTENTS

1.1. Avionics, Missions & Electrical System

Our intention in this report is to present our ideas for the electrical and avionic architecture of our VLA

1.1.1. Avionics and BFI

1.1.1.1. Choosing the Avionics

As choosing the necessary avionic devices for the aircraft, the requirements specified by the TAI is considered. Corresponding requirements considered in this process can be seen at Table 3.5 1.

G5 ve GTX345 tablolarda yok,

Requirement	Definition	Chosen Avionic
ODTÜ-VLA-SRD-017	Gösterge ve Kontrol Sistemi, Haberleşme/Tanıma Sistemi, Seyrüsefer Sistemi, diğer elektronik arayüzü olan uçak sistemlerinin ve bu sistemlerin destek/bakım fonksiyonlarının kontrol edilmesini (pilota ve/veya bakım personeline yönelik), gerekli veri gösterimini ve veri girişini sağlayacaktır.	Garmin G500 TXI-Garmin GTN 750
ODTÜ-VLA-SRD-018	Veri gösterim fonksiyonu etkin görev yönetimi için gündüz koşullarında gerekli bilgiyi pilota sağlayacaktır.	Garmin G500 TXI-Garmin GTN 750
ODTÜ-VLA-SRD-019	Kontrol fonksiyonları, muhtemel tüm uçuş koşullarında pilotların uçuş ve görevlerini etkin bir şekilde icra edebilmesi amacıyla, aviyonik sistemleri kontrol edebilmesini sağlayacaktır.	Garmin G500 TXI-Garmin GTN 750
ODTÜ-VLA-SRD-020	Gösterge ve Kontrol sistemi CS-VLA ve SHGM Talimatnamesi'ni sağlayacak sistemlerden oluşacaktır:	Garmin G500 TXI-Garmin GTN 750
ODTÜ-VLA-SRD-021	Seyrüsefer sistemi Prototip Uçak'ın pozisyonu, hızı, yatışı, yunuslaması, irtifası, mutlak irtifası, baş açısı ve benzeri ilgili verileri; işlemek, belirleyebilmek, ilgili sistemlere sağlamak ve göstermek için gerekli fonksiyonları yerine getirecektir.	Garmin G500 TXI-Garmin GTN 750
ODTÜ-VLA-SRD-022	Seyrüsefer sistemi CS-VLA ve SHGM Talimatnamesi'ni sağlayacak sistemlerden oluşacaktır.	Garmin GTN 750
ODTÜ-VLA-SRD-023	Haberleşme/Tanıma Sistemi Ses Dağıtım, VHF radyo haberleşme, Mode-S Transponder kabiliyetlerine sahip olacak ve bu sistemlerin kontrolünü sağlayacaktır	Garmin GTN 750-Garmin GTX 335
ODTÜ-VLA-SRD-024	Sesli ikaz üretimi fonksiyonu pilotların her uçuş koşulunda sesli ikazlarını duymasını sağlayacaktır.	Garmin GMA 345
ODTÜ-VLA-SRD-026	Dâhili Haberleşme Sistemi, Haberleşme ve Radyo Seyrüsefer Sistemi sesleri ve insan sesi iletimi ve kontrolünü sağlayacaktır.	Garmin GMA 345
ODTÜ-VLA-SRD-027	Dahili haberleşme fonksiyonu ile pilotlar arasında çift yönlü eş-zamanlı haberleşme mümkün olacaktır.	Garmin GMA 345
ODTÜ-VLA-SRD-028	Hava-hava, hava-yer haberleşmesi bir adet VHF radyo ile sağlanacaktır.	Garmin GMA 345
ODTÜ-VLA-SRD-029	Uçakta SHGM talimatnamesine göre otomaktik çalışan ve uçağa sabit monte adilmiş (AF tip) 121,5 / 243,0 / 406 Mhz frekanslarında yayın yapabilen bir adet ELT olabilecektir.	Artex ME406 ELT
ODTÜ-VLA-SRD-030	Tanıma Sistemi : Uçakta tanıma sistemi olacaktır.	Garmin GTX 345

Table 3.5 1 Table

Required Equipment	Chosen Avionic
Seyrüsefer Ekipmanı	Garmin GTN 750
Transponder	Garmin GTX 345
Hız/İrtifa Göstergesi	Garmin G5
Motor&Yakıt Kontrol Paneli	Garmin G500 TXI
Elektrik Kontrol Paneli	Garmin G500 TXI
Saat	Garmin G500 TXI
ELT (Emergency Locator Transmitter)	Artex ME 406 ELT
Magnetic Compass	
Statik Port	Garmin G500
Pitot Tube	
Stall Uyarısı	
Haberleşme Sistemi	Garmin GMA 345

