R101 Single Axis Driver / Indexer

User Manual
And Commands Guide

Version 1.20

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Thank you for purchasing the R101 Single-Axis Driver/Indexer. This product is warranted to be free of manufacturing defects for one (1) year from the date of purchase.

PLEASE READ BEFORE USING

Before you start, you must have a suitable step motor, a DC power supply suitable for the motor and a current resistor. The power supply voltage must be between 4 times and 20 times the motor's rated voltage. The current set resistor may be a ¼ Watt, 5% part.

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1. FEATURES

- Single Axis Driver/Indexer for Bipolar Step Motors
- Operates from +15 to 30 VDC
- Phase currents between 0.2 to 2.5 Amp Peak
- Automatic Motor Holding Current reduction available from 0.2 to 2.5 Amps
- Selectable Step Resolution From Full Step, 2x, 4x, and 8x Microstepping
- Optically Isolated Step, Direction, Disable, and Zero Set Inputs
- Programmable trapezoidal profiles for position moves and ramped velocities
- Communications via RS485 Bus to connect multiple modules
- Command format – ASCII Character Strings
- Memory storage of all user configurable parameters after power recycling capabilities

The R101 is a 'Step and Direction' driver for bipolar step motors.

Limited controller functions are provided that allow trapezoidal profile position moves and ramped velocity moves to be made.

Provision is made to reduce motor current when just holding in a fixed position after a preset time.

The module can be configured and controlled via a simple RS485 communications bus. Multiple modules each set with a different address code can be controlled on the same bus.

All of the user configurable parameter values can be saved to a non-volatile memory and automatically restored after a power down power up cycle.

2. ELECTRICAL SPECIFICATIONS

Supply Voltage: +15 to 30 VDC
Phase Current: 0.2 to 2.5 Amps Peak in 0.1 increments (Software Programmable)

I/O Specifications

4x Optically isolated inputs: Step, Direction, Disable, and Zero Set.

3. OPERATING SPECIFICATIONS

Maximum Step Frequency 15 kHz
Operating Temperature
Automatic Motor Holding Current reduction available from 0.2 to 2.5 Amps

Logic Timing

Minimum Step Pulse Width	33 microseconds
Minimum Step Low Time	33 microseconds
Maximum Power-Down Recovery Time	20 milliseconds

Communication Specifications

Address bytes in the RS485 commands allow multiple units (26 units max) to be controlled from a single host port.

Interface Type	RS485
Baud Rate	57600 bits per second (bps)
# Bits per character	8 data bits
Parity	None
Stop Bit	2
Flow Control	None

