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Date: 17.12.2023

Dashboard Design Spec Sheet

Content

1. Introduction

The purpose of this document is to integrate in one place the requirements of the 2023 dashboard with the solutions that solve the requirements. The requirements are defined in the Dashboard req 2023.xlsx and can be accessed via the 01UPBDRIVE_2022-2023 SharePoint folder.

2. Requirements

	Requirement	Owner (from who, gen sa s	Small description + other comments
1	Digital RPM	Tudor M	RPM is read from CAN and presented on the LCD 3 inch display from the dashboard
2	Digital Speed (km/h)	Tudor M	RPM is read from CAN and presented on the LCD 3 inch display from the dashboard
3	Oil pressure warning	Tudor M	OIL PRESSURE is read from CAN and if it is too low, a RED warning will be shown on the LCD 3 inch display
4	Coolant temp. warning	Tudor M	COOLANT TEMP is read from CAN and if it is too low, a RED warning will be shown on the LCD 3 inch display
5	Safety circuit button on the same PCB	Tudor M	The SAFETY CIRCUIT BUTTON will be implemented on the same PCB with the dashboard
6	Small database with CAN packets with important data for the display	Tudor M	The DASHBOARD will have a small database to provide the DISPLAY / other systems if necessary with CAN data
7	CAN communication interface && UART communication interface	Tudor M	The DASHBOARD will be able to read / transmit CAN packets and will also be able to transmit / receiveUART serial data
8	Car speed	Catalin B	Less important than gear / rpm, but can have a mediun font; can be determined from ECU (since there we have routed
9	Gear indicator	Catalin B	Middle of the dash, big font since it s almost the most important thing you need to look while on track; 'N' could be gre
10	Shift light(s)	Catalin B	see: 'motorcycle shift light'. basically an led or a sequence of led s that turn on / flash when you need to shift. should be
11	Launch control 'ON' warning	Catalin B	A small symbol which announces the pilot that 'Launch control' (a to-be-implemented functionality) is turned on: shoul
12	(optional) Traction control activation button	Catalin B	if possible, mount the button for TC activation on the same pcb (as I see you do with the safety button). NOT A PRIORIT
13	redundancy: gear indicator, RPM shift light,	Catalin B	these should be on the LCD but also have a redundancy in the dashboard (LEDs or, for the gear indicator, 7-segment dis
14	Oil temperature	Chitu	On display
15	TPS (Tire pressure)	Chitu	On display
16	Change the page displayed BUTTON	Chitu	On display
	IP65 weather proofing	IP65 weather proofing	IP65 weather proofing

3. Techincal solution proposed

For the requirements:

- Digital RPM
- Digital Speed
- Oil pressure warning
- Coolant temperature warning
- Current speed
- Oil temperature
- TPS

A market analysis is needed in order to correctly choose the display. To do this, we defined a simple set of requirements that need to be met by it:

1. A minimum amount of 500 cd/m^2 brightness

   This was defined by research conducted for outdoor display usage. There is a an ISO 3664:2009 standard that regulates the viewing conditions for the color proofing of originals and reproductions in the graphic arts industry. It says that **80-120 cd/m^2 in a controlled environment** should be enough for a display. By a controlled environment they mean a dimmed room with minimal light from outside [1]. So, this can be taken as a minimum amount of brightness for an indoor display.

