# Remote Terminal Unit nanoRTU™

- Compatible with SPA-1 – *'SPAready'*
- Fast, easy integration of payloads, sensors and sub-systems on complex systems
- Compact, high-density design
- Suitable for many space and defense applications

## Versatile miniaturized interface and control computer

Remote Terminal Unit devices (RTUs) are flexible, compact high-density interface and control computers with support for many common protocols and analog/digital IOs. The units are suitable for nano/micro-satellites in Low-Earth Orbit (LEO).

RTU devices allow fast and easy integration of payloads, sensors and sub-systems on complex systems like spacecraft and unmanned aerial vehicles. nanoRTU™ supports a flexible, user-friendly RTU interface with a flash-based FPGA in the core that allows either ÅAC Microtec-supplied software or user-own.

## Perfect for interfacing electronic devices and payloads

nanoRTU™ (Fig. 1) is a low-power interface module with optional Space Plug-and-Play Avionics (SPA-1) compliance. nanoRTU™ has many space and defense applications. In addition to being used with the SPA-1 standard, nanoRTU™ can perform many distributed tasks as a stand-alone device. The available user IO is provided as through-holes suitable for pig-tail soldering, while the spacecraft side IO is provided in a Pico-EZmate™ (FM)/ Micro-MaTch (EM) connector.

**FIG. 1.** The nanoRTU™ 212 (FM) unit is ideal for interfacing electronic devices and payloads.

Key nanoRTU™ applications include:

- Interfacing passive devices or active sensors and actuators
- Providing SPA-1 support to passive devices or active sensors and actuators
- Control Power Switches
- Collecting temperature data
- Radiation-tolerant/hard computer-controlling power on S/C

## Space Plug-and-Play Avionics (SPA) compatible

nanoRTU™ has been developed together with the US Air Force Research Laboratory (AFRL) and the Swedish Defence Materiel Administration (FMV). The device is SPAready, but can easily be used with custom-user protocols without enabling SPA to reduce software overhead.

SPA is defined as an interface-driven set of standards encompassing hardware, software and protocols intended to promote the rapid, affordable design and integration of spacecraft busses and payloads. SPA standards combine different data transport standards, such as Universal Serial Bus (USB) (SPA-U), SpaceWire (SPA-S) and $I^2C$ (SPA-1) with a component-transparent publish/subscribe software infrastructure called the Satellite Data Model (SDM), on which software for command, control, data collection, processing and analysis can be implemented. nanoRTU™ is compliant with the SPA standard, SPA-1.

An electronic data sheet called the extended Transducer Electronic Data Sheet (xTEDS) stored with each SPA component contains descriptions