4. MECHANICAL SPECIFICATIONS

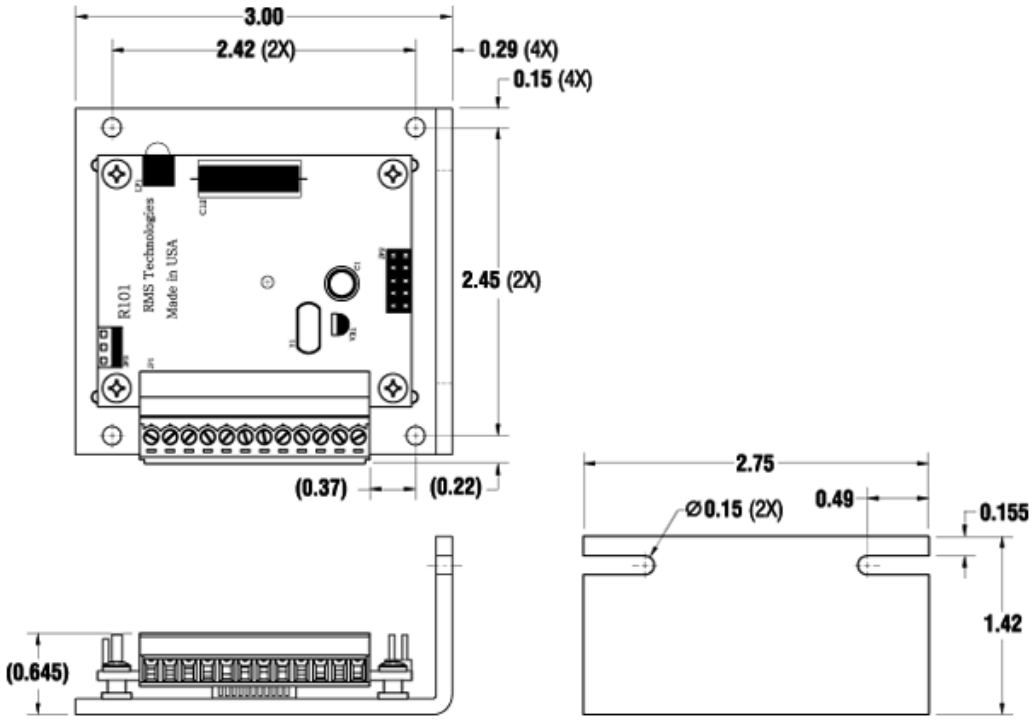

Figure 1: Dimensions Diagram

5. PIN ASSIGNMENTS

A 12 pin pluggable terminal strip connector JP1 provides power and the step and direction control functions for the module. All of these signals are optically isolated. Open-collector drives are required to provide pulses for Step, levels for Direction Disable, and Zero Set. The common +ve supply can be +ve 5 to 30 VDC with respect to the signal input; however if the supply is greater than 5 VDC then a resistor must be inserted in series with each signal line to limit the current to 10 mA.

JP1 Configuration	
Pin No	**Function**
1	Common +ve External
2	Step (in)
3	Direction (in)
4	+5 VDC Internal
5	Disable (in)
6	Motor A+ (out)
7	Motor A- (out)
8	Motor B+ (out)
9	Motor B- (out)
10	Zero Set (in)
11	Power Ground
12	Power Positive

A separate three pin connector JP3 is provided for the RS485 bus interface

JP3 Configuration	
Pin No	**Function**
1	A Input (-ve)
2	Ground
3	B Input (+ve)

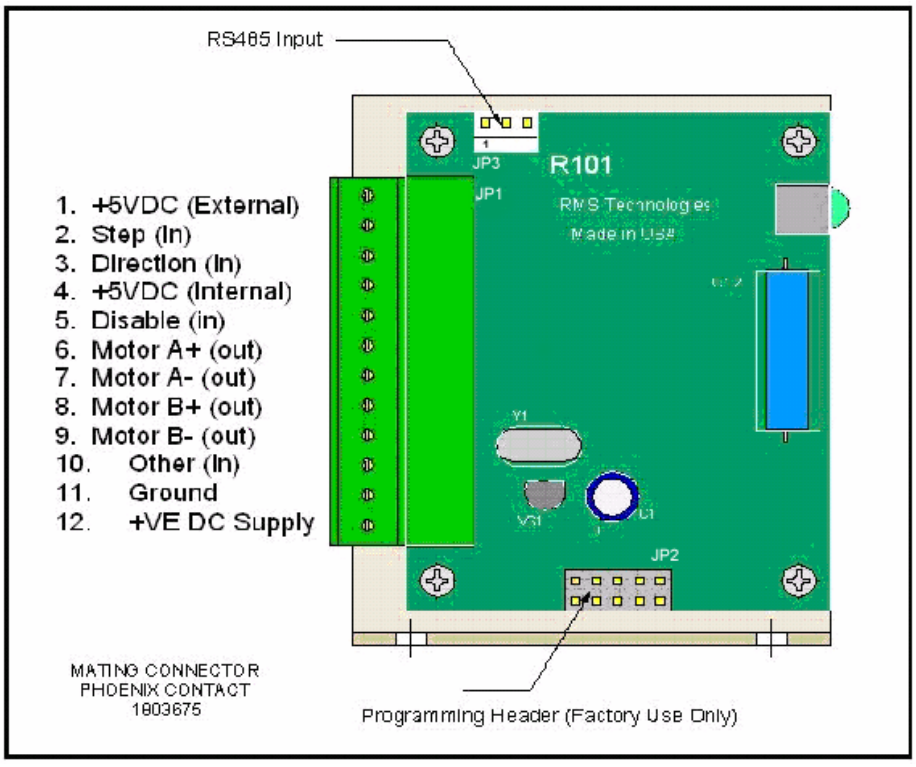

Figure 2: R101 Pin Usage Diagram

6. CONNECTION SPECIFICATIONS

To begin using the R101 Driver/Indexer we must first connect a power supply. Then a few basic settings must be made to setup the R101 for basic operation. These settings are typically made using Windows HyperTerminal. The R101 is connected to a PC by using the RS485 Converter Card connected to JP3 (See Section 5 for Pin Assignments) with 15-30 VDC being applied to the board. The converter card allows the R101 to connect to the PC via a standard serial port. It is good practice to connect the motor last after the driver current has been set properly.