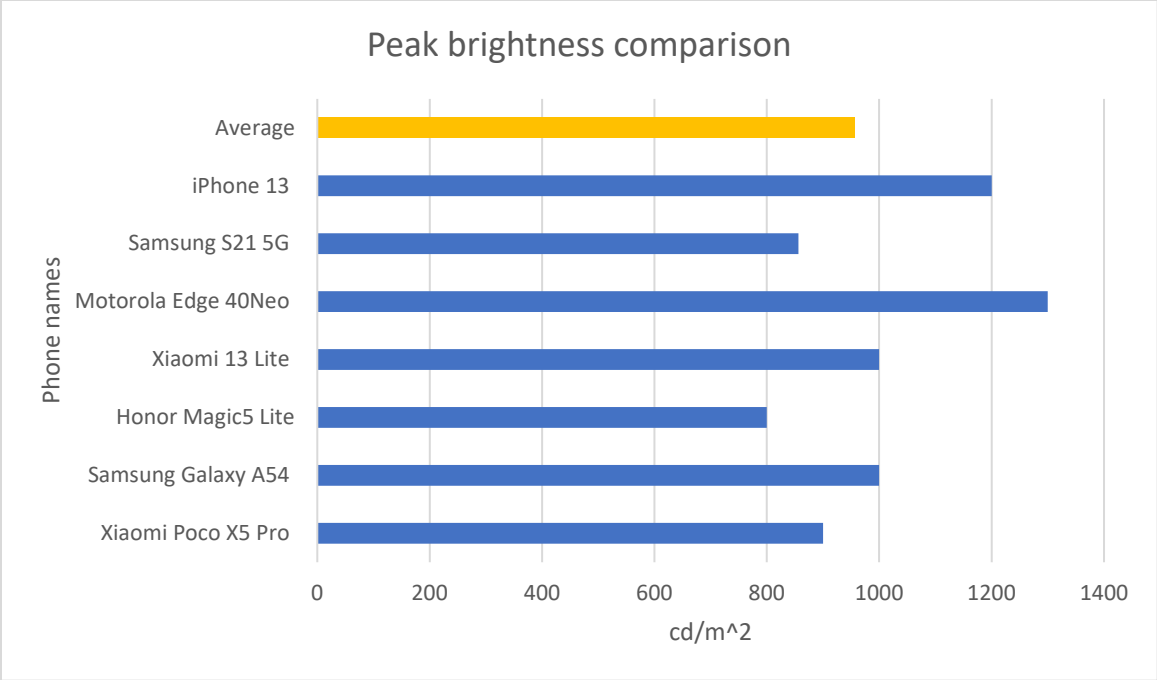
   For the minimum amount of light for a outdoor display, there are vendors ad displays that mention a minimum of **1000 cd/m^2 needed in order to have a visible screen in a bright sunny day** [2]. Another aspect worth considering is the brightness of the high-end daily driver phones. The S21 5G has an 856 cd/m^2 peak brightness when showing white spots, whereas the iPhone 13 has a peak brightness of 1200 cd/m^2.

   To strengthen the argument, I compared completely arbitrary 5 average priced phones that are ranging from 1500 – 2000 RON on emag.ro marketplace. The first one is Motorola Edge 40Neo which has a peak brightness of 1300 nits. The second one is the Xiaomi 13 Lite having a peak brightness of 1000 nits. The third one is the Honor Magic5 Lite having a HBM brightness of 800 nits. The fourth one is the Samsung Galaxy A54 which has a 1000 nits HBM brightness and the last one is the Xiaomi Poco X5 Pro having a HBM brightness of 900 nits.

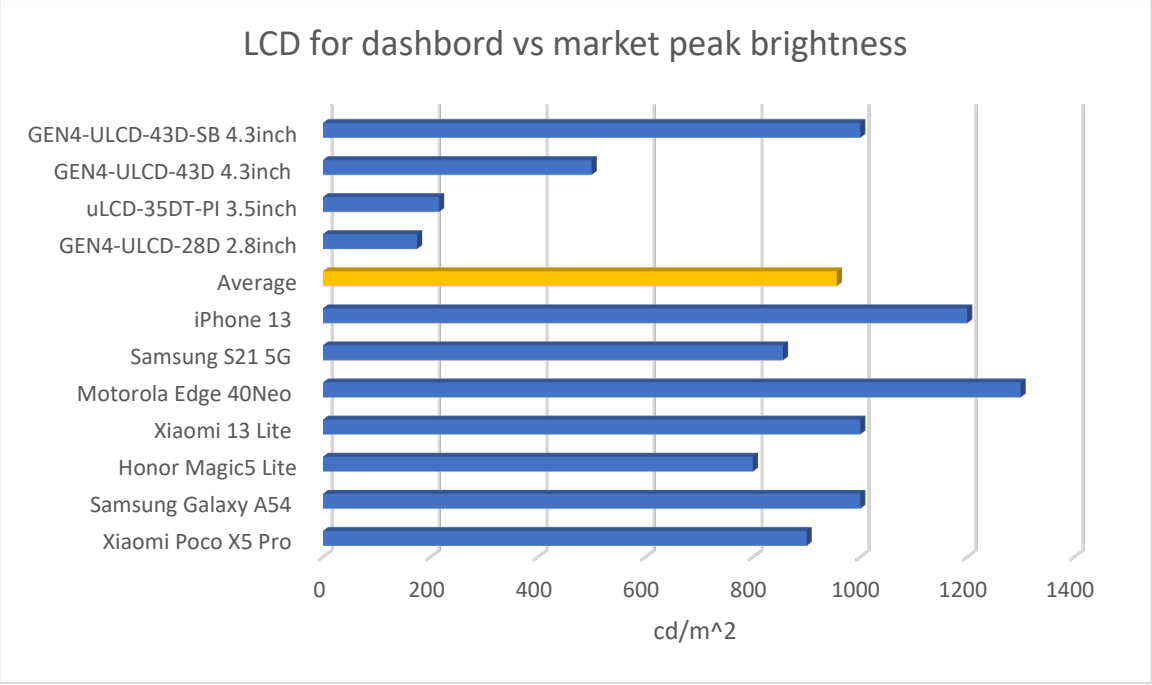
   Taking all the points above into consideration there yields an average of:

