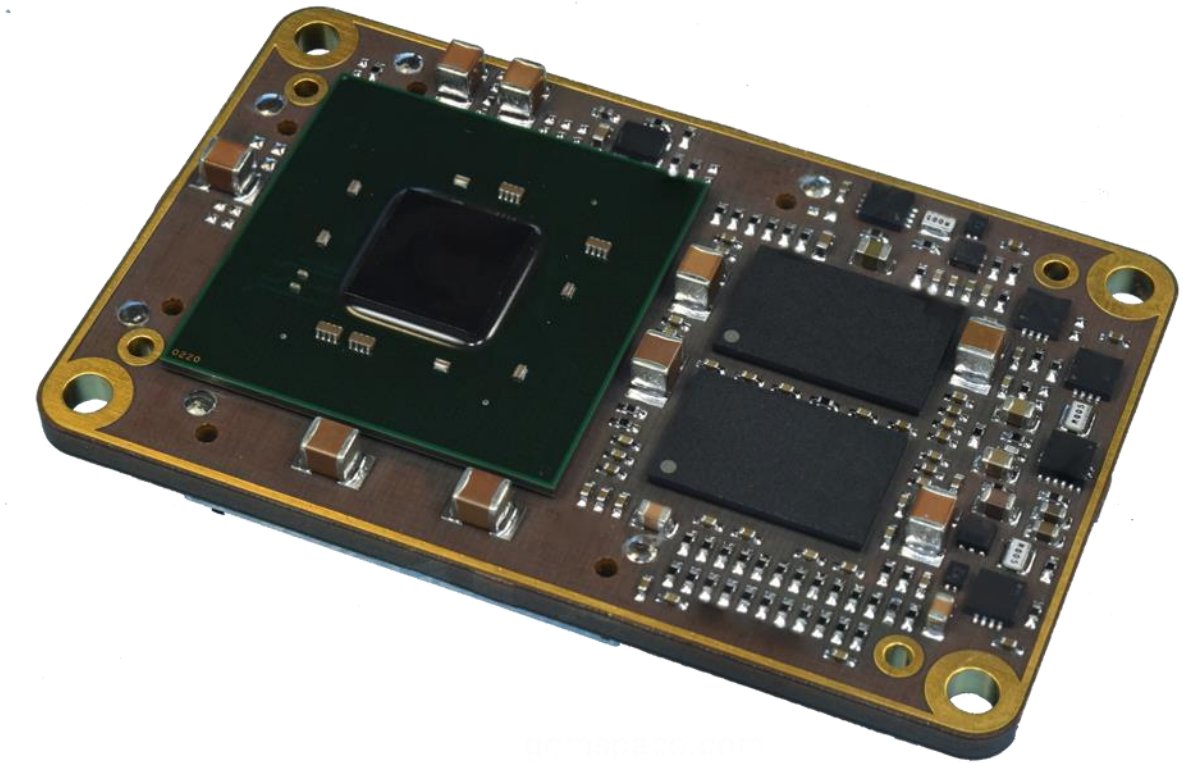


NanoMind
Z7000

Datasheet

On-board CPU and FPGA for space applications

GomSpace A/S | Langagervej 6 | DK-9220 Aalborg East | Denmark
gomspace.com | sales@gomspace.com | T: +45 71 741 741

Product name: NanoMind Z7000

Document No.: 1019292

Revision: 1.5

Author: KLK

Approved by: TIM

Approval date: 29 March 2019

Confidentiality Notice

1 Table of Contents

2 Overview

The NanoMind Z7000 (Z7000) provides a powerful flight proven processing module for small satellite systems. The module is a System on a Chip solution and can be used for a variety of advanced solutions such as communication systems and signal/image processing systems.

