• **2301D-GT** – Digital Simplex Controller
  – Single shaft, single fuel gas turbines

• **GTC100** – Digital Simplex Controller
  – Single shaft, dual fuel small gas turbines

• **GTC190** – Digital Simplex Controller
  – Single shaft, dual fuel frame gas turbines
  – Programmable Sequence Logic
  – Optional Distributed I/O

• **GTC200** – Digital Simplex Controller
  – Two shaft, dual fuel small gas turbines

• **GTC250** – Digital Simplex Controller
  – Two shaft, dual fuel aero-gas turbines
  – Programmable Sequence Logic
  – Optional Distributed I/O
The 2301D-GT control is a 2301D based platform with a standard application program designed to control single shaft, single fuel gas turbines.
2301D-GT – Gas Turbine Controller

- 24 Vdc
- ModBus Interface
- Load Sharing Lines
- Contact Inputs
- Analog Inputs
- Relay Outputs
- SPM-A Input
- PTs & CTs
- EGT
- Fuel Demand
- CDP
- Inlet Temp
- Turbine Speed
- Generator
- Load
- SPMA
- Utility Bus
- Plant DCS or OCP
- To other 2301Ds or 2301As
- Raise, Lower, Start, SD, Reset, 52G, Idle/Rated
- Remote Speed Setpoint
- Alarm, Shutdown, Overspeed
- Turbine controls - Overview
**Sales Attributes:**

- Microprocessor Based Control
- Integral, Pre-Programmed Application Software
- Highly Configurable To Specific Site Requirements
- Provides Core Fuel Control For A Single Shaft Gas Turbine
- Single Printed Circuit Board In Sheet Metal Chassis
  - Versions For Ordinary Or Hazardous Locations
- Easy Replacement For 2301A Systems
  - Equivalent Environmental Specs
  - Terminals In Same General Locations

2301D-GT – Gas Turbine Controller
2301D-GT – Long Term Product Strategy

2301D-GT Manual Improvement Project
• Improve Configure & Service function information
• Add wiring diagrams to other Woodward products
• Add application examples
**Product Description:**

- Single Shaft Gas Turbine Control
  - Focused on turbines up to 15MW
  - Single or Dual Fuel control w/ Auto Transfer
  - Generator or Mechanical Drive applications
- **Standard Software**
  - End user configurable, user friendly
  - Field proven, robust
  - GAP based – expandable by Woodward’s Recognized Turbine Retrofitters and OEMs
- **Standard Hardware**
  - Atlas SC based
  - Small package size
  - Robust platform
**Market Focus:**
- One (1) Shaft Gas Turbines
- Small Industrial Applications up to 15MW
- Power Generation
  - Co-Generation
  - Combined Cycle
- Process Industries
  - Power House
  - Gas Production & Platforms
  - Gas Processing
  - Petroleum Refining
- Pipeline Compressors
- Pump Drives
GTC100 – Gas Turbine Controller

- Two RS232, RS-422 Serial Modbus Ports
- Configurable Analog Outputs
- Turbine Shutdown, Turbine Alarm, Configurable Discrete Outputs
- Configurable Analog Inputs
- ESD, Reset, Raise/Lower Speed, Configurable Inputs

- GTC100
- 24 Vdc

- Mechanical Drive Application

- Pressure Sensors
- Discharge
- Suction

- Compressor Discharge Pressure
- Turbine Inlet Temperature
- Gas Fuel Valve Demand Signal
- Liquid Fuel Valve Demand Signal
- Turbine Speed
- Exhaust Gas Temperature
- Dual Fuel Skid
  - Gas Vlv
  - LIq Vlv
  - Steam Vlv

- Pump

- Turbine controls - Overview
GTC100 – Gas Turbine Controller

- Two RS232, RS-422 Serial Modbus Ports
- Configurable Analog Outputs
- Configurable Analog Inputs
- ESD, Reset, Raise/Lower Speed, Configurable Inputs
- Configurable Discrete Outputs
- Configurable Analog Outputs

- 24 Vdc

- Compressor Discharge Pressure
- Turbine Inlet Temperature
- Gas Fuel Valve Demand Signal
- Liquid Fuel Valve Demand Signal
- Steam Vlv
- Dual Fuel Skid
- Liq Vlv
- PTs & CTs
- Load
- Auto Sync Gen Brkr

- Load Sharing
- LON Network

TURBINE ENGINE CONTROLS BV
Sales Attributes:

- **Packaged Experience**
  - Woodward Experience with Aero-Derivative Gas Turbine Control
  - Woodward Experience with Turbine Retrofits
  - Hardware & Software experience on many turbine applications

- **Field Proven Hardware and Software**
  - Based on the robust Woodward AtlasSC
  - GAP based software
    - Code Software Reuse = Bug-free Software
    - Easily Expanded Functionality
    - Multiple Rate Groups with 5, 10, 20, 40, 80 msec Recursion Rates
    - Superior Derivative Sensing and Control

