DART
CONTROLS

Instruction Manual

ModBus RTU for 150 Series

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Warranty

Dart Controls, Inc. (DCI) warrants its products to be free from defects in material and workmanship. The exclusive remedy for this warranty is DCI factory replacement of any part or parts of such product which shall within 12 months after delivery to the purchaser be returned to DCI factory with all transportation charges prepaid and which DCI determines to its satisfaction to be defective. This warranty shall not extend to defects in assembly by other than DCI or to any article which has been repaired or altered by other than DCI or to any article which DCI determines has been subjected to improper use. DCI assumes no responsibility for the design characteristics of any unit or its operation in any circuit or assembly. This warranty is in lieu of all other warranties, express or implied; all other liabilities or obligations on the part of DCI, including consequential damages, are hereby expressly excluded.

NOTE: Carefully check the control for shipping damage. Report any damage to the carrier immediately. Do not attempt to operate the drive if visible damage is evident to either the circuit or to the electronic components.

All information contained in this manual is intended to be correct, however information and data in this manual are subject to change without notice. DCI makes no warranty of any kind with regard to this information or data. Further, DCI is not responsible for any omissions or errors or consequential damage caused by the user of the product. DCI reserves the right to make manufacturing changes which may not be included in this manual.

Warning

Improper installation or operation of this control may cause injury to personnel or control failure. The control must be installed in accordance with local, state, and national safety codes. Make certain that the power supply is disconnected before attempting to service or remove any components!!! If the power disconnect point is out of sight, lock it in disconnected position and tag to prevent unexpected application of power. Only a qualified electrician or service personnel should perform any electrical troubleshooting or maintenance. At no time should circuit continuity be checked by shorting terminals with a screwdriver or other metal device.

-M51

The –M51 option card utilizes Modbus RTU, a RS-485 serial communication protocol, to establish a master-follower communication between the 150 Series controls and a variety of intelligent devices. A single master device can send commands to individually addressed controls that are wired together. These commands include set speed, acceleration, deceleration, inhibit, power up configuration settings, and a variety of diagnostic features.

Auto/Manual Modes

In order for the controls to communicate with the master device, the –M51 must be in "Auto" mode. By connecting spade connectors P1 and P2, the –M51 enters "Auto" mode. In "Manual" mode, the base control will function as a normal control without the –M51.

