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Intelligent Cockpit Domain Control Unit (DCU) and Head Unit Dismantling Report, 2023 (1)

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Dismantling of Head Unit and Cockpit Domain Control Unit (DCU) of NIO, Toyota and Great Wall Motor

The report highlights the dismantling of Toyota's MT2712-based head unit, Fisker's Intel A2960-based head unit, Great Wall Motor's Qualcomm 8155-based head unit and NIO ET7 cockpit DCU, and estimates and analyzes Great Wall Motor's head unit and NIO's DCU.

This article takes NIO ET7 cockpit DCU we dismantle as an example.

"In terms of hardware, NIO ET7 packs a second-generation digital cockpit that is equipped with a 12.8-inch AMOLED center console screen, a 10.2-inch HDR digital cluster, a 6.6-inch HDR multi-function control screen in the rear row, and an enhanced head-up display (HUD) system. It runs the Banyan IVI System based on Qualcomm Snapdragon 8155 chip. The head unit carries the 16GB+256GB memory portfolio, supports multiple unlock methods like UWB digital key, and is equipped with some remote functions and AR-HUD system, as well as a built-in driving recorder."

2nd-generation Digital Cockpit of NIO ET7



Source: NIO

NIO ET7 bears NIO's second-generation cockpit DCU. Compared with the first-generation, the SoC chip of the second-generation cockpit DCU is changed from Nvidia Parker to Qualcomm SA8155P. The second-generation cockpit DCU will be applied to all NIO models.

The interfaces on the lower side of the bottom view in the above picture, from left to right, are: center console display and rear display connector, cluster and HUD connector, 1 USB3.0 connector, 2 USB connectors, and 2 Ethernet connectors, and inside the white plastic sleeves are WiFi and Bluetooth antennas.

Appearance of NIO ET7 Cockpit DCU



Source: ResearchInChina

NIO ET7 cockpit DCU has a distinctive appearance. The heat sink on the backboard is recessed in the middle in a bid to be close to the SA8155P module that generates the most heat.

The interior of the housing of NIO ET7 cockpit DCU is relatively complicated. The inner layer of the housing is also embedded with a spongy material that absorbs impact. The holes on the right correspond to the two large capacitors on the PCB. The two capacitors are relatively high with ultra-large capacity up to 25 farads. They function as a battery. It is presumed that the two capacitors are added in the consideration of the fact that sometimes when a vehicle is parked for too long, the battery runs out of power but some wireless remote vehicle control functions still need to work.

Unlike most vehicle PCBs with connectors on one side, NIO's cockpit DCU PCB has connectors on both sides.

Internal Structure of NIO ET7 Cockpit DCU





Source: ResearchInChina

CPU and memory chip

In the center of the DCU PCB lies the SoC module which accommodates one SA8155P chip, two PMM8155AU power management chips and two Micron memory chips.

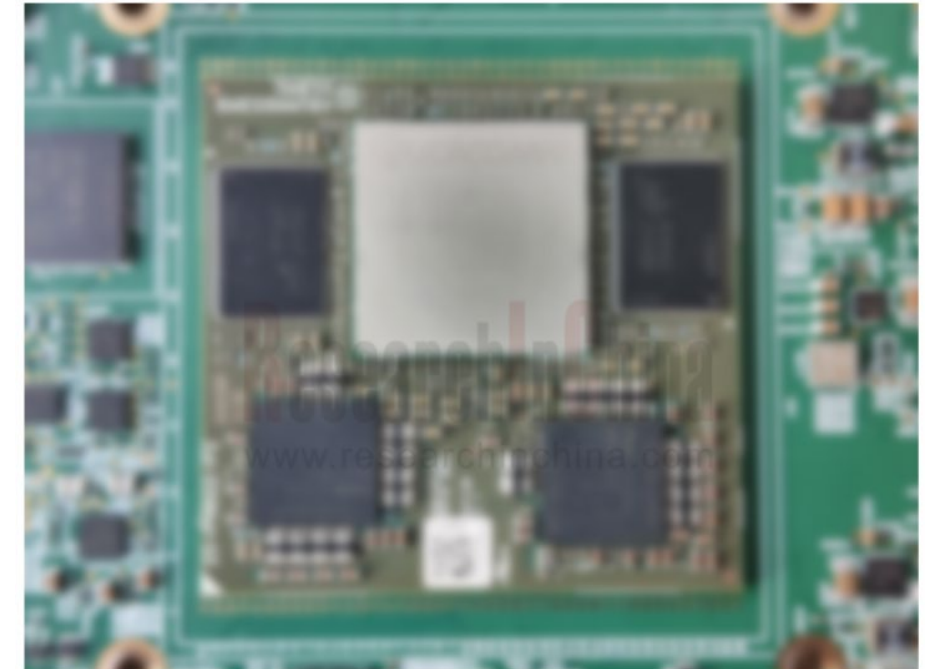
Next to the capacitor side of the SoC module is a 256GB UFS 2.1 memory chip from Samsung. UFS 2.1 features working voltage of 1.8/3.3V, G3 2Lane interfaces, and temperature range of -40°C~105°C. The estimated price range of this chip is USD15-20.

