D1000M SERIES FOR MODBUS
SENSOR TO COMPUTER INTERFACE MODULES

D1000 FEATURES

- Complete sensor to RS-232/RS-485 interface.
- 500V rms analog input isolation.
- 15 bit measurement resolution.
- Continuous self-calibration; no adjustments of any kind.
- Programmable digital filter.
- Digital inputs and outputs connect to solid state relays.
- Requires +10V to +30Vdc unregulated supply.
- Transient suppression on RS-485 communications lines.
- Screw terminal plug connectors supplied.

APPLICATIONS

- Process monitoring and control
- Remote data logging to any host computer
- Product testing

D1000M SPECIFICATIONS (typical at +25°C and nominal power supply unless otherwise noted)

Analog
- Single channel analog input.
- Maximum CMV, input to output at 60Hz: 500V rms.
- Leakage current, input to output at 115Vrms, 60Hz: <2μA rms.
- 15 bit measurement resolution.
- 8 conversions per second.
- Autozero & autocalibration—no adjustment pots.

Digital
- 8-bit CMOS microcomputer.
- Digital scaling, linearization and calibration .
- Nonvolatile memory eliminates pots and switches.

Digital filtering
- Small and large signal with user selectable time constants from 0 to 16 seconds.

Digital inputs
- Voltage levels: ±30V without damage.
- Switching levels: High, 3.5V min., Low, 1.0V max.
- Internal pull up resistors for direct switch input.

Digital outputs
- Open collector to 30V, 30mA max. load.

Communications
- Communications in MODBUS-RTU via RS-485 ports.
- Selectable baud rates: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200.
- NRZ asynchronous data format; 1 start bit, 8 data bits, 1 parity bit and 1 stop bit.
- Parity: odd, even, none.
- User selectable channel address.
- Up to 246 multidrop modules per host serial port.
- Communications distance up to 4,000 feet (RS-485)**.**
- Transient suppression on RS-485 communications lines.
- All communications setups stored in EEPROM.

Power
Requirements: Unregulated +10V to +30Vdc , 0.75W max (D1500M, 2.0W max.).
Internal switching regulator.
Protected against power supply reversals.

Environmental
Temperature Range: Operating -25°C to +70°C.
Storage -25°C to +85°C.
Relative Humidity: 0 to 95% noncondensing.

Warranty
12 months on workmanship and material.

Specifications are subject to change without notice.

D1100M Voltage Inputs
- Voltages: ±10mV, ±100mV, ±1V, ±5V, ±10V, ±100Vdc.
- Resolution: 0.01% of FS (4 digits).
- Accuracy: ±0.02% of FS max.
- Common mode rejection: 100dB at 50/60Hz.
- Zero drift: ±1 count max (autozero).
- Span tempco: ±50ppm/°C max.
- Input burnout protection to 250Vac .
- Input impedance: $\leq$ ±1V input = 100MΩ min.
  $\geq$ ±5V input = 1MΩ min.
- 1 Digital input, 2 Digital outputs.

D1200M Current Inputs
- Currents: ±1mA, ±10mA, ±100mA, ±1A, 4-20mAdc.
- Resolution: 0.01% of FS (4 digits), 0.04% of FS (4-20mA).
- Accuracy: ±0.02% of FS, 0.04% of FS (4-20mA).
- Common mode rejection: 100dB at 50/60Hz.
- Zero drift: ±1 count max (autozero).
- Span tempco: ±50ppm/°C max. (±1A = ±80 ppm/°C max.)
- Voltage drop: ±0.1V max.
- 1 Digital input, 2 Digital outputs.

D1300M Thermocouple Inputs
- Thermocouple types: J, K, T, E, R, S, B, C (factory set).
- Ranges: J = -200°C to +760°C   B = 0°C to +1820°C
  K = -150°C to +1250°C   S = 0°C to +1750°C
  T = -200°C to +400°C   R = 0°C to +1750°C
  E = -100°C to +1000°C   C = 0°C to +2315°C
- Resolution: ±1°.
- Overall Accuracy (error from all sources) from 0 to +40°C ambient: ±1.0 °C max (J, K, T, E).
  ±2.5 °C max (R, S, B, C)(300°C TO FS).
- Common mode rejection: 100dB at 50/60Hz.
- Input impedance: 100MΩ min.
- Lead resistance effect: <20μV per 350Ω.
- Open thermocouple indication.
- Input burnout protection to 250Vac.
- Overrange indication.
- Automatic cold junction compensation and linearization.
- 2 Digital inputs, 3 Digital outputs.