The module contains two main parts:

- A very powerful ARM/FPGA on-board computer (OBC) designed as an efficient system for space application
- The power system is divided into two, one for ARM and one for FPGA

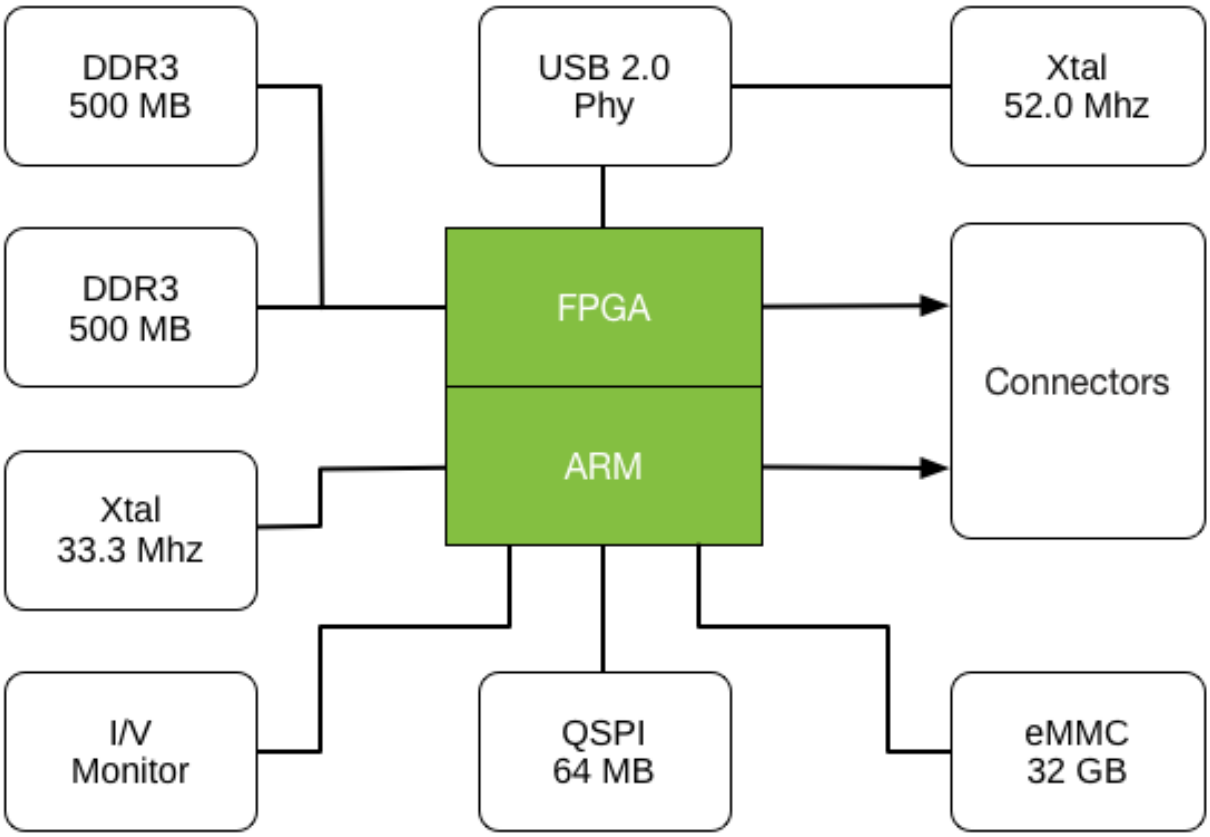
The size of the NanoMind Z7000 is designed to fit on the GomSpace NanoDock SDR. The software platform makes it easy to integrate the system into the satellite system.

2.1 Highlighted Features

- Xilinx Zynq 7030 Programmable SoC
- Dual ARM Cortex A9 MPCore up to 800 MHz
- 1 GB DDR3 RAM
- 32 GB storage
- Powerful FPGA module – 125K logic cells
- Linux operating system
- Fits on top a NanoDock SDR
- Precision milled anodized aluminum heat sink to control thermal load and provide EMI shielding
- Operational temperature: -40°C to +85°C
- PCB material: 22 layer glass/polyimide
- IPC-A-610 Class 3 assembly

Figure 1 Z7000 with shield

2.2 Block Diagram



2.3 Functional description

2.3.1 Microcontroller

The Z7000 is based on a Zynq-7000 All Programmable SoC (AP SoC) devices integrate the software programmability of an ARM-based processor with the hardware programmability of an FPGA, enabling key analytics and hardware acceleration while integrating CPU, DSP and mixed signal functionality on a single device.

