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

RTDS Technologies

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 optical fibre cables connected to the main simulation hardware.

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. The capabilities of each protocol are described below. Purchasing additional GTNETx2 cards will increase the RTDS Simulator's communication capabilities accordingly.
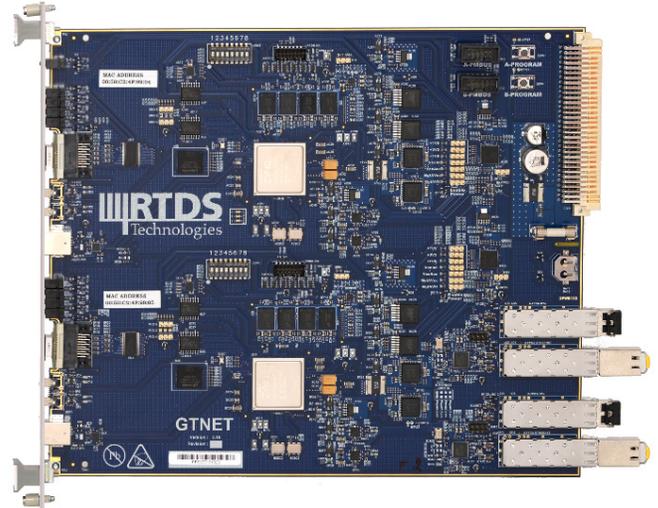
GTNET-SKT

Using the Socket (SKT) protocol, the GTNETx2 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 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's Ethernet port. This master station can be either an external IED or a computer workstation running a Modbus master API.

GTNET-GSE

The GTNET-GSE firmware option, for IEC 61850 GOOSE messaging, supports up to 4 GGIO TX/RX modules, which can be arranged to simulate 1-4 IEDs. Each module is capable of sending and receiving up to 64 points (or 32 points with associated quality bitmap). GTNET-GSE also supports one XCBR/XSWI TX module, which can publish up to 32 circuit breaker/switch statuses plus quality bitmaps. Each of the four GGIO TX/RX modules can be configured to publish/subscribe regular or routable GOOSE (R-GOOSE). The fifth XCBR/XSWI TX module can be configured to publish regular or R-GOOSE.

For each GSE firmware installed, GOOSE messages can be received from a total of 16 unique external IEDs. The GTNET GOOSE configuration is done via an SCD file. RSCAD contains a built in SCD editor which helps the user to easily and conveniently configure the publication and subscription of GOOSE messages. IEC GOOSE fields such as the Test mode, Needs Commissioning and individual Quality bitmaps can be dynamically changed and monitored for both transmit and receive messages during a simulation to allow many scenarios to be thoroughly tested and verified.

GTNET-SV

The SV firmware option provides IEC 61850-9-2LE / 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.

Each IEC 61850-9-2LE stream can have a maximum of 8 channels (i.e. 4 x V, 4 x I). 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 option for the GTNETx2 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.

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.

Both P and M class models (defined in Annex C of the IEC/IEEE 60255-118-1 standard) for synchrophasor data output are available. CBuilder source code is provided for both the P and M class reference models should the user wish to try implementing their own algorithms. Note that M class reporting rates are limited to 10 frames per second. The GTNET-PMU component output is synchronized to an external 1PPS, IRIG-B or IEEE 1588 signal via the GTSYNC card.

GTNET-DNP, -104

The GTNET-DNP firmware option allows the GTNETx2 to act as a DNP3 slave. The GTNET-104 firmware option allows the GTNET to act as a IEC 60870-5-104 slave. DNP and 104 are SCADA protocols commonly used in substations.

For each DNP or 104 protocol operating, the GTNETx2 can communicate with up to 4 external DNP or 104 masters and 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 8 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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