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20010-M

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TWO AXIS STEPPER MOTOR DRIVER WITH RS-232 INTERFACE MODEL 20010

Please read these instructions completely before operating this equipment. If there are any questions or problems regarding the use of this equipment, please contact: ORIEL INSTRUMENTS - or - the representative from whom this equipment was purchased.

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WARRANTY AND RETURNS

I INTRODUCTION

The Oriel Model 20010 Stepper Motor Controller can drive and control two 4 phase 24V stepper motors requiring .5 amps per phase or less.

These motors are controlled by a data link to a computer with an RS-232 Interface or an RS-232 Compatible Terminal. A more detailed description of the data link can be found in Section IV, Set Up and Operation.

14 LEDs are on the front panel of the Model 20010 Stepper Motor Controller. These LEDs indicate the status of the step motor, the translation stage and the controller. A more detailed description of the functions of these indicators can be found in Section II, Specifications.

The rear panel contains the connectors for the power connection, A and B motor connectors and the RS-232 data link. Also, there are four switches located on the rear panel; an Off/On Power Switch, a 6 Position Baud Rate Switch, the Mode Switch and a Control Reset Switch.

II SPECIFICATIONS

I. Power:

120/240; 50/60 Hz; set at Oriel

II. Step Motor Drive:

(2) 24 volt unipolar 4 phase drives

Current set for .5 amps max.

Power down circuitry reduces phase current to less than .1 amps when motor is stopped.

III. RS-232 Interface:

25 pin D style connector

RS-232 compatible output ± 10V @ 3mA

Serial formal 7 data bits, 1 stop bit, no parity

ASCII data format

6 data rates - 300, 600, 1200, 2400, 4800, and 9600

IV. Motor Controller

2 independent motor control axis

Each motor can move ± 16,777,215 steps

Each motor can move from 8 to 1000 steps/sec.

The motor control can interpret 26 motor commands

Diagnostic or control data can be requested

2 modes of interface operation

III DESCRIPTION OF COMMANDS

This section contains a description of the commands the Model 20010 accepts. The typed command is indicated by < >. The output data, if any, is delimited by the work (response) in brackets. The outputs for both the debug/terminal mode and the computer mode are shown. Special operations, such as line feed, space and carriage return are shown in parenthesis: (LF), (SP), and (CR) respectively.

Terminal/Debug Mode

1. A Motor Command - A

   Purpose: To direct the flow of commands, data or status inquiries to the A motor control registers.

   Format: <A> (response) A.

2. B Motor Command - B

   Purpose: To direct the flow of commands, data or status inquiries to the B motor control registers.

   Format: <B> (response) B.

3. Clear Absolute Register - C

   Purpose: To clear the absolute register to zero.

   Format: <C> (response) C.

4. Disable Motor Windings - D

   Purpose: To disable the motor driver so no current flows through the motor windings. The enable LED on front panel goes off.

   Format: <D> (response) D LED Off

5. Enable Command - E

   Purpose: Enables the motor driver. This command allows the motor to step normally. The enable LED on the front panel goes on.

   Format: <E> (response) E LED On

6. Full Step Command - F

   Purpose: Changes to full step motor operation. The half step LED on the front panel goes off.

   Format: <F> (response) F LED Off

7. Go Absolute - G

   Purpose: This command also includes a data field consisting of a + or -and up to 8 digits of data terminated by a comma. After the 8th digit, the numerical field is automatically terminated. A backspace may also be used to edit the data field.

   Format: <G ± 0000dddd,>

   or <G ± dddddddd,>

   Where: d = numeric data up to 8 digits.

8. Half Step Command - H

   Purpose: Changes to half step operation. The half step LED on the front panel goes on.

   Format: <E> (response) H LED On

9. Inquire Command - I

   Purpose: The I command displays the status of the motor to the terminal.

Format: <I> (response) (CR), (LF)

A or B (sp) ± Direction (CR), (LF)

A or B (sp) Full or Half Step (CR), (LF)

A or B (sp) Disable or Enable Axis (CR), (LF)

10. Query Command - Q

Purpose: The Q instruction displays the status of the translator to the terminal.

Format: (Q) (response) (CR), (LF)

A or B Motor On or Off (CR), (LF)

A or B (sp) No. or + Limit (CR), (LF)

A or B (sp) No. or - Limit (CR), (LF)

11. Rate Command - R

Purpose: To set up the desired step rate for each motor. There are 8 preset step rates and they can be changed at any time.