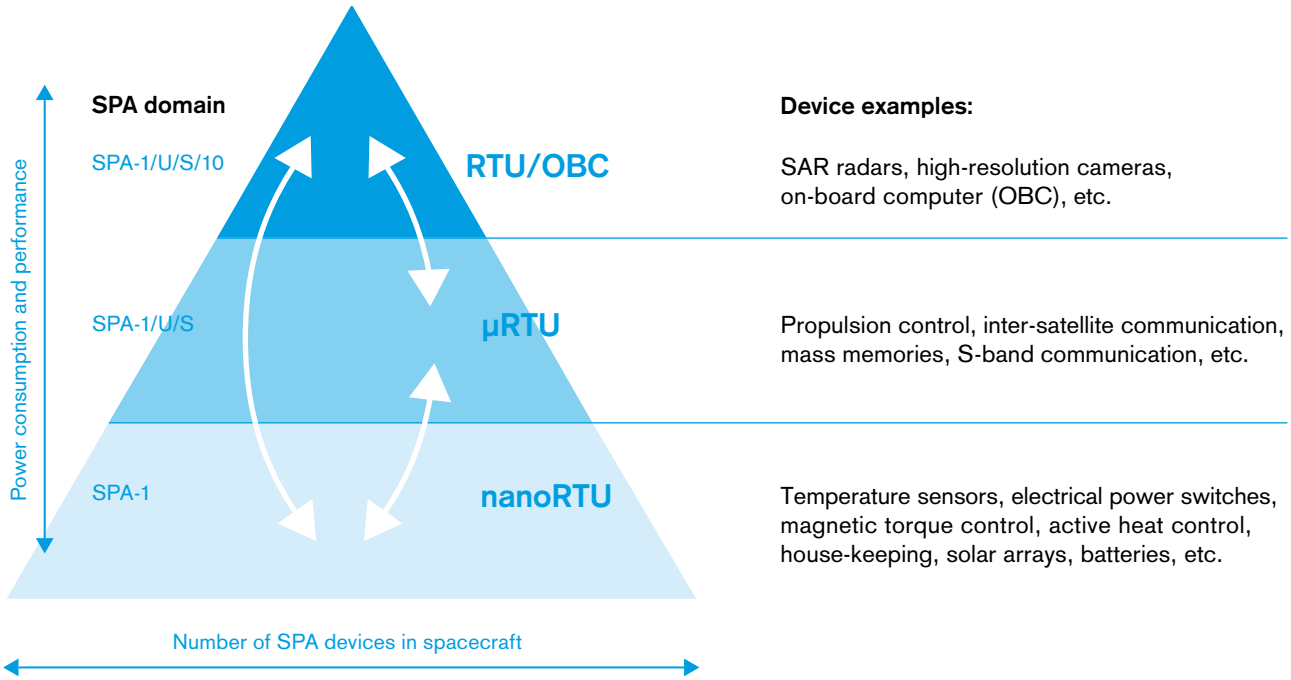


**FIG. 2.** The Rapid Integration Architecture™ (RIA) family showing the numbers and types of SPAready RTU/OBC devices that can be found in a spacecraft.

of all component-specific commands accepted, variables produced and data messages that can be delivered. Thanks to these standardized elements, a Plug-and-Play satellite can be rapidly designed and assembled from off-the-shelf SPA-ready components. Fig. 2 shows device examples of ÅAC Microtec SPAready RTUs/OBCs.

## Architecture

nanoRTU™ contains the SPA-1 core (FPGA) and AD/DA converters. It also supports health-monitoring (housekeeping) information of critical signals. nanoRTU™ also features an advanced set of IP blocks configured for implementation in the internal or a user FPGA. See Fig. 3 for further details.

## Engineering and flight models

The engineering model (EM) is intended for development in a lab environment. Flight model (FM) is designed with respect to the ECSS-Q-30-11A EEE component derating standard. Comprehensive SEE/SEU hardware protection is provided.

## Programming interface equipment and tools

nanoRTU™ is programmed using the graphical user interface based on 'ÅAC Microtec nanoRTU™ Series Firmware programming tool'.

The static (flight) firmware position in the non-volatile memory of the nanoRTU™ can only be programmed using the ÅAC Microtec Development Kit with the Flight software/Debug programming interface. However, the In-Circuit firmware update can be done over the spacecraft (S/C) $I^2C$ interface.

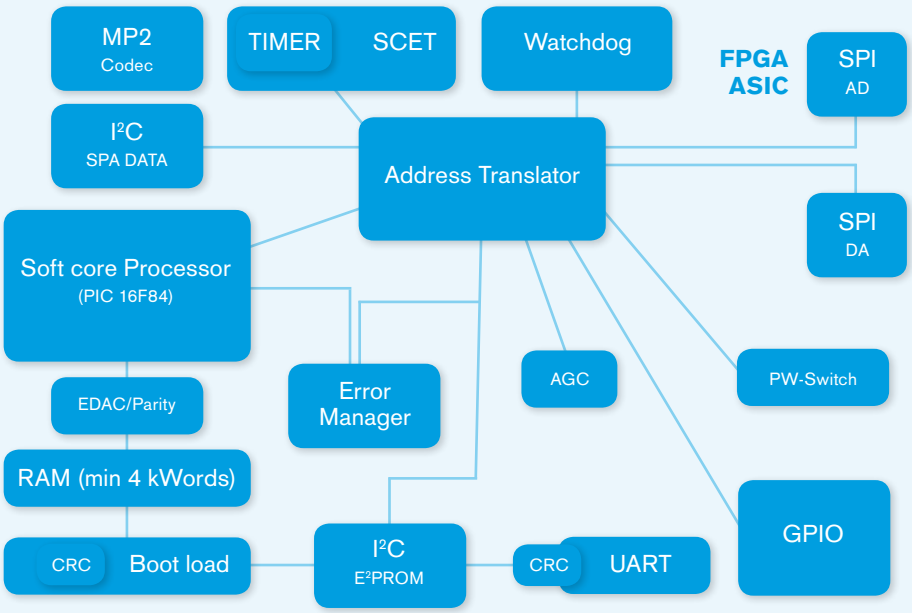


**FIG. 3.** nanoRTU™ block diagram.

## Features

- Fully pipelined ÅAC OpenPIC Fault Tolerant™ microprocessor providing 1 MIPS per MHz. OpenPIC is compatible with the PIC16F84 microprocessor
- Processor clock frequency is 16 MHz
- Core available as radiation-tolerant FPGA
- 4 K Word (x 14 bit) program RAM
- I²C physical interface (SPA-1 4-wire compatible)
- Supports In-flight firmware update
- 128 KB EEPROM storage for program and user data
- 10 x General Purpose IO (GPIO)
- 1 x UART
- Regulated 3.3 V user voltage with power switch
- Internal health monitoring
  - Input voltage level (V)
  - Input current level (A)
  - Module temperature (°C)
  - User-regulated voltage level (V)
- <0.2 W nominal power consumption

Features may be supported on different models. Check technical specifications.