Wiring Diagram
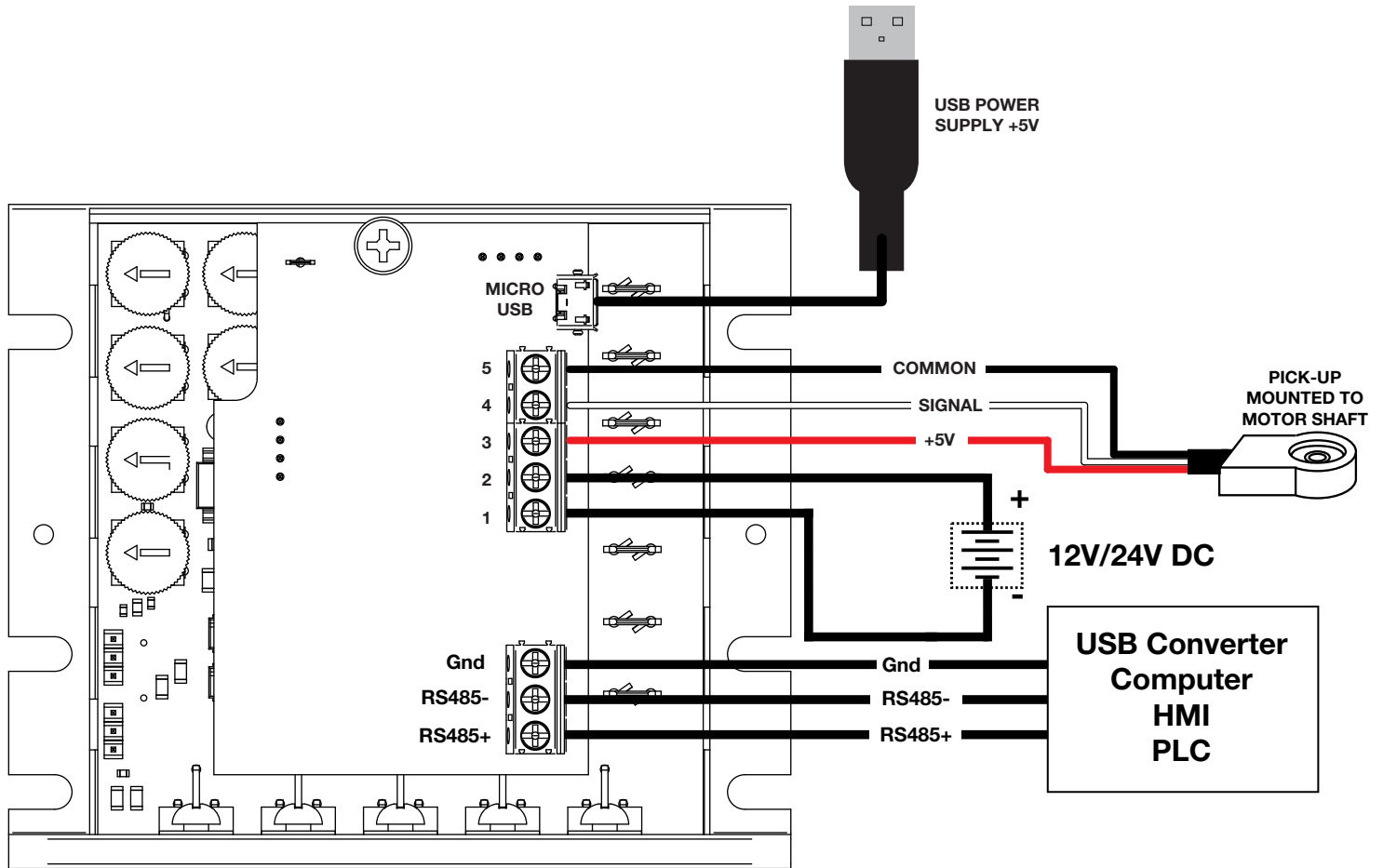
Device Power

The –M51 requires an external power supply to operate. There are two different options for powering the –M51; a 12V–24V DC power supply wired into terminals P7-1 and P7-2, or a 5V, 1A micro-USB power supply plugged into P5. Both supplies should not be used at the same time, to prevent any potential damage to the control.

Device Addressing

Each control needs its own individual address to communicate with the master device. The available addresses for the controls are 1-247. 0 is reserved as a broadcast command for all devices. Each control must be addressed separately before connecting them together. No two controls can have the same address.

Max Number of Devices

While there are 247 available addresses, only 32 controls may be wired together per EIA/TIA-485 standards. A repeater may be used to connect more than 32 controls if needed as long as there are no more than 32 controls per repeater and no more than 247 controls total.

Cable Length

The total cable length should be less than 1000m with connections between devices being no longer than 20m.