Format: <Rn> (response) Rn n = 0 - 7

R7 = 1000 (in half step mode)
R6 = 500
R5 = 250
R4 = 125
R3 = 62.5
R2 = 31.25
R1 = 16.125
R0 = 8

12. Start Command - S

Purpose: To start the selected axis.

Format: <S> (response) S

13. Travel Command

Purpose: This command includes a data field consisting of up to 8 decimal digits of data terminated by a comma. After the 8th digit, the numeric field is automatically terminated. A backspace may also be used to edit the data field.

Format: <Tdddd,>

or <T0000dddd,>

or <Tddddddddd,>

Where: d = numeric data up to 8 digits.

14. U Command

Purpose: Entering a U instructs the controller to output the value of the A motor travel register.

Format: <U> (response) CR), (LF)

dddddd

(CR), (LF)

Where: d = numeric data up to 8 digits.

15. W Command

Purpose: Entering a W will instruct the controller to output the value of the B motor travel register.

Format: <W> (response) (CR), (LF)

dddddd

(CR), (LF)

Where: d = numeric data up to 8 digits.

16. X Command

Purpose: Entering an X will instruct the controller to output the value of the A motor absolute register.

Format: <X> (response) (CR), (LF)

± dddd...

(CR), (LF)

Where: d = numeric data up to 8 digits.

17. Y Command

Purpose: Entering a Y will instruct the controller to output the value of the B motor absolute register.

Format: <Y> (response) (CR), (LF)

± dddd...

(CR), (LF)

Where: d = numeric data up to 8 digit.

18. Zero Command - Z

Purpose: Z clears the absolute destination register. This command is the same as G ± 0.

Format: <Z> (response) Z

19. @ Command

Purpose: @ unconditionally stops both motors. This command is similar to **Panic** stop. @ will also clear a **Go Lockout** caused by specifying a range of travel outside of the limits.

Format: <@> (response) @ (CR), (LF)

A motor off (CR), (LF)

B motor off (CR), (LF)

20. Greater Than Command - >

Purpose: > will take a single step clockwise.

This is the same as entering T1, +S

Format: <>> (response) > (CR), (LF)

A or B (sp) Motor Off

(CR), (LF)

21. Less Than Command <

Purpose: < will take a single step counter-clockwise. This is the same as entering T1, -S.

Format: <<> (response) < (CR), (LF)

A or B (sp) Motor Off

(CR), (LF)

22. Equals Command =

Purpose: = will start both motors simultaneously. This is **similar** to entering AS BS.

Format: <=> (response) =

23. Plus Command +

Purpose: To preset the direction to clockwise.

Format: <+> (response) + LED On.

24. Minus Command -

Purpose: To preset the direction to counter-clockwise.

Format: <-> (response) - LED Off.

25. Change to Debut/Terminal Mode

    Purpose: To take out of computer mode without re-setting computer. This is useful for manual operation.

    Format: [Control] - W (response) (CR), (LF)

    Terminal Mode (CR), (LF)

26. Change to Computer Mode

    Purpose: To return to computer mode without re-setting controller.

    Format: [Control] - X (response) * (CR)

COMPUTER MODE

This section contains the description of the commands the 20010 accepts under the computer mode. In most cases the input formal will be the same. The major difference is in the way the output is presented to the computer. When a command is entered that returns no value, there is no echo back sent. If a command requires that a value be sent, then that value is outputed and terminated with a carriage return and no line feed.

1. A Motor Command - A

   Purpose: To direct the flow of commands, data or status inquiries to the A motor control registers.

   Format: <A> (response) None

2. B Motor Command - B

   Purpose: To direct the flow of commands, data or status inquiries to the B motor control registers.

   Format: <B> (response) None

3. Clear Absolute Register - C

   Purpose: To clear the absolute register to zero.

   Format: <C> (response) None

4. Disable Motor Windings - D

   Purpose: To disable the motor driver so no current flows through the motor windings. The enable LED on the front panel goes off.

   Format: <D> (response) LED Off

5. Enable Command - E

   Purpose: Enables the motor driver. This command allows the motor to step normally. The enable LED on the front panel goes on.

   Format: <E> (response) LED On

6. Full Step Command - F

   Purpose: Changes to full step motor operation. The half step LED on the front panel goes off.

   Format: <F> (response) LED Off

7. Go Absolute - G

   Purpose: This command also includes a data field consisting of a + or - and up to 8 digits of data terminated by a comma. After the 8^{th} digit, the numeric field is automatically terminated.

   Format: <G ± dddd...>

   Where: d = numeric data up to 8 digits.

8. Half Step Command - H

   Purpose: Changes to half step operation. The half step LED on the front panel goes on.

   Format: <H> (response) LED On.