Parameters of Samsung UFS 2.1

 Version UFS 2.1	 Capacity 256GB	 Voltage 1.8 / 3.3 V	 Interface G3 2Lane
 Package Size 11.5 x 13 x 1.72 mm	 Temperature -40 ~ 105 °C	 Product Status Mass Production	

Source: Samsung

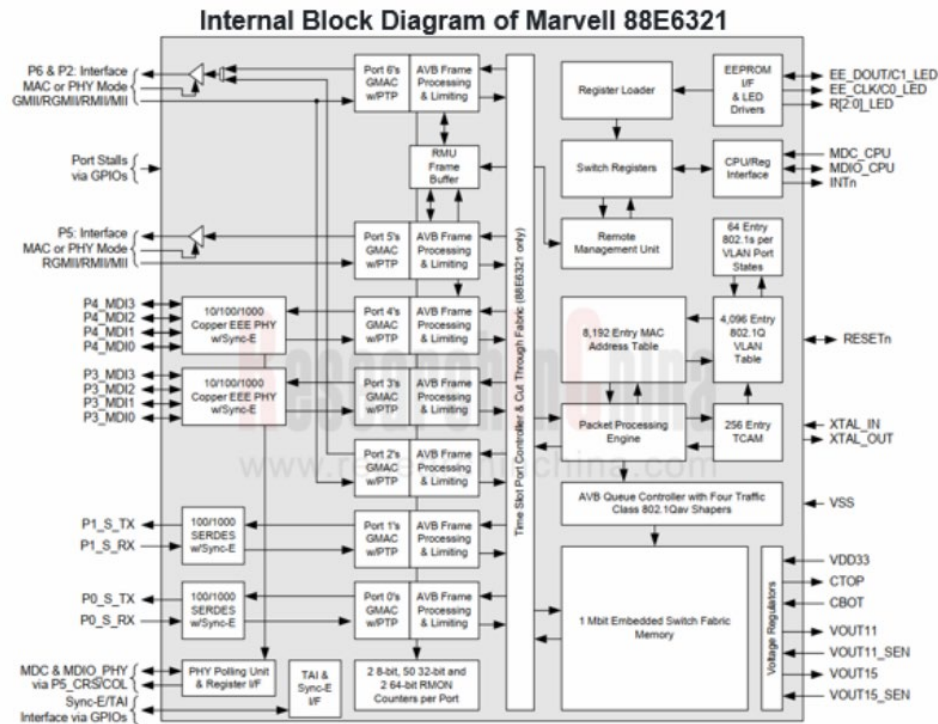
NIO ET7 Cockpit DCU SoC Module



Source: ResearchInChina

Ethernet switch

The relatively big chip next to the MCU and the capacitor is an 88E6321 Ethernet switch provided by Marvell.



The picture shows the internal framework of Marvell 88E6321, a 7-port Ethernet switch for automotive EAVB. 88E6321 carries two IEEE 10/100/1000BASE-T/TX/T interfaces (corresponding to RJ45, namely, a conventional registered jack as often said), two RGMII/xMII interfaces or one GMII interface, two SGMII/SerDes interfaces, and one RGMII/xMII interface. The MII (medium-independent interface) is a standard interface connecting the MAC and the PHY. It is an IEEE-802.3 defined Ethernet industry standard.