Connecting the Power

The R101 requires a supply voltage between 15-30 VDC. Connect the positive end of the power supply to positive terminal (Pin 12) on the R101. And connect the negative of the power supply to the Ground (Pin 11) on the R101.

WARNING! Be careful not to reverse the polarity from the power supply to the driver. Reversing the connection will destroy your driver and void the warranty.

HyperTerminal Configuration

Please follow these steps to properly set up HyperTerminal:

1. Open a terminal from your PC by following these steps: Start Menu → Programs → Accessories → Communications → HyperTerminal
2. Assign a name for your New Connection, "Click Ok"
3. Under "Connect using", select the COM connection that corresponds to your PC serial port (i.e. COM 1, COM 2, etc.) then click "OK"
4. Set your Port Settings to:
   Bits per second: 57600
   Data bits: 8
   Parity: None
   Stop bits: 2
   Flow control: None
   Click "OK"
5. Turn on local echo by going to: File → Properties → Settings tab → ASCII Setup: Check the boxes for "Send line ends with line feeds" and "Echo Typed Characters Locally." These options will be useful when typing commands in HyperTerminal. Click 'OK", Click "OK"
6. HyperTerminal is ready to send commands

The line turnaround from transmit to receive must be less than one character interval (191 µS).

The command syntax is as follows:
#<Board Address><Command><Value><cr><lf>

The reply syntax is:
**<Board Address><Command> <Value><cr><lf>*

Note: Not all commands will return a value.

Example
Setting the Run Current (RI) to 1500mA (1.5A)

```
#ARI1500    //Sent Command
*ARI1500    //Received Reply
```

Setting the Current

There are two current settings on the R101.

1. Run Current (RI) – The peak current that the motor will be run at while in motion.
2. Hold Current (HI) – The current that the motor will receive when idle.

*The default board address of 'A' is used in all examples, please see "MA" command for more detail on addresses.

Examples:

To set Run Current to 2000mA (2.0A):

```
#ARI2000
```

To set Hold Current to 300mA (0.3A):

```
#AHI300
```

Setting Step Resolution

The R101 is capable of full stepping or 2x, 4x, and 8x microstepping.

Example:

To set Step Resolution to 4x microstepping:

```
#ASR4
```

Saving the Configuration

In order to have these settings retained upon a power cycle, the data must be saved. The command to store these settings is "SD" (Save Data).

Example:

To save settings:

```
#ASD
```

Connecting the Motor

WARNING! Make sure the power is OFF when connecting or disconnecting motors from the R101. Damage will occur if the power is being supplied.

Please refer to your motor documentation for wiring color code.

Connect the corresponding Phase from the motor to the proper pin on the R101.

Using the R101

If using the R101 in Step/Direction mode, please proceed to Section 8 – Basic Step and Direction Operation.

If using the R101 as a simple controller, please see the Command Tables in Section 9 and more detailed descriptions of the Commands in Section 10.

8. BASIC STEP AND DIRECTION OPERATION

The four control signals *Step, Direction, Disable,* and *Zero Set* are optically isolated, with a common positive connection (usually 5 VDC).

The common positive connection (Pin 1) is typically 5 VDC. Each of the inputs is set to TRUE by supplying a signal level 5V below the common positive connection powering the optical isolators. The input is set FALSE by putting the signal within 0.5 VDC below the common positive value.

Example: If 5 VDC is supplied to Pin 1 (common positive connection), TRUE is 0V, and FALSE is any value between 4.5 VDC to 5 VDC.

For test purposes, and some applications where input isolation is not required, the internal 5 VDC supply at Pin 4 of the I/O connector can be used as the common positive connection, by linking pins 1 and 4 on the connector.