9. Inquire Command - I

   Purpose: The I command outputs a single digit. The value of this digit represents the sum of the **true** conditions.

   Format: <I> (response) d (CR) d = 0-7

   Where:

Direction:	CW = 1 else CCW = 0
Step Size:	Half = 2 else Full = 0
Enable/Disable:	Enable = 4 else Disable = 0

10. Query Command - Q

    Purpose: The Q command outputs a single digit. The value of this digit represents the sum of the **true** conditions.

    Format: <Q> (response) d (CR) d = 0-7

    Where:

Motor:	On = 1 else Off = 0
CW Limit:	CW Limit = 2 else No CW Limit = 0
CCW Limit:	CCW Limit = 4 else No CCW Limit =

11. Rate Command - R

    Purpose: To set up the desired step rate for each motor. There are 8 pre-set step rates and they can be changed at any time.

    Format: (Rn) (response) None n = 0-7

12. Start Command - S

    Purpose: To start the selected axis.

    Format: <S> (response) None

13. Travel Command - T

    Purpose: This command includes a data field consisting of up to 8 decimal digits of data terminated by a comma. After the 8^{th} digit, the numeric field is automatically terminated.

    Format: <Tddddd...>

    Where: d = numeric data up to 8 digits.

14. U Command

    Purpose: Entering a U instructs the controller to output the value of the A motor travel register.

    Format: <U> (response) dddddd (CR)

    Where: d = numeric data up to 8 digits.

15. W Command

    Purpose: Entering a W instructs the controller to output the value of the B motor travel register.

    Format: <W> (response) dddddd (CR)

    Where: d = numeric data up to 8 digits.

16. X Command

Purpose: Entering an X command instructs the controller to output the value of the A motor absolute register.

Format: <X> (response) ± dddddd (CR)

Where: d = numeric data up to 8 digits.

17. Y Command

Purpose: Entering a Y command will instruct the controller to output the value of the B motor absolute register.

Format: <Y> (response) ± dddddd (CR)

Where: d = numeric data up to 8 digits.

18. Zero Command

Purpose: Z clears the absolute destination register.

Format: <Z> (response) None

19. @ Command

Purpose: @ unconditionally stops both motors. This is similar to **panic** stop. @ will also clear a **go lockout** caused by specifying a range of travel outside of the limits.

Format: <@> (response) a b (CR)

20. Greater Than Command

Purpose: > will take a single step clockwise. This is the same as entering T1, +S

Format: <>> (response) a or b (CR) LED On.

21. Less Than Command <

Purpose: < will take a single step counter-clockwise. This is the same as entering T1, - S.

Format: <<> (response) a or b (CR) LED Off.

22. Equals Command =

    Purpose: = will start both motors simultaneously. This is **similar** to entering AS BS.

    Format: <=> (response) None

23. Plus Command +

    Purpose: To pre-set the direction to clockwise.

    Format: <+> (response) LED On.

24. Minus Command -

    Purpose: To pre-set the direction to counter-clockwise.

    Format: <-> (response) LED On.

25. Change to Debug/Terminal Mode

    Purpose: To take out of computer mode without re-setting computer. This is useful for manual operation.

    Format: [Control] - W (response) (CR), (LF)

    Terminal mode (CR), (LF)

26. Change to Computer Mode

    Purpose: To return to computer mode without re-setting controller.

    Format: [Control] - X (response) * (CR)

COMMAND SUMMARY

Group 1 - Translator Commands

This command group affects the motor driver:

Command	Description
D	Disables motor winding current
E	Enables motor winding current
F	Change to full step mode
H	Change to half step mode
+	Set for clockwise operation
-	Set for counter-clockwise operation.

Group 2 - Data/Status Commands

This command group outputs data:

Command	Description
I	Inquire about the translator status
Q	Query the status of the move
U	Number of steps in motor A relative register
W	Number of steps in motor B relative register
X	Absolute number of steps for motor A
Y	Absolute number of steps for motor B

Group 3 - Control Data Commands

This command group loads the motor control registers:

Command	Description
C	Set the value in the absolute register to Zero
G	Go to an absolute destination
R	Set step rate
T	Set register to travel a number of steps

Group 4 - Direct Control Commands

Command	Description
A	Change data/command flow to motor A
B	Change data/command flow to motor B
S	Start motor
=	Start both motors
@	Stop both motors

Group 5 - Macro Instruction Group

This command group simulates a multiple instruction:

Command	Description
Z	Same as G 0,
<	Same as - T1, S
>	Same as + T1, S

Group 6 - Special/Control Characters

Character	Description
BS	Back Space (control H). Used to edit numeric data

Used as terminator for numeric data field

Control W Switch to terminal mode

Control W Switch to computer mode

SPECIAL MESSAGES

Terminal Mode

Message	Description
A Motor Off	This message is sent when the A motor reaches a limit or its destination count.
B Motor Off	This message is sent when the B motor reaches a limit or its destination count.
Terminal Mode	This message is sent when a <Control> - W is typed. The controller is now in the Terminal/Data mode.
Overflow	This message is sent when a destination value larger than 16,777,215 steps is requested.