2.3.2 Time Sync

A time sync signal can be received through a connector pin on one of the Samtec connectors. View the datasheet for NanoDock SDR chapter 3.2.2 (gs-ds-nanodock-sdr-x.y)

2.3.3 Linux

The NanoMind Z7000 has a default Linux installed.

2.3.4 I^2C Interface

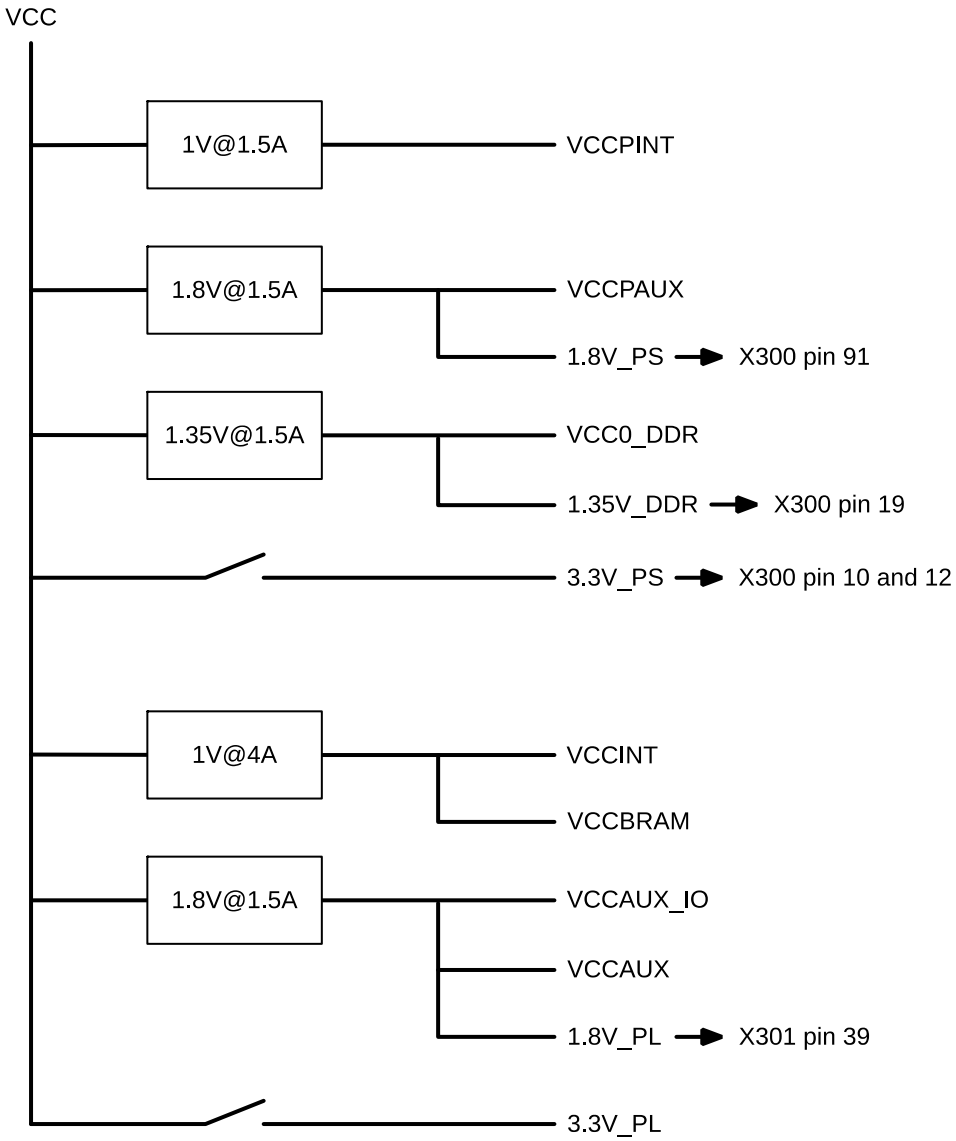
Z7000 has an I^2C bus supporting bidirectional data transfer between masters and slaves, multi- master bus, arbitration between simultaneously transmitting masters without corruption of serial data on the bus. Serial clock synchronization allows devices with different bit rates to communicate via one serial bus and is used as a handshake mechanism to suspend and resume serial transfer.