- **Product Support**
  - Full Service and Technical Assistance Capability through many Woodward RTRs
  - Maximum Life Cycle Support
    - Long Production Cycles
  - Flat Rate Repair & Replacement/Exchange Programs
  - Covered by Woodward’s Standard Warranty
Sales Attributes:

- Pre-engineered Control Functionality
  - Start with proven, high performance control algorithms
- Off-the-shelf hardware
  - Pre-defined wiring reduces system engineering time
- Configurable GAP software
  - User-friendly software, no complicated programming needed
  - Pre-defined logic reduces system engineering time
  - Operates in a deterministic manner at various rate groups (5, 10, 20, 40, 80 ms) assuring all critical control functions are performed quickly and effectively everytime
- Communications and Interface
  - Multiple ModBus ports for communicating to other parts of the overall system
  - Easy interface to various types of actuators and valves
GTC100 without Power Sense Project

- Not Currently scheduled
  - Based on market demand
- Lower cost alternative
GTC190 control Functions:
- Single Shaft Gas Turbine Controller
- Focused at Westinghouse Frame Turbine
- Core Fuel Control (protected, field proven)
- AtlasPC Platform
  - Includes 3 Analog I/O Modules
- Dual Fuel Logic
- Optional MultiProg Sequencing Logic and Distributed I/O
- Can be customized to application
  - Source code included

Description: The GTC190 is an AtlasPC platform with a standard/configurable application program like the Woodward 511 and Excel150 controls except it includes source code to allow Woodward RTRs to add site specific logic and I/O as required. This controller is focused at core fuel control and total package control applications for 10-45MW single shaft Westinghouse frame gas turbines.
TURNER ENGINE CONTROLS BV

GTC190 Frame Gas Turbine Application

- Relay Outputs: Alarm, Shutdown, Overspeed, etc
- 4-20 Analog Outputs: Speed, Load, EGT, CDP, etc
- Contact Inputs: Raise, Lower, Rated, Start, S/D, Reset, Fuel Xfer, etc
- 4-20 Analog Inputs: Remote Speed Setpoint
- Computer/Peripheral Interfaces: Ethernet, Modbus, Profibus Dist I/O
- Contact Inputs: Raise/Lower Speed Signals
- Generator RTDs: Gen MW Signal
- Exhaust Temp
- Gas Demand
- Liq Demand
- Inlet Air Temp
- Turbine Speed
- Compressor Discharge Pressure
- Load
- Utility Bus

Turbine controls - Overview
AtlasSC Based Control:
- Two (2) Shaft Gas Turbines
- Aero-Derivative and Small Industrial Applications
  - Power Generation
    - Co-Generation
    - Combined Cycle
  - Process Industries
    - Power House
    - Gas Production & Platforms
    - Gas Processing
    - Petroleum Refining
  - Pipeline Compressors
  - Pump Drive
  - Marine Drive

GTC200 – Gas Turbine Controller
**Turbine controls - Overview**

**TURNER ENGINE CONTROLS BV**

**GTC200 – Gas Turbine Controller**

- 24 Vdc
- Two RS232, RS-422 Serial Modbus Ports
- Configurable Analog Outputs
- Configurable Analog Inputs
- ESD, Reset, Raise/Lower Speed, Configurable Inputs
- Configurable Analog Inputs
- Turbine Shutdown, Turbine Alarm, Configurable Discrete Outputs
- Two RS232, RS-422 Serial Modbus Ports
- Configurable Analog Outputs

**INPUTS**

- Compressor Discharge Pressure
- Turbine Inlet Temperature
- Gas Generator Speed
- NOx Actuator Signal
- Power Augmentation Signal
- Gas Fuel Valve Demand Signal
- Liquid Fuel Valve Demand Signal

**OUTPUTS**

- Power Turbine Speed
- Exhaust Gas Temperature
- Dual Fuel Skid
- Gas Vlv
- Steam Vlv
- Watt Xducer
- PTs & CTs
- Generator

**POWER TURBINE SPEED**

**REFERENCE**

- Generator

**USING**

- GTC200 – Gas Turbine Controller
**Sales Attributes:**

- Better Turbine Algorithms
  - Industry Proven GAP Software
  - Long Experience List with Aero-Derivative Gas Turbine Control
  - Many Industrial Turbine Retrofits
  - Code Reuse = Bug-free S/W
  - Multiple Rate Groups
    - 5, 10, 20, 40, 80 msec Recursion Rates
    - Reduced Processor Load
    - Superior Derivative Control
    - dN/dT Acceleration / Deceleration Limiting
- Better Integration
  - Faster Update Rates to Minimize Delays to Corrective Action
  - Variety of Decoupling Options
  - Configurable Standard Controls
  - 5 msec Data Logging & Trending of Turbine & Compressor Variables