D1400M RTD Inputs
- RTD types: α = .00385, .00392, 100Ω at 0°C, .00388, 100Ω at 25°C.
- Ranges: .00385 = -200°C to +850°C.
  .00392 = -200°C to +600°C.
  .00388 = -100°C to +125°C.
- Resolution: 0.1°.
- Accuracy: ±0.3°C.
- Common mode rejection: 100dB at 50/60Hz.
- Input connections: 2, 3, or 4 wire.
- Excitation current: 0.25mA.
- Lead resistance effect: 3 wire - 2.5°C per Ω of imbalance.
  4 wire - negligible.
- Max lead resistance: 50Ω**.**
- Input burnout protection to 120Vac .
- Automatic linearization and lead compensation.
- 1 Digital output.

D1450M Thermistor Inputs
- Thermistor types: 2252Ω at 25°C, TD Series
- Ranges: 2252Ω = -0°C to +100°C.
    TD = -40°C to +150°C.
- Resolution: 2252Ω = 0.01°C or F.
    TD = 0.1°C or F
- Accuracy: 2252Ω = ±0.1°C.
    TD = ±0.2°C
- Common mode rejection: 100dB at 50/60Hz.
- Input burnout protection to 30Vdc .
- 1 Digital input, 2 Digital outputs.

D1500M Bridge Inputs
- Voltage Ranges: ±30mV, ±100mV, 1-6Vdc.
- Resolution: 10µV (mV spans).
    0.02% of FS (V span).
- Accuracy: ±0.05% of FS max.
- Common mode rejection: 100dB at 50/60Hz.
- Input burnout protection to 30Vdc .
- Offset Control: Full input range.
- Excitation Voltage: 5V, 8V, 10Vdc, 60mA max.
- Zero drift: ±1µV/°C max.
- Span tempco: ±50ppm/°C max.
- 1 Digital output.

D1600M Frequency Inputs
- Input impedance: 1MΩ.
- Switching level: selectable 0V, +2.5V.
- Hysteresis: Adjustable 10mV-1.0V.
- Input burnout protection: 250Vac .
- 1 Digital input.

Frequency Input
- Range: 1Hz to 20KHz.
- Resolution: 0.005% of reading + 0.01Hz.
- Accuracy: ±0.01% of reading ±0.01Hz.
- Tempco: ±20ppm/°C.

D1700M Digital Inputs/Outputs
- 7 digital inputs and 8 digital outputs.
- Input voltage levels: ±30V without damage.
- Input switching levels: High,3.5V min.,Low,1.0V max.
- Outputs: open collector to 30V, 30mA max. load.
- Vsat: 0.2V max @ 30mA.
- Internal pull up resistors for direct switch input.
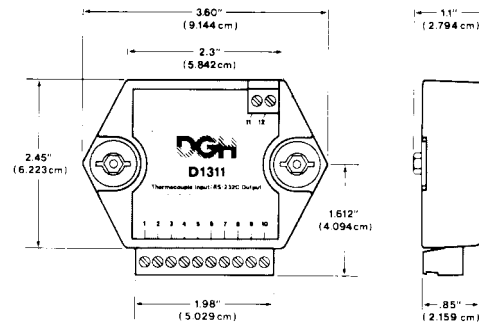- Inputs/Outputs are read/set in parallel.

Mechanicals and Dimensions
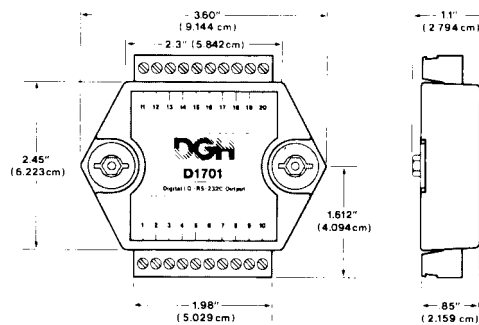Case: ABS with captive mounting hardware.
Connectors: Screw terminal barrier plug (supplied).
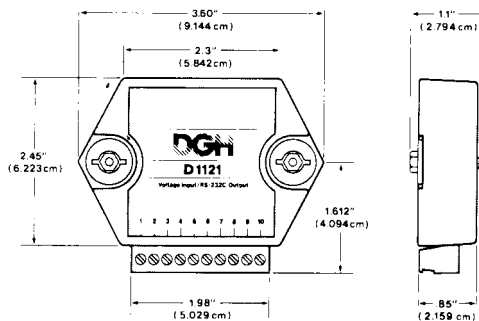   Replace with Phoenix MSTB 1.5/10 ST 5.08
    or equivalent.