   956 cd/m^2 peak brightness

   Therefore, the following graphs can be made for a better visualization of the data taken from the phone's specification sheet.



In order to understand better the market choices that we have, I compared the brightness of the displays of choice with the maximum brightness of the phones.



The price of the displays, however, **are not comparable**, the cheapest being around 300 RON the most expensive being around 600-700 RON. **The comparison above is only meant to see the difference in brightness of the 4 displays of choice.**

2. It must have a library to be controlled via serial bus.

   This was defined by the electronics department in order to minimize the R&D needed to develop software libraries for driving the display. This saves a minimum of 24 hours of work, which can be calculated at an average of 500 RON worth of savings when considering the salary paid for this kind of work is the amount paid by the average software company in Bucharest for a Software Internship.

   The minimum price for an LCD on the market is 250 RON. Which will give us an around minimum 750 total cost for the R&D and implementation of that kind of display, which is only reasonable to assume that it is a worth to buy a more expensive display to save the money and the amount of time needed to be invested.

3. It must not have any resistive or capacitive touch component.

   This is defined by the electronics department in order to minimize the number of failure points the display can have.

4. It must have structural rigidity, which can be achieved by a PCB.

   This was defined by the electronics department in order to minimize the number of failure points the display can have.

The following solution is proposed:

Because of the dimensions constraints, we chose to fulfill the requirements 2., 3. and 4. and to take the best effort solution for the 1. Requirement in regards with the brightness. This solution is the following: GEN4-ESP32-35 from 4DSystems.

For the requirements:

6. Small database with CAN packets with important data – redundancy for the **DAT system**
7. CAN communication interface and UART communication

The following solution is proposed:

The CAN packets will be temporarily stored and parsed by a microcontroller, namely ESP32-WROOM. This microcontroller will update the data on the LCD display, and will also send commands to change the page shown on the LCD screen.

It will also be able to communicate via CAN by means of a CAN transceiver, namely SN65HVD230D from Texas Instruments. It can achieve speeds of CAN communication up to 1Mbps with this transceiver.

The database will be stored on an onboard uSD card that will be connected via a SD card connector like this one.

For the requirements:

12. Change the displayed page button

The following solution is proposed:

Physical buttons will be used on the PCB in order to trigger those actions. The switch of the display page will be handled by the onboard microcontroller, whereas the traction control button will send a signal directly to an ECU pin. The button proposed is this one. It is a momentarily ON button with IP65 rating for weather proofing.

For the requirements:

10. Shift lights

The following solution is proposed:

We can do something like this. The shift light is an off the shelf product which is low cost and the control logic will be handled by the on board microcontroller.

For the requirements:

1. Safety button

The following solution is proposed:

We can use an emergency industrial button like this one. It will be mounted next to the PCB on the right side of the dashboard. Selected with Axle.

For the requirements:

13. Redundancy for gear indicator

The following solution is proposed:

We can use an 8 segment display like this one. The logic of the button will be handled by the onboard microcontroller.