## Software support

Source Boost C
SPA-1 C library with API
ÅAC Microtec nanoRTU™ programming interface

# Technical specifications – Remote Terminal Unit nanoRTU™

| KEY PARAMETERS | |
|---|---|
| Processor | Fully pipelined ÅAC Microtec OpenPIC Fault Tolerant™ micro-processor providing 1 MIPS per MHz. OpenPIC is compatible with the PIC16F84 microprocessor. |
| Processor clock | 16 MHz |
| SCET | 136 years, resolution15.3 µs |
| RAM | 4K Word |
| Memory (EEPROM) | 128 KB |
| Communication | 1 x I2C (100 kbps, 400 kbps)<br>1 x UART |
| Total Ionizing Dose | 20 krad (FPGA) |
| **ANALOG INPUT** | |
| Number of AD channels | 4 (shared with DA) |
| AD resolution | 12 bit |
| AD sampling rate | 150 kSps |
| Input voltage range | 0–2 Vpp |
| Bandwidth | 75 kHz |
| **ANALOG OUTPUT** | |
| Number of DA channels | 4 (shared with AD) |
| DA resolution | 12 bit |
| DA refresh period | 200 kHz |
| Output voltage level | 0–3.3 Vpp |
| Bandwidth | 100 kHz |
| Impedance | 2 kΩ |
| **GPIO** | |
| Number of GPIO | 10 |
| Output/input | 3.3 V – TTL |
| **POWER SUPPLY** | |
| Supply voltage | 5 V |
| Power consumption | 0.2 W |
| User power | 5 V<br>3.3 V (200 mA) |
| **I²C INTERFACE** | |
| Bus speed | 100 or 400 kbps |
| Bus voltage | 3.3 V |
| **DIMENSIONS** | |
| PCB (FM) | 32 x 32 x 6.2 mm |
| PCB (EM) | 32 x 32 x 10 mm |

| ENVIRONMENTAL | |
|---|---|
| Operating temperature | -40–+60 °C |
| Storage temperature | -40–+85 °C |
| Relative humidity, non-condensing | 5%–95% |
| **CONNECTORS** | |
| Engineering Model (EM) | SPA-1, Micro-MaTch |
| Flight Model (FM) | SPA-1, Pico-EZmate™ |

**FAULT DETECTION & CORRECTION**

- 1 bit correction and multiple error detection EDAC on OpenPIC program RAM. Multiple errors lead to automatic reset of the device.
- Parity error checking on OpenPIC data RAM. Parity error leads to automatic reset of the device.
- Parity error checking on 1 KByte user RAM.
- Triple Modular Redundancy (TMR) on all FPGA flip-flops
- FPGA SEU bank flip detection. Bank SEU leads to automatic reset of the device.
- Watchdog. Watchdog tripping leads to automatic reset of the device.
- Cyclic redundancy checking (CRC-8 CCITT) during boot on static firmware and in-flight upgradable firmware
- Cyclic redundancy checking (CRC-8 CCITT) of extensible Transducer Electronic Datasheet (xTEDS)
- The nanoRTU™ first re-boots from in-flight upgradable firmware. This only occurs if the in-flight upgradable firmware exists and CRC checks out, otherwise the device automatically falls back to the static firmware and checks CRC. The device tries to boot the static firmware even during static firmware CRC error. It will, however, flag that a CRC error has been detected. If the device is functioning, this lets the user transmit to the spacecraft fault detection isolation & recovery (FDIR) manager.

| HEALTH MONITORING | |
|---|---|
| Interface temperature precision | 1 °C |
| Input voltage precision | 0.1 V |
| Input current precision | 1 mA |
| User 3.3 V regulated precision | 0.1 V |
| **APPLICATION SOFTWARE** | |
| API Library | C Application Programming Interface device library |
| ÅAC Microtec nanoRTU 200 Firmware Tool | Programming utility for Windows .NET 3.5 |
| **COMPLIANCE** | Space Plug-and-Play (SPA-1) |

**ORDER INFORMATION**

| Part number | Item | Description |
|---|---|---|
| 104096 | nanoRTU 211 (EM) | Engineering Model |
| 104097 | nanoRTU 212 (FM) | Flight Model |
| 104042 | nanoRTU 211 | Development kit (EM) |

**For more information, please contact:**
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