If this is done then each input is set TRUE by bringing the voltage level at the input equal to, or more negative than the Power Supply negative connection at Pin 11.

With this arrangement *Direction, Disable,* and *Zero Set* control can be effected by simple switch closure between the input and the power negative connection at Pin 11.

If the *Step* input is obtained from a Function Generator, then careful adjustment of the Offset control is needed to ensure that the negative level of the input signal is equal to, or more negative than, the power negative connection at Pin 11.

The minimum duration of the active (negative) *Step* input signal level is 33 microseconds and also this is the minimum for the inactive (positive) level. This limits the maximum usable step rate to 15,000 PPS.

The optimum operating arrangement (minimum power usage) is for a constant width negative going pulse of 33 microseconds with the pulse interval varying with pulse rate.

For test purposes, setting the Function Generator duty cycle to 50%, and only varying the frequency is satisfactory.

9. COMMAND TABLES

Basic Configuration Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Load Defaults	N	LD	None	-	-	-
Save Data	N	SD	None	-	-	-
Module Address	Q/N	MA	Numeric	65 (A)	90 (Z)	65 (A)

Axis Configuration Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Acceleration	Q/N	AC	Numeric	1	256	50
Hold Current	Q/N	HI	Numeric	0	2500	300
Hold Timeout	Q/N	HT	Numeric	100	5000	5000
Min. Velocity	Q/N	MV	Numeric	250	15,000	250
Percent Fast	Q/N	PF	Numeric	0	2	1
Run Current	Q/N	RI	Binary	200	2500	1000
Read Switches	Q	RS	Numeric	0	15	-
Step Resolution	Q/N	SR	Numeric	1	8	8
Start Velocity	Q/N	SV	Numeric	250	15,000	1,000
Velocity Limit	Q/N	VL	Numeric	250	15,000	15,000
Zero Position	N	ZP	None	-	-	-

General Operation Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Absolute Position	N	AP	Numeric	-2147483646	2147483647	-
Current Position	Q/N	CP	Numeric	-2147483646	2147483647	-
Current Velocity	Q	CV	Numeric	0	15,000	-
Firmware Rev.	Q	FR	Numeric	-	-	-
Home Axis	N	HA	Numeric	0	1	-
Move Status	Q	MS	Numeric	0	1	-
Position Move	N	PM	Numeric	-32,766	32,737	-
Step Back	N	SB	None	-	-	-
Step Forward	N	SF	None	-	-	-
Stop Motion	N	SM	None	-	-	-
Velocity Move *	Q	VM	Numeric	-15,000	15,000	-

* Velocity Moves in the range –249 to 249 are not legal except zero

10. COMMANDS (Page per Command Listing)

Acceleration<value>

Initial Acceleration (1 to 32767 steps/Sec ^2 *10^-2)

Command or Query.

Used to shape the acceleration and deceleration ramps of position moves, and the rate of velocity change for velocity moves.

Does not affect any of the basic step and direction move operations

Command Example

#AAC10000<cr><lf> Sets acceleration to 100 PPS^2.

Default value is 50

Absolute Position<value>

Absolute Position +/–2,147,483,646

Command Only

Used to make an absolute position move.

Command Example

#AAP1000<cr><lf> Moves to absolute position of 1000.

Current Position

Current Position +/–2,147,483,646

Command or Query.

Returns the absolute position of the axis if no value is passed. Valid after power cycles if a Save Data Command is issued before power down. Can be used to set current position value.

The units are steps at the current step resolution. (Value becomes invalid with step resolution changes.)

The absolute position scale is set to zero by the Zero Position command (ZP) or the execution of a Home Axis (HA) command.

Command Example

#ACP<cr><lf> Returns the Current Position of the Motor

#ACP1000<cr><lf> Sets the Current Position to be 1000

Current Velocity

Query Only +/- 15,000

Only valid when a position move (PM) or velocity move (VM) is in progress. Otherwise returns zero.

Command Example

#ACV<cr><lf>

Firmware Revision

Query Only

Returns product and firmware revision numbers.