Line Termination

A line termination (LT) resistor has been added to each board to minimize reflection from the ends of the RS-485 cable when more than one control is connected. When more than one control is daisy-chained, the LT resistor on each end of the bus needs to be put in circuit. Jumper JP2 is used to put the LT resistor in circuit.
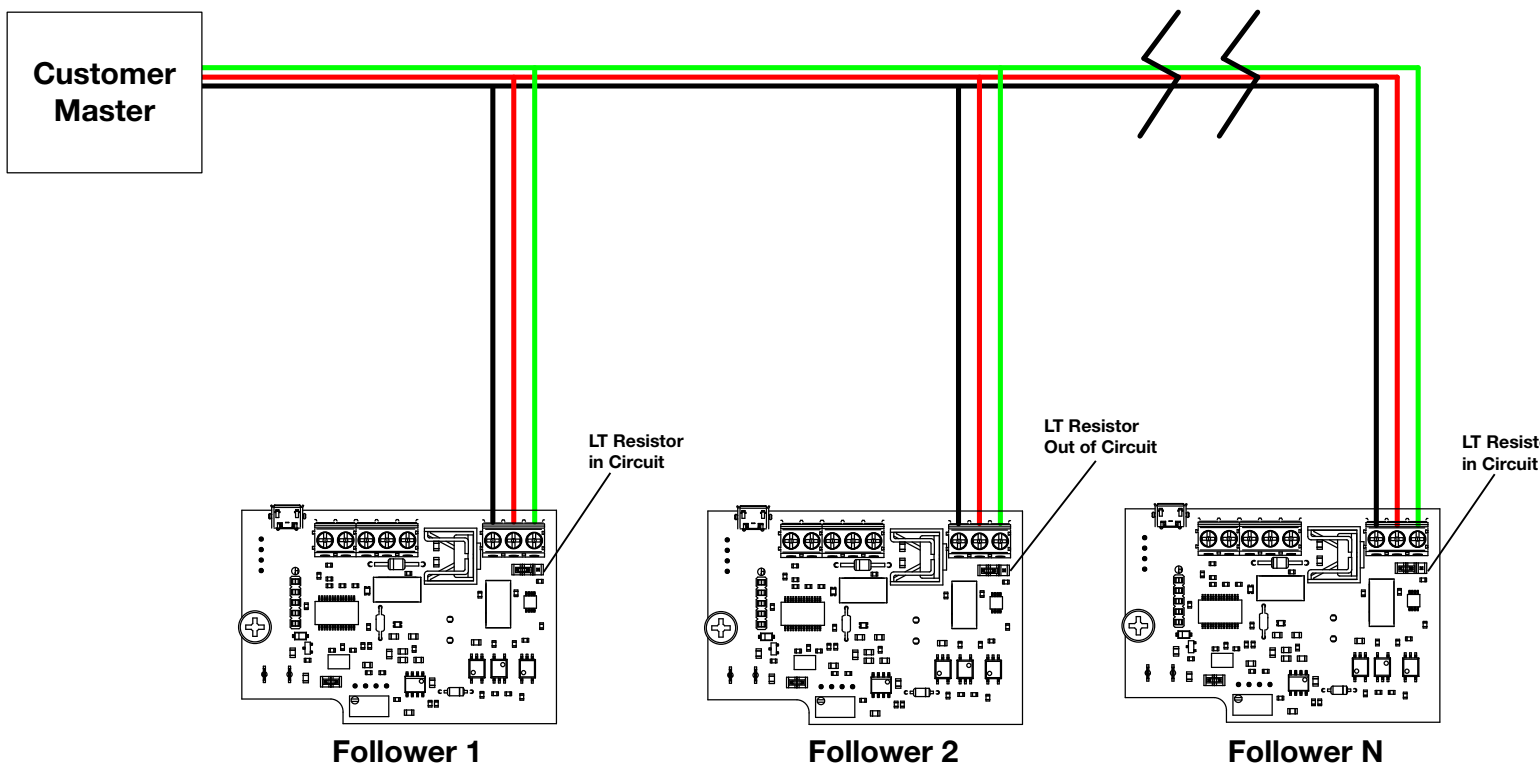
Cables

Modbus over serial line cable must be shielded. It must be a balanced pair (for D0-D1) and a third wire (for the common). Modbus recommends AWG 24 cable. Modbus also recommends a characteristic impedance with a value higher than 100 Ohms for the balanced pairs used.

Reset

Jumper JP1 acts as a reset switch for each individual –M51. Lift the header off the board for 3 seconds, then place back on the board. This will reset the –M51 to factory default settings. If a control is reset, it will need to be re-addressed before it can be used again (unless initial address was default 1).

-M51 P5 Connector Description

P5 (Micro-USB) This is a micro USB type-AB input. A micro-USB cable can be plugged in here to provide power to the –M51.

-M51 P6 Connector Description

P6-1 (RS485+). TxD+/RxD+, Non-inverting pin. This terminal will connect to the RS485+ terminal on additional controls, or to the RS485+ terminal of the master device.

P6-2 (RS485-). TxD-/RxD-, Inverting pin. This terminal will connect to the RS485- terminal on additional controls, or to the RS485- terminal of the master device.