10/100/1000BASE-T/TX/T refers to the transmission cable. Port 2, 5 and 6 can be configured as MAC or PHY mode, and all support RGMII/RMII/MII. Port 2 and 6 also support GMII. Port 3 and 4 support 10M/100M/1000M adaptive Ethernet interfaces. Port 0 and 1 support 100M/1000M optical ports (SFP). 88E6321 launched around 2014 is an old product that does not support the latest TSN. It is not an automotive Ethernet switch in the strict sense, and is currently sold at a markdown price of about USD10-15. (MII refers to Medium Independent Interface; RMII, Reduced MII; SMII, Serial MII; GMII, Giga MII)

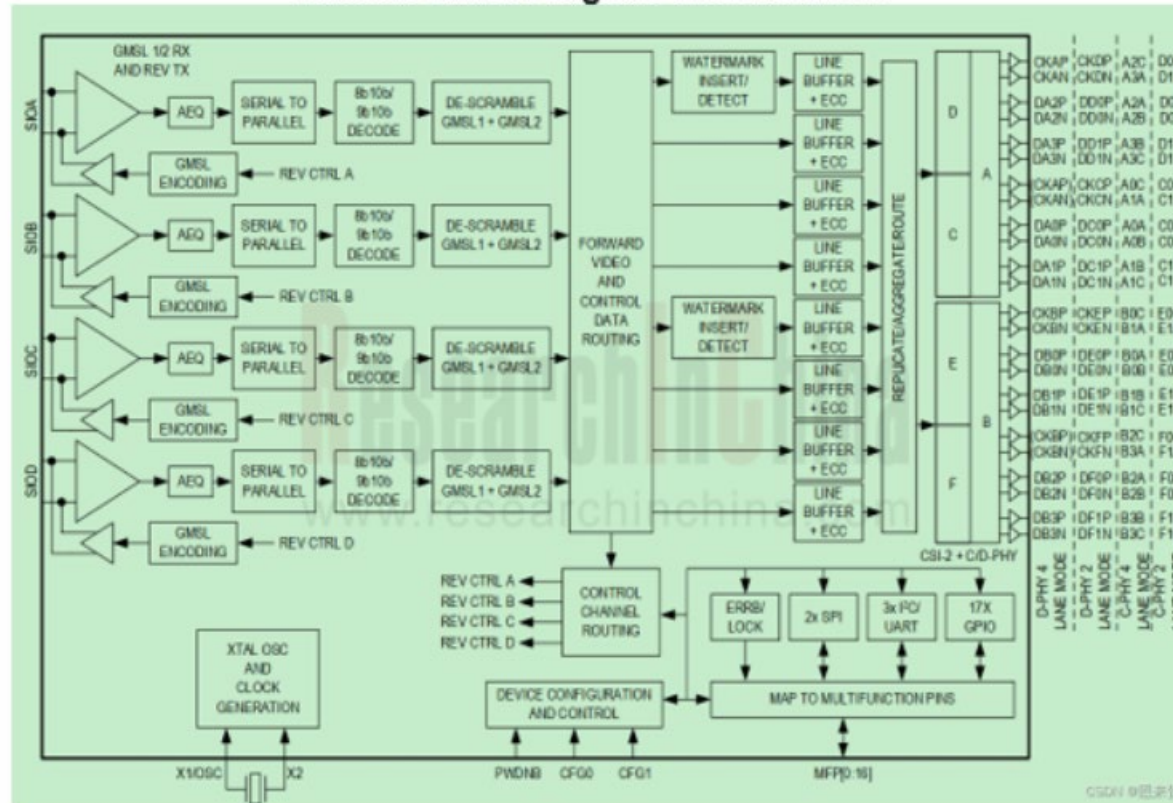
NIO ET7 Cockpit DCU Video Input Part



Source: ResearchInChina

The picture above is the video input part of ET7 cockpit DCU. It uses a total of 4 serializer/deserializer chips (all from MAXIM, a company acquired by ADI), including two MAX96712 deserializer chips, one of which corresponds to the inputs of the four 3-megapixel surround-view cameras of NIO ET7.