Command Example

#AFR<cr><lf>

Reply

*AFR101100 //R101 firmware revision 1.00

Home Axis<value>

Command Only Reverse(1) or Forward(0).

Causes the motor to move at the preset Start Velocity (SV) in the direction set by the command value. Motion stops by either the 'Other' input (JP1-10) being set TRUE, or the entry of a Stop Motion (SM) command.

Forward is defined as the direction the motor turns when the 'Direction' input (JP1-3) is set FALSE, or there is no connection to this input.

Command Example

#AHA1<cr><lf> Motor turns in the Reverse direction.

Hold Current<value>

Command or Query 0 to 2500

Reads or sets the motor Holding Current. The value is the current in Amps times ten.

Command Example

#AHI300<cr><lf> Sets the Hold Current to 300mA (0.3 Amp).

Default value is 300

Hold Timeout<value>

Command or Query 100 to 5,000.

Reads or sets the time interval in milliseconds after any motor movement, before the motor current is changed from Run Current to Hold Current

Command Example

#AHT100<cr><lf> Sets the Hold Timeout to 100 mS.

Default value is 5000

Load Defaults

Command Only

Loads all of the unit Default parameter values. A save Data (SD) command must be issued to have these values retained during a power cycle.

Command Example

#ALD<cr><lf> Loads all default values.

Default values are:

My Address	65 (A)
Absolute Position	0
Step Resolution	8
Run Current	10 (1.0A)
Hold Current	3 (0.3A)
Hold Timeout	5,000
Velocity Limit	15,000
Minimum Velocity	250
Start Velocity	1,000

My Address<value>

Command or Query 65 to 90.

Reads or sets the unit address. The value read or entered is the decimal value of the ASCII character designated as the unit address. (65 = 'A' and 90 = 'Z')

The change to a new address is immediate, in that the command response will use the new address

Command Example

#AMA88<cr><lf> Sets the unit address to 88 ('X').

Default value is 65

Address	Value
A	65
B	66
C	67
D	68
E	69
F	70
G	71
H	72
I	73
J	74
K	75
L	76
M	77
N	78
O	79
P	80
Q	81
R	82
S	83
T	84
U	85
V	86
W	87
X	88
Y	89
Z	90

Move Status

Query Only.

Reads Motion Status. Returns 0 for No Motion, 1 for Position Move, and 2 for Velocity Move.

Command Example

#AMS<cr><lf> Queries the current status

Minimum Velocity<value>

Command or Query 250 to 15,000.

Reads or sets the minimum velocity for both Position and Velocity command moves

The units are steps (at the current Step Resolution) per second

Command Example

#AMV500<cr><lf> Sets Minimum Velocity to 500 SPS

Default value is 250

Percent Fast Decay<value>

Command or Query 0, 1, or 2.

Allows the Damping Mode of the driver IC to be set.

0 = Fast Decay
1 = Mixed Mode
2 = Slow Decay

The optimum setting will vary with motor inductance and step rate; however the default 'Mixed Mode' setting will work well with almost all motors.

Command Example

#APF1<cr><lf> Sets Mixed Mode Damping.

Default value is 1

Position Move<value>

Command Only +/-2,147,483,646

Causes a 'Relative Motion' Position Move, using an approximately trapezoidal profile. The initial velocity is defined by 'Start Velocity' (SV), the profile ramp is defined by 'Acceleration' (AC), and the 'Constant Velocity' step rate by 'Velocity Limit' (VL). 'Minimum Velocity' (MV) is used to ensure that the deceleration ramp does not set velocity to zero before the target position is reached.

It should be remembered that, while the 'Position Move' value defines the number of steps to be made from the current position, the value returned by 'Current Position' (CP) both before and after a 'Position Move' are on an 'Absolute' step count scale.

CP readings can be used to determine PM values required to reach any given position on the 'Absolute' step count scale.

Command Example

#APM1000<cr><lf> Makes a 1,000 step move from the Current Position.

Note: This command does not return a value.

Run Current<value>

Command or Query 200 to 2500.

Sets the motor Phase Current for any form of motion in 100mA increments.

200 = 200mA (0.2 Amp)
2500 = 2500mA (2.5 Amp)

The set 'Run Current' is maintained for a time set by 'Hold Timeout' (HT) before dropping to the current set by 'Hold Current' (HI)

Command Example

#ARI1000<cr><lf> Sets the run current to 1000mA (1 Amp).

