D3000M MODBUS SERIES
COMPUTER TO ANALOG OUTPUT MODULES

D3000M FEATURES

- Analog output ranges: 0-1V, ±1V, 0-5V, ±5V, 0-10V, ±10V, 0-20mA, 4-20mA.
- Communicates in ASCII with RS-232 or RS-485 serial ports.
- Programmable high/low output limits.
- 500Vrms output isolation.
- 12-bit output resolution.
- Scaling in engineering units.
- Baud rates: 300 to 115,200.
- Nonvolatile digital calibration.
- Output protection: 240VAC (current output).
  ±30V (voltage outputs).
- Direct connection to ‘dumb’ terminals or modems.
- Requires +10 to +30Vdc unregulated supply.
- May be located up to 4,000 feet from host (RS-485).
- Addressable: up to 247 Modbus units per serial port.
- ‘Bumpless’ manual control inputs.

D3000M PROGRAMMING FEATURES

- Fully programmable output slopes: 0.01V/s (mA/s) to 65535V/s (mA/s).
- Programmable watchdog timer provides orderly shutdown in the event of host failure.

APPLICATIONS

- Motion control
- Motor speed control
- Robotic welding control
- Interfaces to modems
- Programmable analog source for product test

D3000M SPECIFICATIONS (typical @+25°C and nominal power supply unless otherwise noted.)

Analog Output
- Single channel analog output.
  Voltage: 0-1V, ±1V, 0-5V, ±5V, 0-10V, ±10V.
  Current: 0-20mA, 4-20mA.
- Output isolation: 500V rms.
- 12-bit output resolution.
- Accuracy: 0.1% FSR max (Integral & Differential Non-linearity.
- Zero drift: ±30µV/°C (Voltage Output).
  ±1.0µA/°C (Current Output).
- Span tempco: ±50ppm/°C max.
- 1000 conversions per second.
- Settling time to 0.1% FS: 300µs typ (1ms max).
- Output change manual mode (-FS to +FS): 5s.
- Programmable output slope: 0.01V/s (mA/s) to 65535V/s (mA/s).
- Current output voltage compliance: ±12V.
- Voltage Output drive: 5mA max.

Digital
- 8-bit CMOS microcomputer.
- Digital scaling and calibration stored in nonvolatile memory.
- Programmable High/Low output limits.
- Programmable watchdog timer provides orderly shut-down in the event of host failure.

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

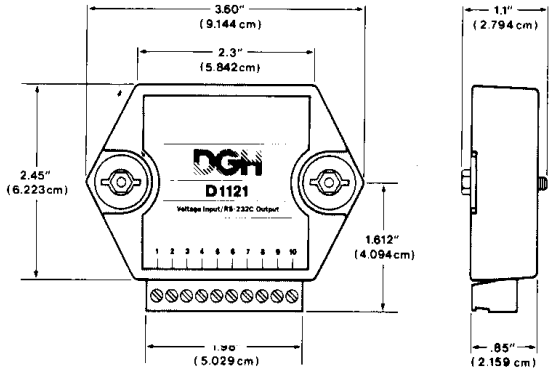
Communications
- Communications in ASCII via RS-232C, RS-485 ports.
- Selectable baud rates: 300, 600, 1200, 2400, 4800, 9600,19200, 38400, 57600, 115200.
- NRZ asynchronous data format; 1 start bit, 7 data bits, 1 parity bit and 1 stop bit.
- Parity: odd, even, none.
- User selectable channel address.
- ASCII format command/response protocol.
- Up to 247 Modbus multidrop modules/host serial port.
- Communications distance up to 4,000 feet (RS-485).
- Can be used with “dumb” terminal.
- All communications setups (address, baud rate, parity) stored in nonvolatile memory using EEPROM.
- Checksum can be added to any command or response.

Power
Requirements: Unregulated +10V to +30Vdc, 0.75W max. (voltage output), 1.0W max. (current output).
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.

Specifications are subject to change without notice.