Internal Block Diagram of MAX96712

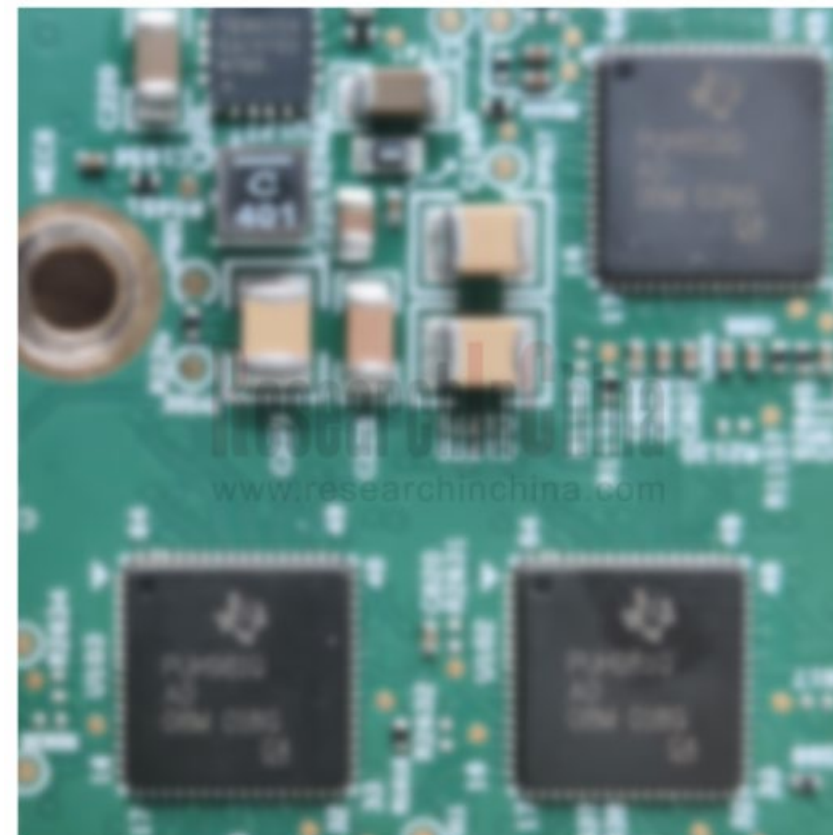


Source: ADI

The picture above is the internal framework of MAX96712 which enables MIPI CSI-2 4Lane reception and delivers the maximum bandwidth of 6Gbps, that is, it can connect four 4-megapixel cameras and outputs two channels. It is currently the highest bandwidth deserializer chip priced at about USD15-20.

The video output part of NIO's head unit in the picture above uses three TI serializer chips and video format conversion. All the three serializer chips require signing a non-disclosure agreement (NDA). SA8155 can support a variety of up to 24-megapixel display configuration interfaces (e.g., at most three 4K60 displays) via three native displays. It supports two 4-lane DSI D-PHY at 2.5 Gbps per lane or two 3-trio C-PHY at 5.7 Gbps per lane, an integrated display port shared with USB 3.1 Gen 2 at 8.1 Gbps/lane. It allows for 4K60 display ports concurrency and USB 3.0 operation, and enables other display single interfaces (DDSI) by using DisplayPort multi-stream transport (MST) and dual displays.

NIO ET7 Cockpit DCU Video Output Part



Source: ResearchInChina

There is a flying line on the front and back of the PCB. The flying line on the back is very obvious, about 4.5cm in length, which means that the PCB needs hand soldering in the end. This will affect efficiency and quality stability, and will also push up the overall cost of the cockpit DCU.

Back of NIO ET7 DCU Motherboard



Source: ResearchInChina

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Beijing Headquarters

TEL: 010-82601561, 82863481

Mobile: 137 1884 5418

Email: report@researchinchina.com

Website:
www.researchinchina.com

WeChat: [zuosiqiche](#)



Chengdu Branch

TEL: 028-68738514

FAX: 028-86930659