Default value is 1000

Read Switches

Query Only

Reads the TRUE (1) or FALSE (0) state of the four optically coupled inputs, combined into a single four-bit value. This command is used to check the correct operation of this interface.

The value order of the inputs is 'Zero Set', 'Disable', 'Direction', and 'Step'. in descending order.

'Zero Set' has the value 8 (1000)
'Direction' has the value 4 (0100)
'Disable' has the value 2 (0010)
'Step' has the value 1 (0001)

Command Example

#ARS<cr><lf> Reads the switch inputs.

Step Back

Command Only

Makes a single step move at the current step resolution

Forward is defined as the direction the motor moves with the ‘Direction’ input in the FALSE state, or with no connection. Backwards is thus the direction the motor moves when the ‘Direction’ input is in the energized or TRUE state.

Command Example

#ASB<cr><lf> Moves one step back.

Save Data

Command Only

This command causes a set of parameter values to be written to non-volatile memory. On power up the last set of values written are set to be the parameter initial values.

The parameters whose values are thus saved are:

My Address
Absolute Position
Velocity Limit
Minimum Velocity
Start Velocity
Acceleration
Hold Timeout
Step Resolution
Run Current
Hold Current
Percent Fast Decay

Command Example

#ASD<cr><lf> Saves Data.

Step Forward

Command Only

Makes a single step move at the current step resolution

Forward is defined as the direction the motor moves with the ‘Direction’ input in the FALSE state, or with no connection. Backwards is thus the direction the motor moves when the ‘Direction’ input is in the energized or TRUE state.

Command Example

#ASF<cr><lf> Moves one step forward.

Stop Motion

Command Only

This command can be used to affect an end to any Position Move or Velocity Move in progress. It has no effect on motion produced by the Step and Direction inputs.

Command Example

#ASM<cr><lf> Stops any Position or Velocity move in progress.

Step Resolution<value>

Command or Query 1, 2, 4, or 8

Reads or sets the current step resolution

Allowed values are:

8 for 8x microstepping
4 for 4x microstepping
2 for 2x microstepping
1 for Full step

Command Example

#ASR4<cr><lf> Sets the step resolution to 4x microstepping.

Default value is 8

Start Velocity<value>

Command or Query 250 to 15,000

Reads or sets the velocity used for the first step in a position move. Value based on motor performance.

Command Example

#ASV500<cr><lf> Sets Start Velocity to 500 PPS.

Default value is 1,000

Velocity Limit<value>

Command or Query 250 to 15,000

Reads or sets the velocity used for the constant velocity portion of a position move.

Command Example

#AVL5000<cr><lf> Sets the velocity limit to 5000 PPS.

Default value is 15,000

Velocity Move<value>

Command Only +/- 250 to 15,000, or 0

The sign of the value determines the direction (positive for forward, and negative for backward) in which the velocity move is made. The value sets the step rate in steps per second at the current step resolution. Velocity cannot exceed Velocity Limit

The move begins at the set 'Minimum Velocity' (MV), with the speed ramping to the command velocity at the rate set by 'Acceleration' (AC).

Changes to new velocity values from new VM commands, will also occur at the rate set by 'Acceleration' (AC).

Command Example

#AVM1000<cr><lf> Starts a velocity move of 1000 steps per second.

Zero Position

Command Only

Sets the current value of the Absolute Position scale to zero

Command Example

#AZP<cr><lf> Sets Absolute Position to zero.

11. RS485 Communication

1. The Interface

The EIA specification RS485 defines an integrated circuit that is to be used to connect up to 32 nodes to a two-wire party line bus that does not exceed 4,000 ft. in length, and for use with data rates up to 10M Baud.

The two-wire bus must be terminated at one-end for short wire runs and at both ends if the runs exceed 20 ft. One of the two wires must be biased positive with respect to the other by approximately 700 millivolts.

A single 5VDC supply can be used to power the interface IC, and this same supply can be used to satisfy the bias and termination requirements. A 681 ohm 1% resistor is connected between the +5VDC supply and the positive line. A second 681 ohm 1% resistor is connected between ground and the negative line, and a 220 ohm 1% resistor is connected across the two lines. The transceiver A terminal is connected to the negative line and the B terminals to the positive line.