Computer Mode

Message	Description
* <CR>	This message is sent when a <Control> - X is typed. The controller is now in the computer mode.
a <CR>	Same function as "A Motor Off"
b <CR>	Same function as "B Motor Off"

IV SET UP AND OPERATION

Motor connection: The motor connection is made at the rear panel. There are two rectangular 10 pin connectors marked Motor A and Motor B respectively. Connection to the Stepper Mike™ or stepper translation stage is made by a ribbon cable. This cable is supplied with the mike or translation stage.

Pin	Function
1	+5 volts; 50 mA maximum
2	Rev limit - logic low = limit
3	Low limit logic low = limit
4	+ 24 volts
5	0A
6	0B
7	0C
8	0D
9	NC
10	Logic common

The 20010 is configured to drive 4 phase unipolar motors having a phase current of less than 500 mA. These motors may be 5, 6 or 8 wire motors, variable reluctance, permanent magnet or hybrid types.

Stepper Motors

Stepper motors may have 4 different winding configurations.

4 wire

Circuit	Description
	This winding configuration is also called 2 Phase because the current must reverse in the windings for the motor to rotate. The Oriel 20010 will not operate with this type of motor.

5 wire

	This is the winding configuration used on the Oriel stepper mikes and translations stages. A + 24 volt supply is connected to the CT wire and the A, N, C and D wires are connected to the drivers on the 20010.

6 wire

8 wire

MOTOR TYPES

Permanent Magnet:

The permanent magnet step motor has a rotor made of a permanent magnet. The rotor rotates as it is attracted to the stator poles. Permanent magnet motors generally have few stator poles and therefore have large step angles 15° to 90°, and are relatively slow <300pps. These motors can produce high torque and good damping characteristics due to the back EMF from the magnetic rotor.

Variable Reluctance:

The variable reluctance step motor has a soft iron slotted rotor. The rotor is constructed with fewer poles than the stator. The poles on the rotor attempt to align with the poles on the stator as the phases are sequenced. The difference between the number of stator poles and rotor poles produces a force.

Variable reluctance motors operate with step angles from 5° to 15°. Because they do not have a permanent magnet in the rotor, these motors produce no back EMF and have no detent torque. The lack of detent torque enables these motors to achieve high slew speeds. The Oriel stepper mikes and translation stages use these motors.

Hybrid:

The hybrid step motor combines the desirable features of both the variable reluctance and the permanent magnet motor. The hybrid motor has a slotted rotor like the variable reluctance motor, but the rotor is made of a permanent magnet. The stator is constructed with multiple poles also. Rotation is produced by sequencing the stator phases. This changes the attraction between the stator and the rotor.

Hybrid motors have magnetic rotors and therefore produce back EMF. The magnetic rotors in these motors produce high detent torque and dynamic torque. These motors have step angles from

The Oriel 20010 stepper motor controller driver can operate all three types of step motors. The only conditions being that the step motor winding voltage be between 5 and 24 volt and the winding current is less than 500 mA.

Translator - Phase Sequence

1. Half Step

2. Full Step

3. Wave Drive - One phase on (not recommended)

   Pulse translator to even state - then change to full step.

   All state sequence drawings show clockwise. Labels A, B, C and D are same convention as pin out for Oriel Stepper Mike™.

RS-232 Interface:

RS-232 standard was chosen for computer interface because 1) most computers offer this interface option, 2) it can work at long distances (>100m), 3) it has high noise immunity and 4) it is supported by most computer languages.

RS-232 is an electrical standard, meaning that it is not important what format the signal is in, as long as it is the proper voltage level and can supply the proper current. For RS-232, the asserted voltage or logic high level must no be higher than +25 volts and the not asserted voltage or logic low level must now be less than -25 volts.

After the electrical conditions have been met, the speed or rate has to be considered. Information rates are measured in bits per second or baud. To relate that to information exchange rates, a terminal operating at 4800 baud can transmit or receive 480 characters per second.