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



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

D3000M Ordering Guide

MODEL	OUTPUT RANGE/INPUT
	Voltage Output
D3121M	±1V Output/RS-232C Input
D3122M	±1V Output/RS-485 Input
D3131M	±5V Output/RS-232C Input
D3132M	±5V Output/RS-485 Input
D3141M	±10V Output/RS-232C Input
D3142M	±10V Output/RS-485 Input
D3161M	0 to 1V Output/RS-232C Input
D3162M	0 to 1V Output/RS-485 Input
D3171M	0 to 5V Output/RS-232C Input
D3172M	0 to 5V Output/RS-485 Input
D3181M	0 to 10V Output/RS-232C Input
D3182M	0 to 10V Output/RS-485 Input
	Current Output
D3251M	0 to 20mA Output/RS-232C Input
D3252M	0 to 20mA Output/RS-485 Input
D3261M	4 to 20mA Output/RS-232C Input
D3262M	4 to 20mA Output/RS-485 Input

GENERAL DESCRIPTION & BLOCK DIAGRAM

The DGH D3000M series are complete computer-to-analog output interfaces. They are designed designed for systems based on the Modbus™ RTU protocol. Simple Modbus commands are used to control a 12-bit DAC (Digital-to-Analog Converter) which is scaled to provide commonly used current and voltage ranges. An 8-bit CMOS microprocessor provides an intelligent interface between the host and the DAC.

The DGH modules are easy to use. You do not need engineering experience in complicated data acquisition hardware. This modular approach to data acquisition is extremely flexible and cost effective. The modules can be mixed and matched to fit the 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.

Figure 1 shows a functional block diagram of the D3000M. The DAC converts digital data derived from host commands into the desired analog output. The microprocessor receives commands and data from the host computer through an RS-232 or RS-485 port.

In response to host commands, the microprocessor produces the appropriate digital data necessary to control the DAC. Digital data is transmitted to the DAC through opto-isolators that provide electrical isolation. The DAC produces a precise analog current that is directly proportional to the magnitude of the digital data. The DAC output current is processed and amplified by signal conditioning circuits to produce the desired output voltage or current. Output protection circuits protect the module from potentially damaging output faults.
An EEPROM (Electrically Erasable Programmable Read-Only Memory) retains important data such as the address, baud rate, parity and calibration data even if the module is powered down.

The power supply converts the raw 10 to 30V input power into regulated voltages used to operate the module. The power it supplies to the DAC and output circuits is transformer isolated from the input power and communications connections. The transformer and opto-isolators provide an isolation barrier between the output section and the rest of the circuitry. The isolation barrier is helpful in breaking ground loops, isolating troublesome common-mode voltages and protects the host and module in cases where the output may accidentally contact AC power lines.

The combination of an accurate high-resolution DAC and a dedicated microprocessor produces a very powerful system for generating process control signals. The microprocessor provides software addressing for multidrop capability, data formatting in engineering units, limit checking, digital calibration and many other features not possible with unintelligent analog output systems.

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.

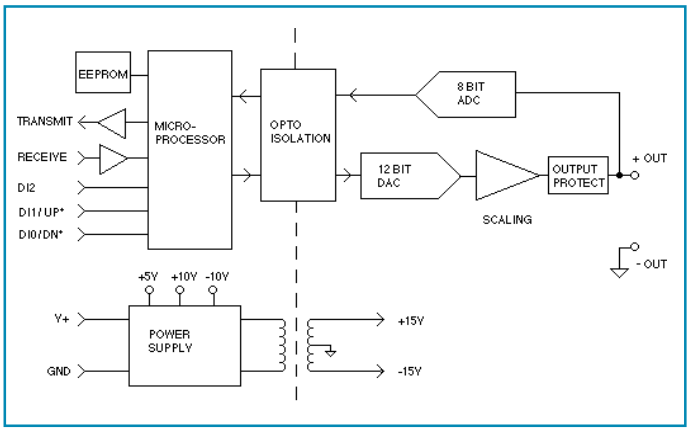


Figure 1. D3000M Block Diagram.

