# GTNETx2: THE RTDS® SIMULATOR'S NETWORK INTERFACE CARD

The GTNETx2 card provides a real-time communication link to and from the simulator via Ethernet. Different protocols can be used with the GTNETx2 depending on the application. The GTNETx2 communicates with the simulation via an optical fibre cable connected to the main simulation hardware.

Each GTNETx2 card has two modules. Each module has one Ethernet port, which may be equipped for one of three connection options: 100/1000 Copper, 100BASE-FX, or 1000BASE-SX.

Each GTNETx2 card comes with all available protocols (listed below) installed. Each module can have 1 active network protocol at any given time, which means each GTNETx2 card can operate a total of 2 network protocols simultaneously.
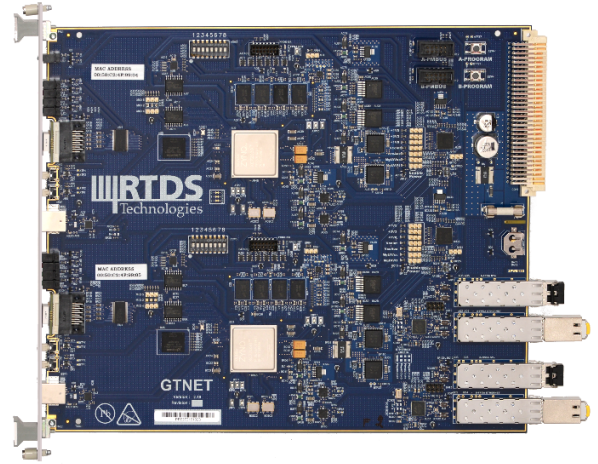
GTNET-SKT

Using the Socket (SKT) protocol, the GTNETx2 module communicates with external software and physical equipment over a Local or Wide Area Network connection using TCP or UDP sockets. When communicating with a single external device, GTNET-SKT is capable of sending up to 300 input and output data points per packet, with each point defined over 4 bytes. The data transmitted can be of either integer or floating-point (IEEE 754) type. When communicating with multiple external devices (to a maximum of 10), GTNET-SKT is capable of managing up to 30 input and 30 output data points for each channel.

GTNET-MODBUS

The MODBUS firmware provides Modbus communication over TCP/IP networks using the GTNETx2 hardware. The component supports Modbus TCP, Modbus UDP, Modbus RTU over TCP, and Modbus ASCII over TCP. GTNET-MODBUS operates as a Modbus server (slave) communicating to a Modbus master station through the GTNETx2 module's Ethernet port. This master station can be either an external IED or a computer workstation running a Modbus master API.

Each instance of the MODBUS firmware can simulate up to 10 Modbus outstations simultaneously, each with independent data mapping. Each outstation can maintain two concurrent communication channels with two different clients, using two different TCP ports (20 connections in total).

GTNET-GSE

The GTNET-GSE firmware provides IEC 61850 Ed 2.0 and 2.1 GOOSE communication and MMS server services. GTNET-GSE can simulate 1-4 IEDs, which can be configured to publish/subscribe regular or routable GOOSE. Each GTNET-GSE firmware can publish up to 16 GOOSE message streams and receive GOOSE messages from up to 32 unique external IEDs. Each firmware can publish up to 512 data items (of types integer, Boolean, double position, float or quality) and can receive up to 512 data items.

The GTNET GOOSE configuration is done via a companion software tool within RSCAD called the IED Configuration Tool. IEDs simulated by GTNET-GSE component can include standard IEC 61850 data models obtained from the ICTs' Logical Node (LN) database. In addition, the GTNET-GSE supports simulated switch-objects to represent and test switchgear operations, test (simulated) GOOSE messages, and GOOSE subscription monitoring.

GTNET-SV

The SV firmware option provides IEC 61850-9-2 / IEC 61869-9 Sampled Value messaging for power system voltages and currents. In order to timestamp the sampled values, the simulation must be synchronized to an external time reference (1PPS, IRIG-B, or IEEE 1588) using the GTSYNC card. In output mode, GTNET-SV can publish up to 2 independent SV streams simultaneously. Each IEC 61869-9 stream can have up to 24 channels at sampling rates of 80 and 96 samples/cycle and 4800 Hz. Each stream can have up to 9 channels at sampling rates of 256 samples/cycle and 14,400 Hz.

In input mode, GTNET-SV can subscribe to one SV stream (with the same sampling rate and channel limits as written above). GTNET-SV can be configured to publish/subscribe regular SV or routable SV (R-SV). GTNET-SV also supports connection-oriented IEC 61850 MMS client/server communication, acting as a service device. A client can connect to GTNET-SV as an MMS server and access, view, and control the data objects in the model.

GTNET-PMU

The PMU firmware provides synchrophasor output data streams according to the IEC/IEEE 60255-118-1 standard. Two PMU streaming options are available for GTNET-PMU.

Using the first option, a single GTNET-PMU firmware can represent and provide output for up to eight (8) PMUs with symmetrical component information related to 3-phase sets of voltage and current using UDP or TCP connections. The reporting rate of each PMU can be set individually between 1 and 60 frames per second. Using this option, reporting rates as high as 240 frames per second are supported. Frame rates as high as 240 frames per second are supported, but require the maximum number of PMUs represented by one GTNETx2 to be reduced from eight. Using the second option, a single GTNET-PMU firmware can represent and provide output for up to twenty four (24) PMUs containing only positive sequence data. Frame rates up to the system frequency (50/60 Hz) are supported.

GTNET-DNP, -104

The GTNET-DNP and GTNET-104 firmwares allow the GTNETx2 module to act as a DNP3 or IEC 60870-5-104 slave. Each instance of the DNP or 104 firmware supports simulation of up to 10 outstations, with a maximum of 2 masters connected per outstation (20 connections total). The maximum polling rate is 5 Hz.

For each instance of the DNP or 104 firmware operating, the GTNETx2 can accommodate the following maximum communication capacity:

- 1024 binary simulation status points (i.e. breaker positions) at scan rate of 1000 Hz
- 512 binary simulation control points (i.e. breaker commands) at scan rate of 1000 Hz
- 500 analogue status points (i.e. output from simulator) at scan rate of 10 Hz
- 100 analogue control (i.e. input to simulator) at scan rate of 10 Hz

GTNET-PB

The Playback firmware option is used to read large data files stored on a PC hard drive and allow them to be played back in an RTDS simulation. Sampling frequencies as high as 20 kHz can be maintained in a true real time simulation. Up to 48 channels of floating point data can be imported from an external data file (COMTRADE or ASCII).

The GTNET card brings in the data using TCP/IP Ethernet communication. Because the data file is stored remotely on a PC, file sizes of several GB can be handled easily. The component also allows for independent pre and post fault looping.

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