**GTC200 – Gas Turbine Controller**
GTC200 with Power Sense Project

• Not Currently scheduled
  • Based on market demand
• Same Power Management function
AtlasPC Based Control:
• Two (2) Shaft Gas Turbines
• Aero-Derivative Applications
  – Power Generation
    • Co-Generation
    • Combined Cycle
  – Process Industries
    • Power House
    • Gas Production & Platforms
    • Gas Processing
    • Petroleum Refining
  – Pipeline Compressors
  – Pump Drives
  – Marine Drives
GTC250 – Gas Turbine Controller

- 24 Vdc
- Configurable Analog Outputs
- Configurable Analog Inputs
- ESD, Reset, Raise/Lower Speed, Configurable Inputs
- One Optional Profibus Port, Two RS232 Serial Modbus Ports

- Power Turbine Speed
- Exhaust Gas Temperature
- Compressor Discharge Pressure
- Turbine Inlet Temperature
- Gas Generator Speed
- NOx Actuator Signal
- Power Augmentation Signal
- Gas Fuel Valve Demand Signal
- Liquid Fuel Valve Demand Signal
- Dual Fuel Skid

- PTs & CTs
- Watt Xducer

- Steam Vlv
- Gas Vlv
- Liquid Vlv

TURBINE ENGINE CONTROLS BV
Sales Attributes:

- Better Turbine Algorithms
  - Industry Proven GAP Software
  - Long Experience List with Aero-Derivative Gas Turbine Control
  - Many Industrial Turbine Retrofits
  - Code Reuse = Bug-free S/W
  - Multiple Rate Groups
    - 5, 10, 20, 40, 80 msec Recursion Rates
    - Reduced Processor Load
    - Superior Derivative Control
  - \(\frac{dn}{dT}\) Acceleration / Deceleration Limiting

- Better Integration
  - Faster Update Rates to Minimize Delays to Corrective Action
  - Variety of Decoupling Options
  - Configurable Standard Controls
  - 5 msec Data Logging & Trending of Turbine & Compressor Variables
GTC250 with Power Sense Project

- Not Currently scheduled
  - Based on market demand
- Same Power Management functionality as GTC100
Application Development
Software Suite
GAP Control Software Overview
Software Development with GAP

• Deterministic Rate Group Structure
  – Ensures critical control loops execute on time every time
  – Ensures proper control of engine or turbine dynamics
  – Consistent Simulation and Field execution

• GAP Programming
  – Windows based Drag and Drop programming using well defined and tested blocks in easy to use engineering units
  – Automated Error checking - On line data type checking, pre-compile completeness checking of all required values and data types, Compile loop execution order checking

• Woodward Library of GAP software Functions
  – E.g., Thermocouple Monitoring (“T_C Mon” block)
  – Speed Sensing, Filtering, Derivative Calculation
GAP Programming

- Multi-GAP - Multiple GAP Files Allowed
  - Separate Core Functions from Packager Functions
  - Manage Engineering Change Control on Core Software
  - Enables Packager to add Value, Without Affecting Core Software

- Configuration Management
  - “Publish” Feature in GAP, Revisions History
  - Comparison of Files – Using Standard GAP features

- IEC 61131-3 Programming Interface
  - GAP (Graphical Application Programmer) Function Blocks
  - Ladder Logic Programming
  - Sequential Function Chart (SFC)
  - C Programming Language

- Export/Import Features
  - Export/Import from and to Databases and Other Programs,

- GAP Supports Multiple Rate Group Structure
  - Design Control to Execute at Different Rates
  - Adding or Subtracting Blocks will NEVER change dynamics
Multi-Lingual Sequence Logic
- On-Line Program Changes
- Multi-Lingual Program Environment
- Ladder Logic with Sub-Routine & Function-Call Capabilities
- Functional Block Logic
- IEC61131 Certified
- Hierarchical Function Blocks
- Offered in GTCxxx Product Line

Description: This product is a multi-lingual programming tool which, allows AtlasPC users create and make changes to application based ladder logic and block type sequencing programs. This tool is licensable and can be used to make changes while the control is off-line or on-line, without shutting down the control or machine.

This tool also allows users to program in their own native language, and as a minimum will include language selection for English, Japanese, Chinese, Spanish, German, French..
Turbine controls - Overview

TURNER ENGINE CONTROLS BV

Multiprog/GAP – Integration

Core Software

GAP Application

Multiprog Application

Compiler
Recipe & Logic Analyzer Functionality
Software Service Tools Suite

- **GAP Management / Monitoring Tools**
  - Application Manager – Load / Retrieve Applications
  - Monitor GAP Tool – Allows In Context Logic Monitoring

- **Watch Window**
  - *Windows Based Service tool for troubleshooting, variable monitoring and tuning. Ethernet OPC Option Available.*

- **Control Assistant**
  - *Windows Based service tool for graphical display of high speed (5 millisecond) data for detailed analysis of dynamic control data.*
  - Capture, sort, compare, save and upload tunable values

- **NetSim Basic**
  - *Windows Based simulation tool used to test the GAP program on your computer before it is loaded onto the control.*