Table 3.5 2 Table

1.1.1.2. Avionics

Avionic	Configuration	Functionality	Width	Height	Dept
G500 TXI	10.6”	Display	11.4”	7.25”	3”
G500 TXI	7”	EIS	5.5”	7.25”	3”
GTN 750	-	GPS/NAV/COMM/MFD	6.25" (159 mm)	6.00" (152 mm)	11.25 (286 mm)
GTX 345	-	ADS-B & Transponder	6.30” (160 mm)	1.65” (42 m)	10.07” (256 mm)
GMA 345	-	Audio Panel	6.30" (160 mm)	1.33" (34 mm)	8.09" (205 mm)
G5	-	Attitude Indicator	3.4” (86.4 mm)	3.6" (91.4 mm)	3.0” (76.2 mm)

Table 3.5 3

Avionic	Configuration	Functionality	Weight	Weight with Additions
G500 TXI	10.6”	Display	6.49 lbs.	7.25 lbs. (with integral ADAHRS)
G500 TXI	7”	EIS	3.99 lbs.	4.45 lbs. (with integral ADAHRS)
GTN 750	-	GPS/NAV/COMM/MFD	9.3 lbs. (4.24 kg)	
GTX 345	-	ADS-B & Transponder	3.1 lbs. (1.41 kg)	
GMA 345	-	Audio Panel	1.78 lbs. (807.4 g)	
G5	-	Attitude Indicator	13.3 oz (377.0 g)	

Table 3.5 4

1.1.1.2.1. Garmin G500 TXI

The G500 TXi is a display and sensor system available in three display options:

- GDU 1060 – 10”display
- GDU 700P – 7”portrait display
- GDU 700L – 7”landscape display

Display options can be seen at Figure 8. Depending on system specifics one or more of the following functions may apply:

1. **Primary Flight Display (PFD)** – provides attitude, heading, air data, and navigation information to the pilot
2. **Multi-Function Display (MFD)** – provides pilot awareness of factors that may affect the overall conduct of a flight
3. **Engine Indicating System (EIS)** – provides engine and airframe operating parameters to the pilot

Due to its natural support to EIS, we decided to use G500 TXI over G500. With an integrated EIS at Figure 9, G500 TXI can simply display any vital engine information on its screen. Considering the display configurations for the 1060 and 700P at Figures 176 and 177 respectively, we decided to use 10” configuration and 7” configuration of the G500 TXI instead of dual 7” option. Using MFD/PFD configuration of 10” configuration and EIS only mode of 7” configuration, pilots can be informed about the plane from two screen.

Figure 1 GDU 1060 Display Configuration

Figure 2 GDU 700P Display Configuration

Electrical loads of subsystems of G500 TXI can be seen at Figure 179.

LRU	14 Volt Current Draw		28 Volt Current Draw	
	Typical	Maximum	Typical	Maximum
GDU 700( )	3.0 A	6.0 A	1.5 A	3.0 A
GDU 1060	5.0 A	8.0 A	2.5 A	4.0 A
GRS 79/GMU 44	480 mA	958 mA	240 mA	479 mA
GRS 77/GMU 44	600 mA	1.0 A	300 mA	1.0 A
GSU 75( )/GMU 44/GTP 59	760 mA	958 mA	380 mA	479 mA
GDC 72/GTP 59	420 mA	958 mA	210 mA	479 mA
GDC 74( )/GTP 59	410 mA	480 mA	200 mA	235 mA
GAD 43	410 mA	720 mA	210 mA	350 mA
GAD 43e	790 mA	1.22 A	390 mA	590 mA
GCU 485	120 mA	357 mA	64 mA	179 mA
GEA 110	0.30 A	0.60 A	0.15 A	0.30 A

Figure 3 Electrical Load of Subsystems of G500 TXI

1.1.1.2.2. Garmin GTN750

Figure 4 Garmin GTN750

1.1.1.2.3. Garmin GMA345

Figure 5 Garmin GMA 345

1.1.1.2.4. Garmin GTX345

Figure 6 Garmin GTX 335/345

1.1.1.2.5. Garmin G5

Figure 7 Garmin G5

1.1.1.3. Proposed Avionic Architecture

Figure 184 shows our design for the avionic architecture. The avionic architecture relies mainly on ARINC-429 standard, which is well known to be wide spread in non-military avionic applications. However, the system also employs discrete and Ethernet connections. To denote briefly the individual components on the architecture:

- **CV / FDR** stands for “Cockpit Voice / Flight Data Recorder”, is the black box of the aircraft.
- **G500** represents Garmin G500 dual screen electronic display.
- **BFI** or more commonly BFS is the “Backup Flight System”.
- **ADC** is the air data computer.
- **INS / GPS** stands for the Inertial Navigation System and the Global Positioning System.
- **ELT** is the Emergency Locator Transmitter.
- **ICS** is the Intercom equipment.
- **V/UHF** is the Very High and Ultra High Frequency Radio.
- **Mode-S** is the Mode-S Transponder.