D1300 Series

D1700 Series

D1000/D2000 Series

NOTE: Spacing for mounting screws = 2.700" (6.858 cm).
Screw threads are 6 X 32.

GENERAL DESCRIPTION

The D1000M Sensor to Computor Modules are a family of data acquisition modules designed for systems based on the Modbus™ RTU protocol. The modules convert analog input signals to digital data and transmit in hexadecimal characters via RS-485 to a controller which may be a computer or other processor-based equipment. The modules can measure temperature, pressure, voltage, current and various types of digital signals. The modules provide direct connection to a wide variety of sensors and perform all signal conditioning, scaling, linearization and conversion to percent of full scale in binary units. Each module also provides digital I/O lines for controlling devices through solid state relays or TTL signals. These digital I/O lines along with built-in limit setting capability provide alarm and control outputs.

The modules contain no pots or switches to be set. Features such as address, baud rate, parity, alarms, echo, etc., are selectable using simple commands over the communications port-without requiring access to the module. The selections are stored in non-volatile EEPROM which maintains data even after power is removed.

The key to the DGH product concept is that the modules are easy to use. You do not need engineering experience in complicated data acquisition hardware. With the DGH modules, anyone familiar with a personal computer can construct a data acquisition system. This modular approach to data acquisition is extremely flexible, easy to use and cost effective. Data is acquired on a per channel basis so you only buy as many channels as you need. The modules can be mixed and matched to fit your application. They can be placed remote from the host and from each other. You can string up to 247 modules on one set of wires by using RS-485 with repeaters.

All modules are supplied with screw terminal plug connectors and captive mounting hardware. The connectors allow system expansion, reconfiguration or repair without disturbing field wiring. Their small size allows them to be mounted in virtually any location or position including explosion-proof housings and DIN rails.

Utility software (S1000) is available on IBM-compatible diskette from DGH to make the D1000M easier to learn and use. S1000 software is provided at no charge on request with a purchase order and is not copy protected.

THEORY OF OPERATION

Each DGH module is a complete single-channel data acquisition system. Each unit contains analog signal conditioning circuits optimized for a specific input type. Sensor signals are converted to digital data with a microprocessor-controlled integrating A/D converter. Offset and gain errors in the analog circuitry are continuously monitored and corrected using microprocessor techniques. The D1000M converts the digital signal data and stores the resultant data as two hexadecimal characters in a memory buffer. The modules continuously convert data at the rate of 8 conversions per second and store the latest result in the buffer. Host processors may request data by sending a query to the module. The D1000M will instantly respond by communicating data back to the host processors. Up to 247 modules may be linked to a single RS-485 port. Each module on a serial line is identified by a unique user-programmable address. This addressing technique allows modules to be interrogated in any order.

DIGITAL INPUTS/OUTPUTS

D1000M modules contain up to three digital outputs and two digital inputs. The digital outputs are open-collector transistor switches that may be controlled by the host processors. These switches may be used to control solid-state relays which in turn may control heaters, pumps and other power equipment. The digital inputs may be read by the host processor and used to sense the state of remote digital signals. They are ideal for sensing the state of limit or safety switches.
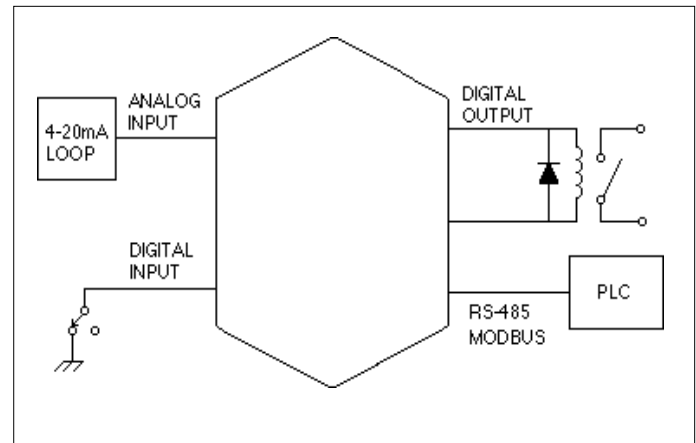

Figure 1 Typical D1000M application.