2.3.5 CAN Interface

One of the main interfaces of the Z7000 to communicate with other subsystem hardware is a Controller Area Network (CAN) bus interface. It is a serial communications protocol that supports distributed real-time control with a high level of security.

3 Power Supply

All outputs have hardware overcurrent, under voltage and thermal protection with auto retry. All power domains are power-up/down sequenced by design.



Make sure the software limits the power usage on each voltage supply so the values do not hit the hardware limits.

4 Connector Pinout

The pinouts of the 2x 100 pin Samtec and the 1x Samtec LSHM-130-04.0-L-DV-A-S-K-TR connectors can by acquired upon request from GomSpace.

5 Data Interface

The Z7000 uses the CubeSat Space Protocol (CSP) to transfer data to and from CSP nodes on-board the main system bus. CSP is a routed network protocol that can be used to transmit data packets between individual subsystems on the satellite bus and between the satellite and ground station. For more information about CSP please read the documentation on libcsp.org and on Wikipedia: http://en.wikipedia.org/wiki/Cubesat_Space_Protocol

The CSP network layer protocol spans multiple data-link layer protocols, such as CAN-bus, I^2C and KISS.

5.1 CAN-BUS / CFP protocol

The standard method to communicate with the SDR is the CAN-bus. The CAN interface on the SDR uses the CSP CAN Fragmentation Protocol (CFP). CFP is a simple method to make CSP packets of up to 256 bytes, span multiple CAN messages of up to 8 bytes each. The easiest way to implement CSP/CFP over CAN is to download the CSP source code from http://libcsp.org and compile the CFP code directly into your own embedded system.

The CAN-bus is connected to each individual module.

5.2 I^2C Communication Protocol

It is possible to communicate with the SDR modules over multi-master I^2C. Please note that since the CSP router sends out an I^2C message automatically when data is ready for a subsystem residing on the I^2C bus. The bus needs to be operated in I^2C multi-master mode.

The SDR uses the same I^2C address as the CSP network address per default. This means that if a message is sent from the radio link, to a network node called 1, the SDR will route this message to the I^2C interface with the I^2C destination address 1.

The I^2C bus is connected to each individual module in the SDR system.

5.3 KISS Protocol

The KISS protocol uses special framing characters to identify a data-packet on a serial connection. It is designed to be easy to implement in simple embedded devices, which are capable of asynchronous serial communications. http://en.wikipedia.org/wiki/KISS_(TNC)

The KISS protocol is available on the motherboard RS-422 and UART connector (TTL level). This is not a bus but a point-to-point connection. Hence the CSP routing service is used to allow communication with daughterboards in the SDR system.

6 Absolute maximum ratings

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the Z7000. Exposure to absolute maximum rating conditions for extended periods may affect the reliability.

Symbol	Description	Min.	Max.	Unit
VCC	Supply voltage	3.0	3.6	V
I	Supply current	1.2	n.a.	A
T_{amb}	Operating Temperature	-40	85	°C
V_{io}	Voltage on I^2C/USART/JTAG pins	3.0	3.6	V

7 Electrical characteristics

Typical values are with a standard software image idle.

Symbol	Description	Min.	Typ.	Max.	Unit
VCC	Supply voltage	3.0	3.3	3.6	V
I	Supply current	0.3	0.7		A
P_{max}	Max power consumption		2.3		W

Process System:
26 3.3 V I/O on connectors for SPIO, I^2C SPI, SD, UART etc

Description	Min.	Typ.	Max.	Unit
DDR3L Data rate			1066	MT/s
NOR flash performance (bootable)			400	Mb/s
eMMC sequential Read			25	MB/s
SD interface performance			25	MB/s
USB interface performance (used for debuggning)			480	Mb/s

Programmable Logic:
75 1.8 V differential or 150 single ended

Description	Min.	Typ.	Max.	Unit
DDR LVDS Transceivers			1250	MT/s

8 Physical characteristics

Description	Value	Unit
Mass of PCB	28.7	g
Mass total PCB + shield	76.8	g
Size	65 x 40 x 6.5	mm

9 Environment Testing

To simulate the harsh conditions of launch and space, the Z7000 has been exposed to a number of environment tests. For detailed information about the tests please contact GomSpace.