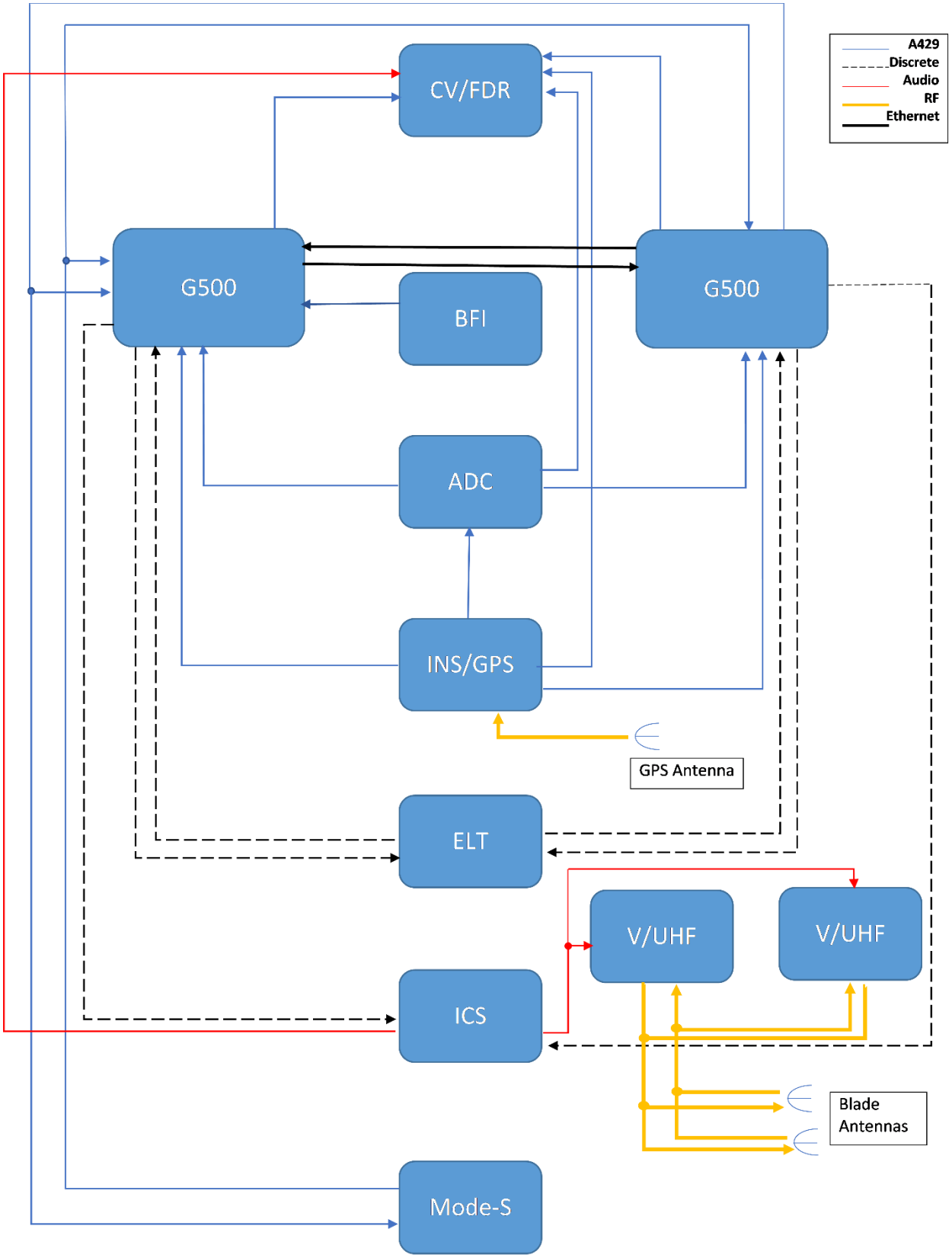

Figure 8 : The proposed avinoic architecture. Notice the legend.

1.1.2. Choosing the Necessary Lighting Equipments

According to CS-VLA 1384, external lights must be installed with regard to CS-23 23.2530. These sub-paragraphs mention that any position lights must include a red light on the left wing, a green light on the right wing and a white light facing aft. Also any position or anti-collision lights must have proper features to provide sufficient time for another aircraft to avoid a collision. Therefore, we deduced that we should have 3 position lights, as red, green and white, and 2 anti-collision lights.