P6-3 (GND).Signal and Power Supply Common. This terminal will connect to the common terminal on additional controls, or to the common terminal of the master device.

-M51 P7 Terminal Block Descriptions

P7-1 (GND) This terminal will connect to – (negative) supply on the external power supply.

P7-2 (+VDC) This terminal will connect to + (positive) supply on the external power supply.

P7-3 (Signal) This is the signal input terminal for the motor's digital pickup or encoder. This signal is internally "pulled-up" to +5VDC via a 4.7k ohm resistor.

P7-4 (+5V) This is a self-contained +5VDC power supply capable of up to 50mA. The speed sensor supply lead can be connected to this terminal for its power source.

P7-5 (COM) This is the common point for the control logic. The speed sensor common lead as well as any other source needing to reference the control common will be connected to this terminal.

-M51 Register Map

http://www.dartcontrols.com/support-downloads/

Commonly Used Software

When using a computer to configure the –M51, a few things are needed. First, a computer with an RS-485 communications port or an USB port must be located. An adapter cable is likely required to connect to a PC. We recommend the ATC-820 USB to RS485 Converter from gridconnect when connecting to a USB port. Other serial converters are available, though hardware connections may vary from application to application. Please consult the manufacturer's specs for proper pin outs.

Second, a software package that allows the computer to easily communicate with a selected COM port must be obtained. Fortunately, there are a number of available packages that are capable of filling this need. For a windows computer, a terminal program call "Tera Term" can be downloaded from the internet at 'https://en.osdn.jp/projects/ttssh2/releases/'. The download includes the terminal program Tera Term and an additional program called TTL Editor which is used to write macro scripts.

Regardless of the chosen software package, it will be necessary to configure the software appropriately to allow it to communicate with the –M51. These products ship with their serial communication port set at 19200 baud, 8 data bits, even parity, and 1 stop bit. Flow control should also be set to none, and transmit delay should be at 0 for both settings.

When communicating with a computer, there are a number of pitfalls to overcome. Initially, it is important to make sure the terminal program is communicating with the correct port (i.e. COM1, COM2, etc.). This can be difficult because the port numbers are not labeled on the back of most machines. Use the following outline when troubleshooting new connections:

1) Using TTL Editor, create a new macro script with the diagnostic command as shown below,
```
1  setdebug 2
2  send $01 $08 $00 $00 $01 $23 $45 $67 $89 $FE $DC $BA $55 $2D $69
3
```

2) Set the terminal program to the selected serial port: COM1, COM2, etc. (guess if unknown)
3) Set the terminal program to 19200 baud, 8 data bits, even parity, 1 stop bit, no flow control, and 0 transmit . delay.
4) Click the Control dropdown menu in Tera Term and select Macro.
5) Navigate to the macro file from step 1 and select it.
6) The terminal window should display '01 08 00 00 01 23 45 67 89 FE DC BA 55 2D 69'. If nothing displayed in the terminal window then it is likely the wrong com port was selected. If all com ports have been checked ..... and still no response, the cable could be bad.

NOTE: Many of the commercially available modular connector cables you buy off the shelf will invert the wires going between the two connectors on the ends of the cable. Improperly wiring the serial ports will not damage the control or the communications peripheral but the communications will not work. In case of difficulty, Dart's Technical Support Department will be happy to help you, or ask your computer dealer for assistance.

RS485 Connection to Terminal Block

Depending on what the –M51 will be connected to will determine where the +485/-485/GND connections will go. Users should look up the manufacturers' specifications to determine proper pinouts to connect to the –M51. Adapters may be required to interface with some devices.

Format for Messages

All messages sent to the –M51 follow a common structure, or "format". The command message format is shown below:

<address><function code><start address><quantity><Cyclical Redundancy Check>

<address> ...Represents the address of the control the command is being sent to. 00 for a broadcast command to all controls.

<function code> ....Represents the function to be performed by the command E.g. Read Coils, Read Input Registers, Write Holding Registers.

<start address> ....Represents the register address of the command E.g. Target Speed – 07, Acceleration – 09, Deceleration – 0A.