Standard baud rates are:

Characters per second = CPS

CPS = Baud/10

150 Baud

300 Baud

600 Baud

1200 Baud

2400 Baud

4800 Baud

9600 Baud

RS-232 Data

The next area to be considered is the word structure or how the information is to be transmitted. Since RS-232 formats the information serially or sequentially in the form of bits which are either logic 1 or logic 0, a beginning tag (start bit) and ending tag (stop bit) must also be encoded. Now the information must be encoded into bits.

A common form of information encoding is called ASCII (American Standard Communication Information Interchange) in which the information is encoded into words of 10 bit length (1 start bit, 7 information bits and 2 stop bits). 7 information bits can produce up to 128 different information combinations (a typical key board has about 70 - 96 characters).

The last important item in the RS-232 standard is to be aware of information structure. RS-232 information is transmitted in asynchronous mode which can be as character strings or single characters transmitted randomly. This mode often requires a buffer to gather up randomly sent characters so that they can be properly interpreted.

RS-232 Interface Standard

On the preceding pages are some excerpts from the RS-232 standard. This may be helpful in configuring the interface between the computer or terminal and the Oriel 20010 step motor controller.

Pins Out for RS-232 Connector

Pin Number	Circuit	Description
1	AA	Protective Ground
2	BA	Transmitted Data
3	BB	Received Data
4	CA	Request to Send
5	CB	Clear to Send
6	CC	Data Set Ready
7	AB	Signal Ground (Common Return)
8	CF	Received Line Signal Detector
9	--	(Reserved for Data Set Testing)
10	--	(Reserved for Data Set Testing)
11		Unassigned
12	SCF	Sec. Rec'd Line Sig. Detector
13	SCB	Sec. Clear to Send
14	SBA	Secondary Transmitted Data
15	DB	Transmission Sig. Element Timing (DCE Source)
16	SBB	Secondary Received Data
17	DD	Receiver Sig. Element Timing (DCE Source)
18		Unassigned
19	SCA	Secondary Request to Send
20	CD	Data Terminal Ready
21	CG	Signal Quality Detector
22	CE	Ring Indicator
23	CH/CI	Data Signal Rate Selector (DTE/DCE Source)
24	DA	Transmit Signal Element Timing (DTE Source)
25		Unassigned

V_0 is the open-circuit voltage

R_0 is the driver internal DC resistance.

C_0 is the total effective capacitance associated with the driver, measured at the interface point and including any cable to the interface point.

V_1 is the voltage at the interface point.

C_L is the total effective capacitance associated with the terminator, measured at the interface point and including any cable to the interface point.

R_L is the terminator load DC resistance.

E_L is the open circuit terminator voltage (bias).

The driver on an interchange circuit shall be designed to withstand an open circuit, a short circuit between the conductor carrying that interchange circuit in the interconnecting cable and any other conductor in that cable, or any passive non-conductive load connected between that interchange circuit and any other interchange circuit including Circuit AB (Signal Ground) without sustaining damage to itself or its associated equipment. The terminator on an interchange circuit shall be designed to withstand any input signal within the 25 volt limit.

For data interchange circuits, the signal shall be considered in the marking condition when the voltage (V_1) on the interchange circuit, measured at the interface point, is more negative than minus three volts with respect to Circuit AB (Signal Ground). The signal shall be considered in the spacing condition when the voltage (V_1) is more positive than plus three volts with respect to Circuit AB.

The region between plus three volts and minus three volts is defined as the transition region. The signal state is not uniquely defined when the voltage (V_1) is in the transition region.

Interchange Circuit

A circuit between the data terminal equipment and the data communication equipment for the purpose of exchanging data, control or timing signals. Circuit AB (signal ground) is a common reference for all interchange circuits.

Interchange circuits between data terminal equipment and data communication equipment fall into four general categories:

- Ground or Common Return
- Data Circuits
- Control Circuits
- Timing Circuits

Driver

a) The electronic circuitry or relay contact at the transmitting end (source) of an interchange circuit which transmits binary digital signals to a terminator via an interconnecting cable.

b) The transmitter of a binary digital signal.

Terminator

a) The electronic circuitry at the receiving end (sink) of an interchange circuit which receives binary digital signals from a driver via an interconnecting cable.

b) The receiver of a binary digital signal.

Signal Characteristics, General

Interchange circuits transferring data signals across the interface point shall hold marking (binary ONE) or spacing (binary ZERO) conditions for the total nominal duration of each signal element.

During the transmission of data, the marking condition shall be used to denote the binary state ONE and the spacing condition shall be used to denote the binary state ZERO.