The NanoMind Z7000 has been in space and performed perfectly.

10 Software

The software for the NanoMind Z7000 comes in two packages, Board Support Package and a Linux Software Development Kit (SDK).

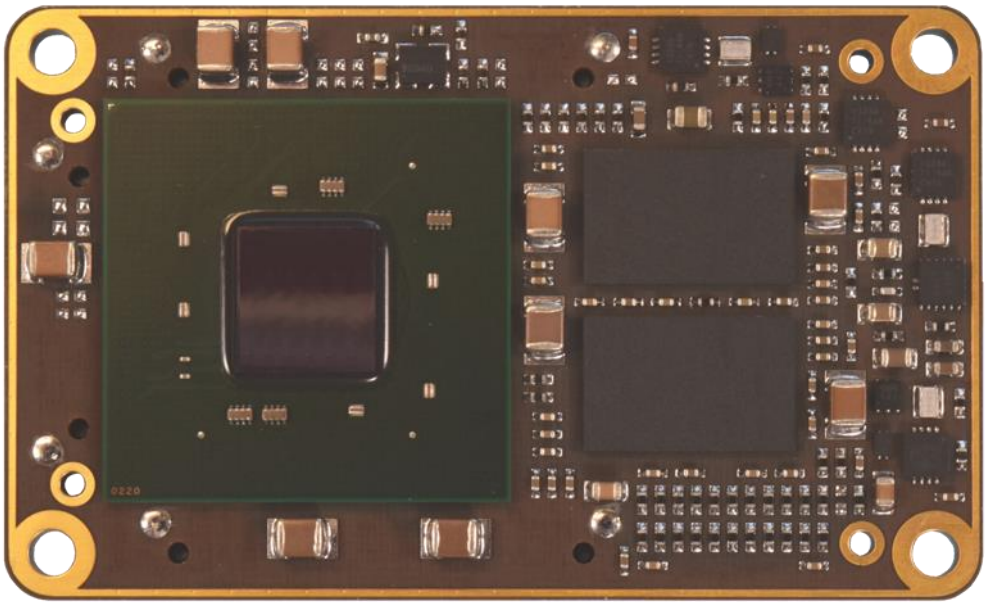
The Z7000 hardware comes with the Board Support Package. The Linux SDK for Z7000 software can be purchased separately.

In the table below the different features are listed for the Board Support Package and the Linux SDK.

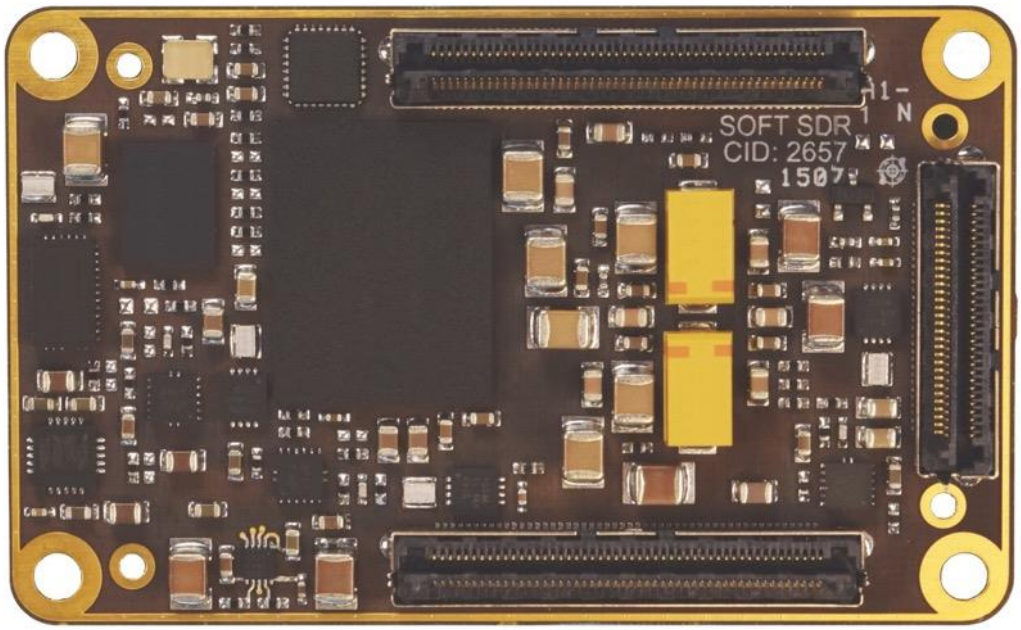
Feature	Board Support Package	Linux SDK
FSBL	✓	✓
u-boot	✓	✓
Linux	✓	✓
Build Environment	✓	✓
FPGA-code	✓	✓
Example App. Binary	✓	✓
Example App. Source		✓
PARAM		✓
LOG		✓
GOSH		✓
CSP		✓
UTIL		✓
FTP		✓