MANUAL MODE

Manual Up/Down control option provides a local operator interface to control the analog output value independent of the host. As shown in Figure 2, the analog output may be moved up or down by shorting the UP* or DN* inputs to the GND terminal. Grounding both pins at once holds the output at its present value and inhibits any output commands from the communications ports. The control inputs may also be logic signals from other equipment. The manual mode controls the output with a linear slope. The slope rate on D3000M modules is fixed and scaled so that a full-scale output change takes 5 seconds.Most

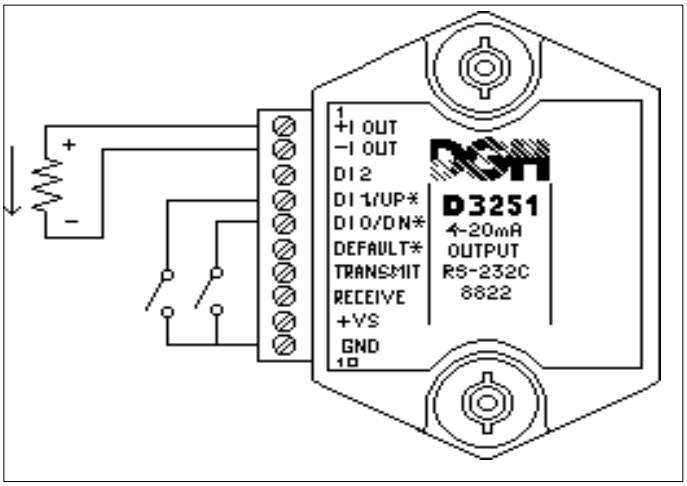


Figure 2. Manual Up/Down Control.

SLOPE CONTROL

Most DACs provide a step function when a new output value is desired. That is, the analog output change is instantaneous subject only to DAC settling time. In many applications this characteristic is undesirable and a gradual controlled output slew rate is more appropriate. In applications where controlled output rates are needed, precious host computer time must be used to continually monitor and step the DAC until the desired output is reached.
The D3000M allows controlled output slopes automatically without host computer intervention. User-programmable output slew rates are stored in nonvolatile memory. If a command is sent to the D3000M to change

the output value, the output will automatically slope to the new value at the specified rate. The nonvolatile slope value is restored each time the module is powered up.

The D3000M microprocessor controls the output slew rate by updating the DAC at a rate of 1000 conversions per second at precise 1ms intervals. In this manner the DAC is smoothly stepped until the final output value is reached. The DAC's incremental output steps and its conversion rate combine to make the output change appear to be a linear ramp.

WATCHDOG TIMER

The D3000M contains a user-programmable software timer to provide an orderly shutdown of the output signal in the event of host computer or communications failure. The timer is preset using the Watchdog Timer command to specify a timer interval in minutes. The timer is continually incremented in software. Each time the module receives a valid command, the timer is cleared to zero and restarted. If the timer count reaches the preset value, the output will automatically be forced to slew to the starting value using the present output slope rate. The starting value should be programmed to provide a "safe" output value to minimize damage and disruption to the system under control.

COMMAND SET

The D3000M 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. 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:

Code	Description
01	Read Coil Status
02	Read Input Status
03	Read Holding Register
04	Read Input Register
06	Preset Single Register
10	Preset Multiple Registers

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

02 Read Status inputs reads the status of discrete inputs.

03 Read Holding Register is used to read the analog output value.

04 Read Input Register is used to read the ana log output value.

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

10 Presset Multiple Registers is used to write multiple data values to multiple registers.

Typical Command/Response sequence

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

01 06 00 00 80 00 EB 0A

This example is a Modbus Force Single Coil command.

The 01 is the address of the slave DGH module being commanded. Each slave device must have its own unique address. The 06 character specifies the Modbus Preset Single Register command. The next two characters 00 00 specify the address of the register to be modified. The 80 00 is the data value to be written. The final two characters of the command (EB 0A) make up the Cyclical Redundancy Check (CRC), used to check for errors in the message.

The typical response message for this command is to echo the command back to the host computer. Therefore, the response message would look like this:

01 06 00 00 80 00 EB 0A

Any other response message, other than the echoed command, would indicate that a Modbus exception error code was returned or communications time out occurred.

All messages must be transmitted as continuous strings. Messages are terminated by a silent period of at least 3.5 character times.

SETUP

The D3000M series are initiated at the factory using the DGH ASCII protocol. This allows easy setup and configuration, including the Modbus slave address value. Setup and configuration can be performed using a Terminal program or using the DGH Utility Software on a Windows based computer. Each D3000M module must be properly configured before installation into a Modbus system.

SOFTWARE COMPATABILITY

The Modbus RTU protocol is supported by all major process control software programs on the market today. Including OPC server programs. Using these software programs and the DGH Modbus compatible modules, a data acquisition system can be created with ease.