For timing and control interchange circuits, the function shall be considered **ON** when the voltage (V_1) on the interchange circuit is more than plus three volts with respect to circuit AB and shall be considered **OFF** when the voltage (V_1) is more negative than minus three volts with respect to Circuit AB. The function is not uniquely defined for voltages in the transition region between plus three volts and minus three volts.

Notation	Interchange Voltage	
	Negative	Positive
Binary State	1	0
Signal Condition	Marking	Spacing
Function	OFF	ON

Interchange Circuits

Circuit AA Protective Ground
Direction Not applicable

This conductor shall be electrically bonded to the machine or equipment frame. It may be further connected to external grounds as required by applicable regulations.

Circuit AB Signal Ground or Common Return
Direction Not applicable

Circuit BA Transmitted Data
Direction TO data communication equipment

Signals on this circuit are generated by the data terminal equipment and are transferred to the local transmitting signal converter for transmission of data to remote data terminal equipment.

The data terminal equipment shall hold Circuit BA (Transmitted Data) in marking condition during intervals between characters or words and at all times when no data are being transmitted.

In all systems, the data terminal equipment shall not transmit data unless an ON condition is present on all of the following four circuits, where implemented.

1. Circuit CA (Request to Send)
2. Circuit CB (Clear to Send)
3. Circuit CC (Data Set Ready)
4. Circuit DC (Data Terminal Ready)

All data signals that are transmitted across the interface on interchange circuit BA (Transmitted Data) during the time an ON condition is maintained on all of the above four circuits on all of the above four circuits, where implemented, shall be transmitted to the communication channel.

Circuit BB Received Data
Direction FROM data communication equipment

Signals on this circuit are generated by the receiving signal converter in response to data signals received from remote data terminal equipment via the remote transmitting signal converter. Circuit BB (Received Data) shall be held in the binary ONE (Marking) condition at all times when Circuit CF (Received Line Signal Detector) is in the OFF condition.

On a half duplex channel, Circuit BB shall be held in the Binary One (Marking) condition when Circuit CA (Request to Send) is in the ON condition and for a brief interval following the ON to OFF transition of Circuit CA to allow for the completion of transmission.

Circuit CA Request to Send
Direction TO data communication equipment

This circuit is used to condition the local data communication equipment for data transmission and, on a half duplex channel to control the direction of data transmission of the local data communication equipment.

The one way only channels or duplex channels, the On condition maintains the data communication equipment in the transmit mode. The OFF condition maintains the data communication equipment in a non-transmit mode.

On a half duplex channel, the ON condition maintains the data communication equipment in the transmit mode and inhibits the receive mode. The OFF condition maintains the data communication equipment in the receive mode.

Circuit CB Clear to Send
Direction FROM data communication equipment

Signals on this circuit are generated by the data communication equipment to indicate whether or not the data set is ready to transmit data.

The ON condition together with the On condition interchange circuits CA, CC and, where implemented, CD is an indication to the data terminal equipment that signals presented on Circuit BA (Transmitted Data) will be transmitted to the communication channel.

The OFF condition is an indication to the data terminal equipment that it should not transfer data across the interface on interchange Circuit BA.

Circuit CC Data Set Ready
Direction FROM data communication equipment

Signals on this circuit are used to indicate the status of the local data set.

The On condition on this circuit is presented to indicate that a) The local data communication equipment is connected to a communication channel ("OFF HOOK" in switched service), and b) the local data communication equipment is not in test (local or remote), talk (alternate voice) or dial mode, and c) the local data communication equipment has completed, where applicable:

1) any timing function required by the switching system to complete call establishment and

2) the transmission of any discreet answer tone, the duration of which is controlled solely by the local data set.

Circuit CD Data Terminal Ready
Direction TO data communication equipment

Signals on this circuit are used to control switching of the data communication equipment to the communication channel. The ON condition prepares the data communication equipment to be connected to the communication channel and maintains the connection established by external means (e.g., manual call origination, manual answering or automatic call origination).

table

The load impedance (R and C_L) of the terminator side of an interchange circuit shall have a DC resistance (R_L) of not less than 3000 Ohms measured with an applied voltage not greater than 25 volts in magnitude nor more than 7000 Ohms measured with an applied voltage of 3 to 25 volts in magnitude. The effective shunt capacitance (C^L) of the terminator side of an interchange circuit, measured at the interface point, shall not exceed 2500 picofarads. The reactive component of the load impedance shall not be inductive. The open circuit terminator voltage (E_L) shall not exceed 2 volts in magnitude.

RS-232 Connection

On the rear panel of the 20010 is the RS-232 connector. The RS-232 connector is a 25 pin subminiature D style connector thru which all data and commands are processed.