Figure 9 Anti-collision LED light – Red or White

Since those lighting systems are very common, companies like AVEO Engineering are building compact systems. AVEO's Ultra DayLite and Andromeda DayLite products are two examples of that. They both have navigation (red and green lights), position (white light) and strobe (anti-collision light) systems built in. When compared in terms of weight and power usage, they do not have an important difference. Main reason to choose one to other can be the design. Their prices are same, $769.00. However, these products are not TSO certified. If a TSO certified product is necessary, TSO certified Ultra Galactica can be used, priced at $1099.00. An example for Anti-collision LED light from AVEO can be seen from Figure 185 while an example for Navigation / Position / Strobe LED light can be seen at Figure 186.

Figure 186 Navigation / Position / Strobe LED light

1.1.3. Preliminary Electrical Architecture

On Figure 187, you can observe the preliminary electrical architecture. Two busses – main and essential- are used on the architecture, typical for such aircraft. The generator relies on the engine to provide power while battery is used to provide a steady and safe source of energy in the case of a discrepancy.

- **GMFD** stands for the control panels.
- **CVR** is the black box.
- The rest is given below.

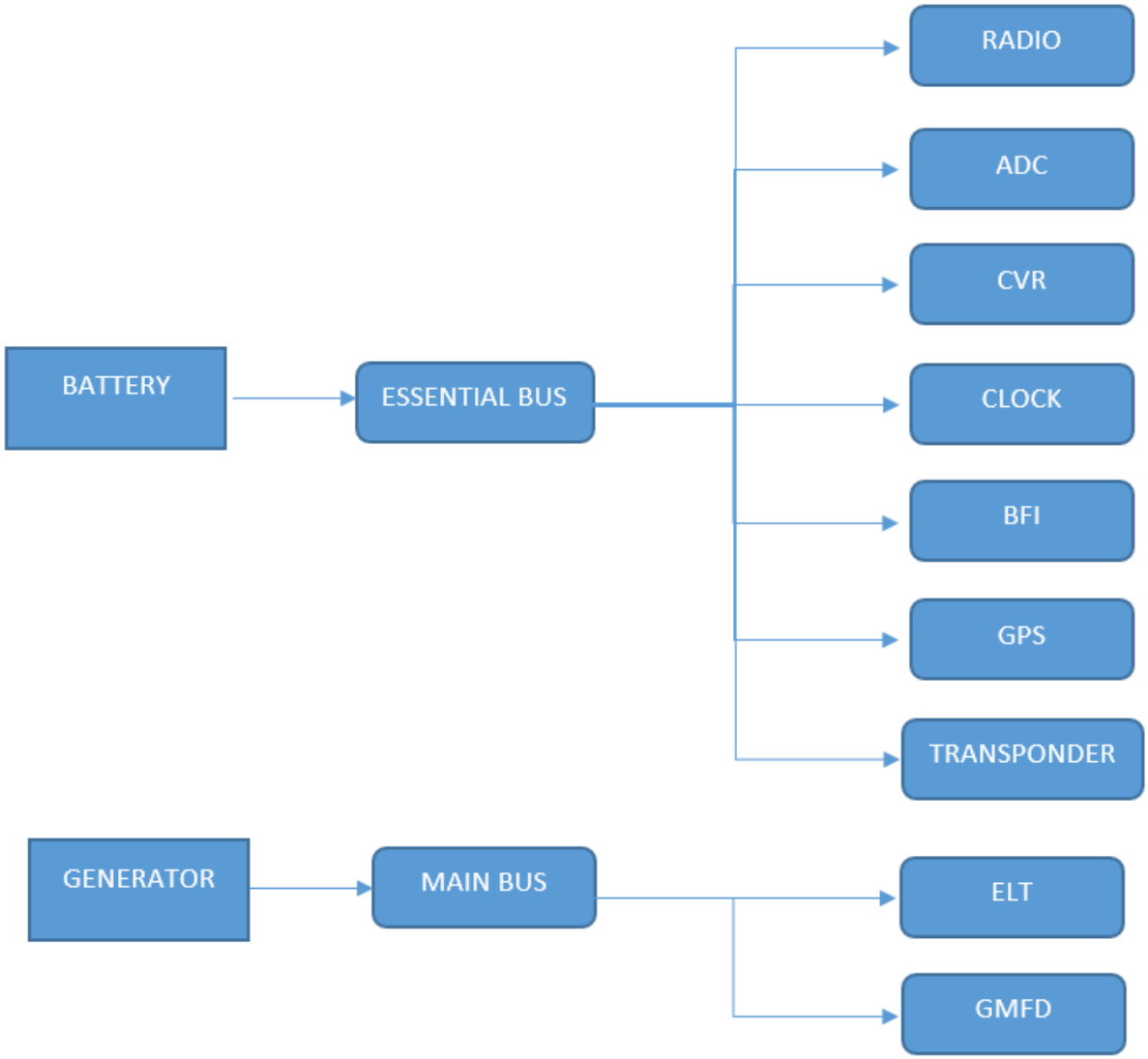

Figure 10 : Preliminary Electrical Architecture