For the requirements:

14. Traction control on/off

The following solution is proposed:

We can use a 2 position switch like this one. It will be panel mounted on the dashboard. Unlike the button used to change the page, this one is either ON or OFF, not momentarily ON.

For the following additional requirements:

- Having a turn on/off button for the radiator FAN on the dashboard

The following solution is proposed:

We can use a 2 position switch like this one. It will be panel mounted on the dashboard. Unlike the button used to change the page, this one is either ON or OFF, not momentarily ON.

- Having a start switch on the dashboard.

The following solution is proposed:

The button proposed is this one. It is the same button that is used for changing the page of the LCD. It has IP65 rating for weather proofing and it is a momentarily ON switch.

- Having a 12V to 3.3V converter with resettable short circuit protection.

The following solution is proposed:

We can have an LDO as this one. It is a fixed output of 3.3V voltage LDO regulator with thermal protection.

- Having a 12V to 5V converter with resettable short circuit protection.

The following solution is proposed:

We can have an LDO as this one. It is a fixed output of 5V voltage LDO regulator with thermal protection.

- Having a selector for HY system 12 postions, IP54 or better.

We can have this 12 position switch. It does not have a IP54 rating, however it will be mounted on the PCB which will be behind the dashboard carbon fiber.

- Having a boost button on the steering wheel.

We can have this switch. It is the same button as the start engine button, a momentarily (ON) switch.

4. Bill of materials

Component	Necessary Quantity	Reserve Quantity	In stock UPB	Total Quantity	Price per Unit	Total Price	Useful links
GEN4-ESP32-35	1	0	0	1	350 RON	350 RON	1
8 Segment display	2	0	0	0	5.15 RON	10.3 RON	23
Shift lights	2	0	0	2	60 RON	60 RON	22
SN65HVD230D CAN Transciever	2	2	0	4	34 RON	34 RON	2
ESP32-WROOM-32	1	0	0	1	33 RON	33 RON	3
MCP16361 Buck 12V to 5V	1	1	0	2	10 RON	20 RON	4
LDO regulator 12V to 3.3V	2	0	0	0	9.16 RON	18.32 RON	5
R 2K 5% SMD 0805	4	0	0	0	0.46 RON	1.56 RON	6
R 10K 5% SMD 0805	4	0	0	0	0.46 RON	1.56 RON	7
R 22K 5% SMD 0805	2	0	0	0	0.46 RON	0.92 RON	8
R 47.5K 5% SMD	2	0	0	0	0.46 RON	0.92 RON	9
BJT NPN SMD	4	0	0	0	1.34 RON	5.36 RON	10
LED RED SMD	4	0	0	0	1.52 RON	6 RON	11
C 22uF 10V SMD	6	0	0	0	1.84 RON	11.04 RON	12
C 0.1uF 50V SMD	5	0	0	0	1.38 RON	6.9 RON	13

C 4.7uF 6.3V SMD	2	0	0	0	1.89 RON	3.78 RON	14
CON USBC	2	0	0	0	2.30 RON	4.60 RON	15
CON Display	1	1	0	2	4 RON	8 RON	16
D Transient Voltage Supressor	6	0	0	0	2.16 RON	12.96 RON	17
D BAT760-7	5	0	0	0	0.82RON	5RON	24
CON SMD button	2	2	0	0	1.92RON	1.92RON	25
Button panel mount (ON) – OFF IP65	4	0	0	4	58 RON	58 RON	19
Safety button panel mount	1	0	0	1	140 RON	140 RON	20
Button panel mount ON-OFF IP65	3	0	0	3	48 RON	48 RON	21
Switch 12 position HY	2	0	0	0	15 RON	30 RON	23
uSD card holder	2	0	0	0	9 RON	18 RON	24
USB-UART converter	2	0	0	0	42.3 RON	84.6 RON	25
MPU6050 accelerometer	1	1	0	0	39.55 RON	80 RON	26
Harness CON	1	2	0	0	105 RON	315 RON	27

5. References

1. ESP32 devboard schematic esp32_devkitc_v4-sch.pdf (espressif.com).
2. Adafruit SDCard Breakout adafruit_products_SDIO_breakout_sch.png (9258×6378).