The RS-232 interface has a pin for input (Rx) and a pin for output (Tx). These two signals and the signal common are the only signals that the 20010 processes. All other signals and control connections are ignored.

The baud rate or speed at which data is transferred is selected by the baud rate switch on the back panel of the 20010. The switch is tested furing turn on or when the reset button is pressed. Therefore, if the switch position is changed during normal operation, the baud rate will not change until the 20010 is restarted.

Because of the different requirements in each RS-232 installation, the interface cabling between the 20010 and the computer or terminal is the responsibility of the end user. Figure shows which connections are implemented on the 20010.

When attempting to establish a communication interface, it is important to read the interface manuals for the computer or terminal to determine which control signals must be asserted for proper operation. Sometimes connecting an output to an input solves the problem (i.e., connect RTS to CTS and DSR to DTR). Next, if the terminal is available, a test interface can be set up using the terminal to simulate the 20010. Section VIII has program examples for some common personal computers. These listings may be modified for use on other computers or used as sub-programs for larger programs. Also supplied with these listings are some typical wiring connections used to interface the 20010.

Pin Connections Used on 20010

Pin	Function
1	Ground
2	Transmitted Data (Tx)
3	Received Data (Rx)
4	Request to Send (RTS)
5	Clear to Send (CTS)

V OPERATIONAL EXAMPLES

Connect a RS-232 terminal to the 20010 using the appropriate cable. Set the mode switch to terminal mode and the baud rate to the baud rate of the terminal. Turn the terminal on and press the caps lock on the terminal. Push the power switch to the ON position. This message should appear after ~ 2 seconds.

```
** ORIEL CORP **
Model 20010
Dual axis step motor controller
V1.0 1985
```

The ready light and the A and B sync light should be on. If this message does not appear, check the baud rate or the data connection.

Next type AEH+ the enable, half step and the CW LED for motor A should come on. Type DF-; this should turn them off. To control motor B, type BEH+. This should cause the enable, half step and CW LED for motor B to light.

Turn **off** power and connect step motors to 20010 controller. Turn power back on, the log on messages as before should appear. Grasp the thumb nut on the back of the stepper mike A and rotate back and forth. The nut should travel freely in either direction. Type AE and try to rotate the thumb nut as before. The thumb nut should be harder to rotate because the winding current has been engaged. Type H, the half step should come on indicating the driver is in the half step mode. Type >, the forward light should come on. The sync light should go off and the mike should advance 1 step. The message "A Motor Off" should appear on the terminal indicating the motor made the move.

Type X, the message +1 should be on the terminal indicating 1 forward step has been taken. Type <, the forward LED should go off and the synd LED should come on. The message "A Motor Off" should appear on the terminal. Type X again, +0 will be displayed on the terminal indicating the mike has returned to its original position. Type "T 100000, S", the stepper mike spindle will move in until the reverse limit is reached. When the reverse limit has been reached, the reverse limit light will go on and the terminal will display "A Motor Off".

Type Q, the terminal will display:

```
A Motor Off
A No + Limit
A - Limit
```

This message displays the status of the stepper mike.

Type U, type X; U indicates the number of steps left from 100,000 and X will equal the total value and direction from zero. Since zero was defined previously, this will be the total number of steps taken from zero to the reverse limit.

Type +S, the step motor spindle should move out and should not stop till the forward limit is reached. The terminal should display "A Motor Off". Type I, the terminal should display:

A + Direction
A Half Step
A Enable Axis

This indicates the driver is enabled in the half step forward mode.

Type Q, the terminal should display:

A Motor Off
A + Limit
A No - Limit

indicating the stepper mike has reached its forward limit.

Type "T 500," type U; the value displayed should be 500. This value is the amount of steps in the travel register. The travel register is a "down counter" counting from A value set by the T command to zero relative to that register. The direction may be pre-set anytime prior to starting the motor.

Type X, the value displayed on the terminal should be the number of steps required to move the stepper mike from zero, as set initially, to the forward limit. This value will be a positive number.

Type -S, the stepper mike should move in slightly. Type Q, the terminal will display:

A Motor Off
A No + Limit
A No - Limit

This indicates the stepper mike has moved out of its limit position. Type U, a zero should be displayed indicating the full travel has been made. Type X, the value displayed should be the value displayed when at the forward limit minus 500.

Now type Z S, the stepper mike spindle should retract and the message "A Motor Off" will be displayed when stepper mike stops. Type X, the value displayed should be + 0. This value is the absolute reference and the stepper mike should have returned to its initial starting position.

The B motor could have been used in the same fashion simply by typing in B in the beginning of the section and substituting W and Y for U and X respectively.