USER OPTIONS

To provide maximum flexibility, the D1000M offer a variety of user-selectable options including choice of address, baud rate and parity. All options are selectable using simple commands over the communications port. All option selections are stored in a non-volatile EEPROM that maintains data even after power is removed. The modules contain no pots or switches to be set. All options may be changed remotely without requiring access to the module.

DIGITAL FILTER

The D1000M options include a unique programmable single pole digital filter. The filter is used to smooth analog data in noisy environments. Separate time constants may be specified for small and large signal changes. Typically a large time constant is specified for small signal changes to filter out noise and provide stable output readings. A smaller time constant may be chosen for large signal changes to provide fast response to such changes.

COMMAND SET

The D100M series uses the Modbus RTU protocol for communication. The Modbus protocol uses a master-slave technique, in which only the master device can initiate transactions. The slave devices respond by supplying the requested data to the master or by taking the action requested in the query.

The master can address any slave device. The returned messages are considered response messages.

The Modbus protocol format used by a master consists of a device address, a command function code which defines the operation to be performed, data required with the command, and an error checking value. The slave response message contains any required data and error checking value. If an error occurs, an exception code will be generated. The supported master codes are:

01	Read Coil Status
04	Read Input Register
05	Force Single Coil
06	Preset Single Register
15	Force Multiple Coils

01   Read Coil Status is a digital input such as con tact status or contact closure.

04   Read Input Register is the analog input to the module.

05   Force Single Coil is used to set or clear a digital output.

06   Preset Single Register is used to temporarily suspend Modbus RTU mode and return to DGH ASCII protocol mode.

15   Force Multiple Coils is used to set or clear digital outputs.

Typical Command/Response sequence

A typical Modbus RTU command to a module may look like this:

        01 04   00 00   00 01   89 CA

This example is a Modbus Read Input Register command.

The 01 is the address of the slave DGH module being commanded. Each slave device must have its own unique address. The 04 character specifies the Read Input Register command. This is equivalent to the DGH Read Data command to obtain analog input data. The next two characters 00 00 specify the starting address of the registers to be read. The next two characters of this command specify the number of registers to be read, including the starting register. In this case the two binary characters 00 01 indicates only one register is to be read.The final two characters of the command make up the Cyclical Redundancy Check (CRC), used to check for errors in the message.

There are no prompt or terminating characters in the messages. All messages must be transmitted as continuous strings. Messages are terminated by a silent period of at least 3.5 character times.

A typical response to this example command could be:

        01 04 02 14 57 F7 CE

The 01 and 04 characters echo the slave address and the command function. For this command function, the 02 character indicates the number of data characters to follow: 2 characters.

The two character string 14 57 is the value read from Modicon input register 30001. Register data is read back as 16 bits. The remaining two characters, F7 CE is the CRC for the response.

SETUP

The D1000M series are initiated at the factory using the DGH ASCII protocol. This allows setup and configuration, including the Modbus device address, to be easily performed using the DGH setup software (S1000) or a dumb terminal. Each D1000M module must be properly configured before installation into a Modbus system.

S1000 UTILITY SOFTWARE

The S1000 utility software diskette contains executable programs that make it easy to configure the D1000M series modules. The S1000 provides executable programs that can be run on IBM PC/XT/AT or compatible computers. An executable menu-driven setup program is provided to simplify configuration of all user-selectable options such as address, baud rate, parity. Context-sensitive help is available during configuration for each selectable parameter. The S1000 is provided at no charge on request with a purchase order and is not copy protected.

PROCESS CONTROL SOFTWARE
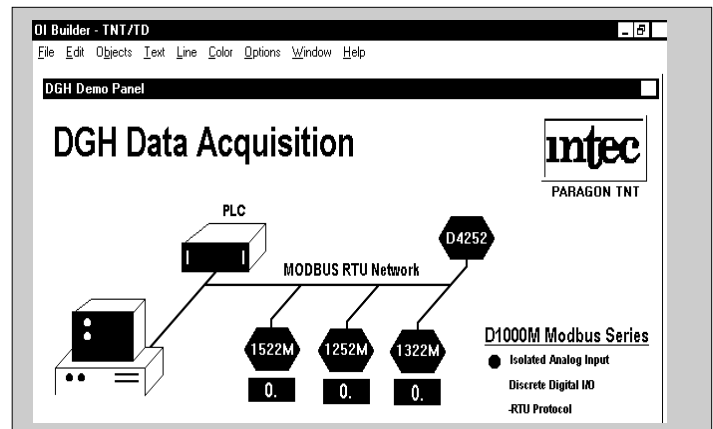
Modbus protocol is supported by virtually all commercial process control software programs available today. These programs operate on IBM AT and compatible personal computers in the Windows, Windows 95, Windows NT and IBM OS/2 environments. Control algorithims such as PID, alarm management, real time and historical trending and system security via password are available in each package.