<quantity> This can represent the number of registers to be read or written, or the specific number to be written to a register depending on which function code is being used.
<CRC>..... The CRC field is calculated by the transmitting device and appended to the command. The receiving device recalculates the CRC value and compares it with the value of the received message. If the values do not match, an error results.

Example: "Set the motor speed of device 3 to 50% duty cycle"
Format: 03 03 00 07 13 88 F8 BF

For more information on the format of Modbus messages and how to calculate the CRC value go to www.modbus.org/specs.php and select 'MODBUS Protocol Specifications', and 'Modbus Serial Line Protocol and Implementation Guide V1.02'. CRC calculation can also be done using online calculators (https://www.lammertbies.nl/comm/info/crc-calculation.html). Just set the input type to hex and use the CRC-16 (Modbus) value. The high and low bytes in the resulting hex number will need to be switched when added to the message.

Example: CRC-16 (Modbus) = 0x4B37. In message - XX XX XX XX XX XX 37 4B

REPAIR PROCEDURE

In the event that a Product manufactured by Dart Controls Incorporated (DCI) is in need of repair service, it should be shipped, freight paid, to: Dart Controls, Inc., 5000 W. 106th Street, Zionsville, IN. 46077, ATTN: Repair Department. Please include Name, Shipping Address (no P.O. Box), Phone Number and if possible, e-mail address.

Those orders received from anyone without an existing account with DCI must specify if they will be paying COD or Credit Card (Master Card/Visa/American Express). This information is required before work will begin. If you have an account with Dart your order will be processed according to the terms listed on your account. Products with Serial Number date codes over 5 years old will automatically be deemed Beyond Economical Repair (BER). A new, equivalent device will be offered at a substantial discount.

Completed repairs are returned with a Repair Report that states the problem with the control and the possible cause. Repair orders are returned via UPS Ground unless other arrangements are made. If you have further questions regarding repair procedures, contact Dart Controls, Inc. at 317-873-5211.
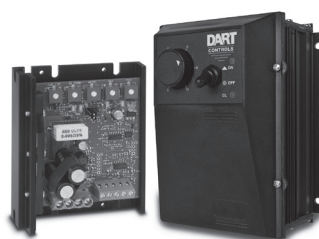
YOUR MOTOR SPEED CONTROL SOLUTION PROVIDER
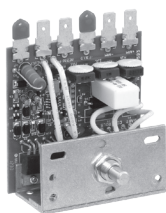
OEM Chassis SCR Drives
Dual Input voltage, adjustable HP range, isolated signal follower and reversing options
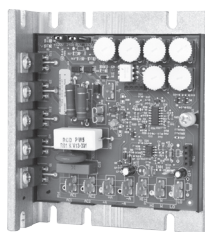
NEMA 4/4X SCR Drives
Dual Input voltage, adjustable HP range, isolated signal follower and reversing options

Low Voltage/Battery PWM Drives
Chassis and NEMA 4X versions, speed pot and signal follower operation

Digital SCR Drives
Closed loop accuracy, 4-20mA and serial communications, integral programmable display

Brushless DC Drives
Closed loop accuracy, line and low voltage versions through 1 HP

Digital Accessory & Resale Items
Motors to 700 HP, VFD's to 200 HP, NEMA rated encoder, digital programmable potentiometers and tachometers

Dart Controls, Inc. is a designer, manufacturer, and marketer of analog and digital electronic variable speed drives, controls, and accessories for AC, DC, and DC brushless motor applications.

Shown above is just a sampling of the expanded line of Dart controls that feature the latest in electronic technology and engineering. Products are manufactured in the U.S.A. at our Zionsville (Indianapolis, Indiana)

production and headquarters facility - with over 2,000,000 variable speed units in the field.

In addition to the standard off-the-shelf products, you can select from a wide variety of options to customize controls for your specific application. For further information and application assistance, contact your local Dart sales representative, stocking distributor, or Dart Controls, Inc.

Dart Controls, Inc.

Manufacturer of high quality DC and AC motor speed controls and accessories since 1963.

5000 W. 106th Street
Zionsville, Indiana 46077
Phone: (317) 873-5211
Fax: (317) 873-1105

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