Type <control - X>, an asterisk should appear on the terminal. The 20010 is now in computer mode. Commands and data may be entered as in the beginning of this section. The major difference is the way the data is outputed and the status messages. Remember, the commands will be accepted but will not echo back. You must send a command I or Q to receive status output or you can type <control -W> to return to terminal mode.

VI CIRCUIT DESCRIPTION

The ORIEL 2 axis stepper motor controller consists of 3 circuit boards. The power supply, the translator/driver and the motor control board.

POWER SUPPLY PC BOARD - Refer to Oriel Drawing 20010-3-1201, Rev. C.

The power supply PC board provides power for the logic circuits and for two stepper motors. It consists of a 56VA step-down transformer (T1) to provide the low voltage and for line isolation. The reduced voltage is rectified and filtered to provide an unregulated source for the two regulators.

The regulators are configured as buck-type step-down regulators which are pre-set to provide 24V (U1) for the motors and 8 volts (U2) for the logic boards. These ICs are 40 kHz switching regulators which, because of their internal configuration, must **float** with respect to circuit ground. During the internal switch **on** time the output inductor changes the output capacitor. The regulator controls the duty cycle of this charging current and will shut the switch off at the pre-determined time. During the **off** time, the flyback current from the inductor will flow through the flyback high speed diodes to maintain the charge across the output capacitors. The output resistors serve to pre-load the outputs to insure that correct startup of the regulators will occur.

The power supply board also contains the restart/reset circuitry. This circuit provides the reset signal whenever the 20010 is powered up or the restart button is depressed.

TRANSLATOR BOARD - Refer to Oriel Drawing 200103-1101.

The translator board contains the components for converting logic signals to phase signals and drive voltages for the motors.

U1 and U4 translate the logic signals and pulses into phase signals. These signals are interfaced by U8 and U5 to the power driver U7 or U6.

Limit switches are sensed and conditioned by U2. U2 drives the display board and the input port to the motor control board. U3 inputs the pulses to the motor driver and powers the motor driver down if no pulses are detected. This keeps the motors cooler when running at low step rates.

MOTOR CONTROL BOARD - Refer to Oriel Drawing 20010-3-1401.

The motor control board contains a microprocessor (MPU) (U3), a program memory (U2) and I/O Interface (U4). This board generates the signals for the motor translator/driver board. The MPU tests the limits, baud rate and mode switches through the I/O interface (U4). The program for the motor control board is stored on U2. This part is a programmed part and must not be substituted with any other part. Digital level ASCII commands and data are processed and executed by the MPU. The MPU converts the commands into logic signals which control the translator drive and data which is stored in the MPU's registers.

The RS-232 interface/baud switch is located on the rear panel. This board translates the RS-232 signals to TTL for the microprocessor as well as being an RS-232 driver for the MPU's output.

20010 FRONT PANEL

1	Ready/Power On
2	CW/Forward Limit Motor A
3	CCW/Reverse Limit Motor A
4	CW Direction Motor A
5	Half Step Motor A
6	Enable Motor A
7	Sync - Motor A
8	Pulse - Motor A
9	CW/Forward Limit B
10	CCW/Reverse Limit B
11	CW Direction Motor B
12	Half Step Motor B
13	Enable Motor B
14	Sync Motor B
15	Pulse Motor B

Description of Indicators -

1. Ready/Power On: LED lights about 1.5 sec. after power is applied indicating the 20020 is ready.

2. CW/Forward Limit: Spindle of stepper mike fully extended. Phase sequence such that motor moving in CW direction (CE LED on).

3. CCW/Reverse Limit: Spindle of stepper mike full retracted. Phase sequence such that motor moving in CCW direction, CW LED off.

4. CW Direction: Direction which causes stepper spindle to move out or forward and the thumb nut on the back move clockwise.

5. Half Step: Phase sequence that repeats after the eighth pulse.

6. Enable: Power to the motor windings is applied so motors can step normally.

7. Sync: LED is on when translator reaches its **home** state. (ABCD) = 0110.

8. Pulse: Translator changes 1 state for each pulse.

Description of Switches -

1.	Reset Switch:	Re-initializes microprocessor and checks baud rate, mode switch.
2.	Power Switch:	On-Off power switch and fuse holder.
3.	Baud Rate Switch:	6 position rotary switch; 300, 600, 1200, 2400, 4800 and 9600 baud can be selected.
4.	Mode Switch:	Two data modes can be selected; terminal mode or computer mode. In terminal mode the data and messages are in plain English. In the computer mode the echo and all line feeds are suppressed.

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