D1000M SERIES ORDERING GUIDE

Voltage Input
D1101M 10mV Input/RS-232 Output
D1102M 10mV Input/RS-485 Output
D1111M 100mV Input/RS-232 Output
D1112M 100mV Input/RS-485 Output
D1121M 1V Input/RS-232 Output
D1122M 1V Input/RS-485 Output
D1131M 5V Input/RS-232 Output
D1132M 5V Input/RS-485 Output
D1141M 10V Input/RS-232 Output
D1142M 10V Input/RS-485 Output
D1151M 100V Input/RS-232 Output
D1152M 100V Input/RS-485 Output

Current Inputs
D1211M 10mA Input/RS-232 Output
D1212M 10mA Input/RS-485 Output
D1221M 1mA Input/RS-232 Output
D1222M 1mA Input/RS-485 Output
D1231M 100mA Input/RS-232 Output
D1232M 100mA Input/RS-485 Output
D1241M 1A Input/RS-232 Output
D1242M 1A Input/RS-485 Output
D1251M 4-20mA Input/RS-232 Output
D1252M 4-20mA Input/RS-485 Output

Thermocouple Inputs
D1311M J Thermocouple Input/RS-232 Output
D1312M J Thermocouple Input/RS-485 Output
D1321M K Thermocouple Input/RS-232 Output
D1322M K Thermocouple Input/RS-485 Output
D1331M T Thermocouple Input/RS-232 Output
D1332M T Thermocouple Input/RS-485 Output
D1341M E Thermocouple Input/RS-232 Output
D1342M E Thermocouple Input/RS-485 Output
D1351M R Thermocouple Input/RS-232 Output
D1352M R Thermocouple Input/RS-485 Output
D1361M S Thermocouple Input/RS-232 Output
D1362M S Thermocouple Input/RS-485 Output
D1371M B Thermocouple Input/RS-232 Output
D1372M B Thermocouple Input/RS-485 Output
D1381M C Thermocouple Input/RS-232 Output
D1382M C Thermocouple Input/RS-485 Output

RTD Inputs
D1411M .00385 RTD Input/RS-232 Output
D1412M .00385 RTD Input/RS-485 Output
D1421M .00392 RTD Input/RS-232 Output
D1422M .00392 RTD Input/RS-485 Output
D1431M .00388 RTD Input/RS-232 Output
D1432M .00388 RTD Input/RS-485 Output
D1451M 2252Ω Thermistor Input/RS-232 Output
D1452M 2252Ω Thermistor Input/RS-485 Output
D1461M TD Thermistor Input/RS-232 Output
D1462M TD Thermistor Input/RS-485 Output

Bridge Inputs
D1511M 30mV Bridge Input, 5V Excitation/RS-232 Output
D1512M 30mV Bridge Input, 5V Excitation/RS-485 Output
D1521M 30mV Bridge Input, 10V Excitation/RS-232 Output
D1522M 30mV Bridge Input, 10V Excitation/RS-485 Output
D1531M 100mV Bridge Input, 5V Excitation/RS-232 Output
D1532M 100mV Bridge Input, 5V Excitation/RS-485 Output
D1541M 100mV Bridge Input, 10V Excitation/RS-232 Output
D1542M 100mV Bridge Input, 10V Excitation/RS-485 Output
D1551M 1-6V Bridge Input, 8V Excitation/RS-232 Output
D1552M 1-6V Bridge Input, 8V Excitation/RS-485 Output
D1561M 1-6V Bridge Input, 10V Excitation/RS-232 Output
D1562M 1-6V Bridge Input, 10V Excitation/RS-485 Output

Timer and Frequency Inputs
D1601M Frequency Input/RS-232 Output
D1602M Frequency Input/RS-485 Output

Digital Inputs/Outputs
D1701M 7 Digital Inputs, 8 Digital Outputs/RS-232 Output
D1702M 7 Digital Inputs, 8 Digital Outputs/RS-485 Output