11 Physical Layout

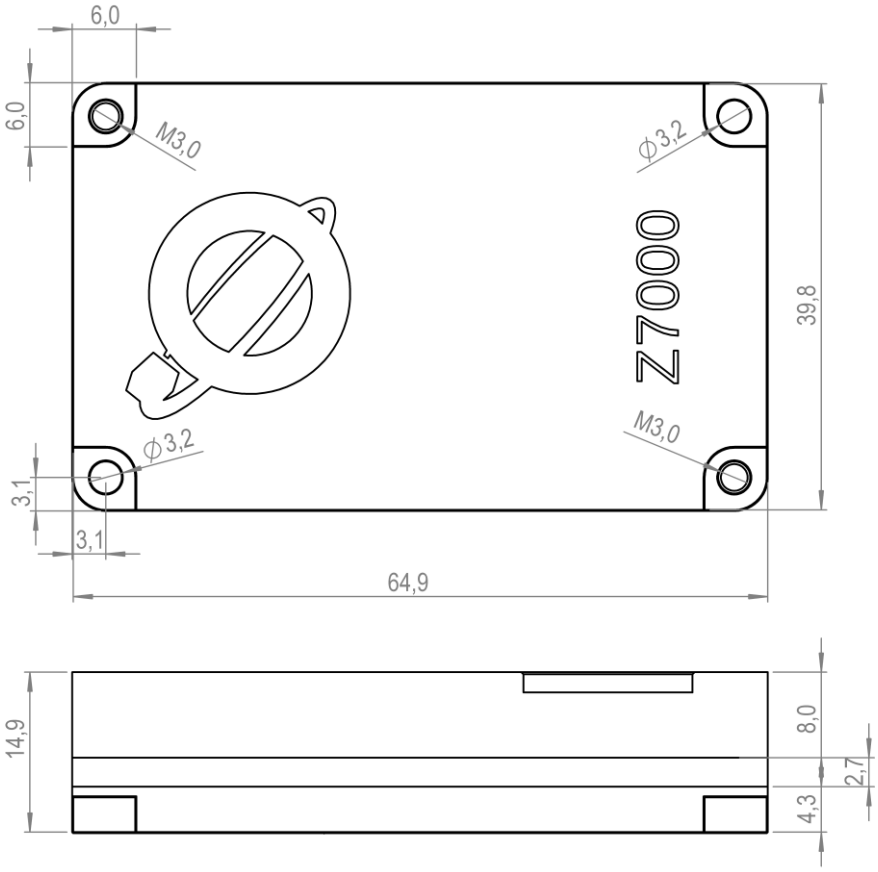
The top of the PCB has the ARM/FPGA to the left and two DDR3 RAM units to the right.



The bottom contains the three connectors to the motherboard (2x Samtec LSHM-150-04.0-L-DV-A-S-K-TR and 1x Samtec LSHM-130-04.0-L-DV-A-S-K-TR). Mid left is the EMMC. Top left is the NOR QSPI flash.



13 Mechanical Drawing



14 Disclaimer

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