For wire runs over 20 ft, twisted pair cable with a characteristic impedance of approximately 100 to 200 ohms, and the far end of the run should be terminated by a 150 ohm resistor across the line pair. For runs under 20ft almost any wire can be used.

2. The Protocol

One node on the bus is designated 'Master' and all other nodes on the bus 'Slaves'. The Master only initiates communication, and does so by sending a message that includes the address of a specific Slave. All Slaves read the message, but only the addressed Slave replies.

The outgoing message from the Master is 'framed' by always starting the message with the '#' character (0x23) and ending with the linefeed character (0x0A). The reply from the Slave is framed by always starting with the '*' character (0x2A) and ending with the linefeed character (0x0A).

The Slave address is the first character after the '#' in the outgoing message, and the first character after the '*' in the reply. For ease of use RMS Technologies restricts the range of address characters to the range of capital letters 'A' to 'Z', with 'A' being the default.

Again for ease of use RMS Technologies restricts the other characters in the message to ASCII printable characters. This enables the default Windows terminal emulation program HyperTerminal to be used for configuring and testing modules. However this restriction and the restricted address range are not an official part of the protocol. Any of the 8 bit character values other than the framing characters can be used for the address and as any other part of the message.

3. Messages

Messages should be transmitted as a continuous character stream with less than a half character time between characters.

Messages are classified as either 'Commands' or 'Queries'. Commands instruct the designated Slave to do something. Queries request the designated Slave to provide information.
Apart from the leading '#' being replaced by a '*', the Slaves response to a Command should be an exact copy of the command message. In the case of a Query the query message is also echoed but the value or other requested information is added into the reply.

A one character time interval has to be allowed between outgoing and incoming messages, to allow for line turn-around (Switching between Transmit and Receive). At 57,600 baud, one character with 11 bits (one start, eight data, and two stop bits) transmits in 191 µS.

4. Validation

Commands are validated by comparing the content of the reply with the content of the command message on a character by character basis.

Queries are partially validated in a similar manner but the information added by the Slave is only subjected to credibility tests. When the information returned is deemed critical, repeating the Query and comparing results can further validate communications.

5. S Message Format

A two-character command/query designator follows the single address character. Depending on the nature of the command, the command designator may be followed by a numeric ASCII character string. No separator characters are used, but a carriage return character (0x0D) is inserted before the termination character in both the outgoing message and the reply.

6. CDS Data Format

Data is transmitted at 57,600 Baud, with eight data bits, no parity, and two stop bits.

7. Recommended Interface Device

The B & B Electronics Mfg. Co. Model 485OI9TB provides both signal translation and optical isolation. Transmit to Receive switching (line turn-around) is automatic, but a resistor (R12) must be set to 16K and a capacitor (C7) set to 0.01µF to establish the required one character turn-round time of 0.176 mS. Both RTS and DTR must be asserted on the RS232 side of the interface. TDA must be strapped to RDA, and TDB must be strapped to RXB to form a two-wire interface on the RS485 side.

8. HyperTerminal Operation

In addition to setting the data format to match that specified in section 6, two settings must be made in the ASCII setup section. Check ‘Send Line Ends with Line Feeds’ and ‘Echo Typed Characters Locally’.

When typing by hand line turn-around will occur between characters. This is normally not a problem, but if you slowly increase the character transmission rate you will find errors occurring, until you reach a rate where the line is held in the transmit mode for the whole of the message. Using HyperTerminal’s file transfer system to send messages is not recommended.

9. Reading Reply Messages

The message read function on the RS232 side of the interface, must make provision for discarding any characters read that proceed the ‘*’ character. Line turn-around can commonly generate false characters.

The function should have a time-out associated with waiting for a reply to allow for a non-operational Slave node. The actual time required is system dependent, but 20mS is a commonly used value.

12. Troubleshooting & FAQ

R101 is not functioning correctly

Try putting the R101 into TEST mode by placing a jumper on Pins 9 & 10 of JP2. The Motor should twitch back and forth slightly.