Zygo 2/20
AQuadB Interface
Accessory Manual
OMP-0222C



Zygo Corporation
Laurel Brook Road
P.O. Box 448
Middlefield, Connecticut 06455-0448

Telephone: (860) 347-8506
Fax: (860) 346-4188
E-mail: inquire@zygo.com
Website: www.zygo.com

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Manual revision status and printing history appear below.

Revision	Publication Date
Original Issue	August 1989
B	March 1990
C	August 1993

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Zygo Corporation
Laurel Brook Road
P.O. Box 448
Middlefield, CT 06455-0448
Attention: Technical Publications Department
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MANUAL NOTATIONS -

WARNING! Denotes a hazard that could cause injury to personnel, or may cause severe damage to the equipment.

Note: Provides helpful information about the topic under discussion.

ZYGO STATEMENT OF WARRANTY AND PRODUCT SUPPORT

Zygo Corporation provides this warranty to protect its customers from defects in product workmanship or product materials. This warranty covers all products manufactured by Zygo Corporation. Zygo warrants that the equipment purchased will be free from any defects in material and/or workmanship under normal operating conditions for a period of one year from the date of shipment. The light source is warranted for a period of three years from the date of shipment.

In addition, being committed to providing our customers with superior service, Zygo will support all standard products for a period of five years after the sale of the last newly-manufactured unit. Beyond this five-year period, we will continue to support these products on a "best-effort" basis.

WARRANTY SERVICE

Zygo's responsibility under this warranty shall be limited to the repair or replacement (at Zygo's option) of defective equipment at no cost to the buyer, except for transportation, cleaning, and recalibration charges.

Zygo will perform warranty service by: (1) sending replacement parts with appropriate installation instructions to the buyer, the buyer returning his defective part to Zygo or; (2) repairing the product at a Zygo repair facility after it has been returned freight prepaid, or; (3) at the buyer's request, dispatching a service representative to the buyer's facility. The buyer shall pay Zygo's travel and living expenses as well as travel time.

Defective products or parts will be repaired or replaced with new or like-new parts. These replacement parts will be warranted for a period of 90 days after they are shipped, or for the remainder of the original warranty period, whichever is longer. Warranty service will be performed only if the buyer notifies Zygo within 14 days of discovering any defects. Equipment or parts that are to be returned to Zygo must be issued a Return Authorization number. This number can be obtained by contacting the Zygo Service Department. Should Zygo's subsequent inspection reveal that the parts were not defective, all expenses incurred by Zygo shall be charged back to the buyer. Defective equipment that is replaced shall become the property of Zygo.

Warranty period begins when the product is shipped from Zygo. Replacement parts, service workmanship, used equipment, and refurbished equipment are warranted for a period of 90 days.

RETURNS

Unused and undamaged products, in their original shipping containers, may be returned for credit within 30 days of receipt. All such products will be subject to a restocking fee equal to 20 percent of the purchase price. Custom products are not returnable.

EXCLUSIONS

The above warranty and product support statement applies only to equipment that is an integral part of a Zygo manufactured product. It does not apply to peripheral equipment manufactured by others, such as: computers, printers, vibration isolation tables, etc. In such cases, the warranty and the support that the original manufacturer supplies will apply.

In addition, warranty service does not include or apply to any product or part which, in Zygo's judgment:

a. Has been repaired by others, improperly installed, altered, modified, or damaged in any way.
b. Malfunctions because the customer has failed to perform maintenance, calibration checks or good operating procedures.
c. Is expendable or consumable (such as panel lights, fuses, batteries, windows, and filters) if such items were operable at the time of initial use.
d. Requires replacement because of decomposition due to chemical action.
e. Fails because of poor facility, operating conditions, or utilities.

Other than expressly described above, Zygo makes no express or implied warranties, including any regarding merchantability or fitness for a particular purpose relating to the use or performance of the equipment. Zygo will not be liable for personal injury or property damage (unless caused solely by its own negligence), loss of profit or other incidental or consequential damages arising out of the use or inability to use the equipment. Nor does this warranty apply to any equipment which has been subject to misuse, neglect or accident; or repaired or altered by other than service representatives qualified by Zygo.

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INTRODUCTION

Note:

The user should be familiar with the "standard" ZYGO 2/20 laser measurement system before using the AQuadB interface. This document describes the ZYGO 2/20 AQuadB option and uses laser interferometry terminology without explanation. The ZYGO 2/20 Operation and Reference Manual, OMP-0220, is referenced when necessary.

The AQuadB (A quadrature B) option for the ZYGO 2/20 laser measurement system provides an interface to servo controllers that require phase quadrature feedback or up/down pulse feedback. With the AQuadB option, the ZYGO 2/20 may be used as a displacement measuring device for the machine tool industry. The AQuadB option requires two basic parts: 1) The AQuadB Board, and 2) firmware (revision E or later) stored in memory on the Control and Interface Board.

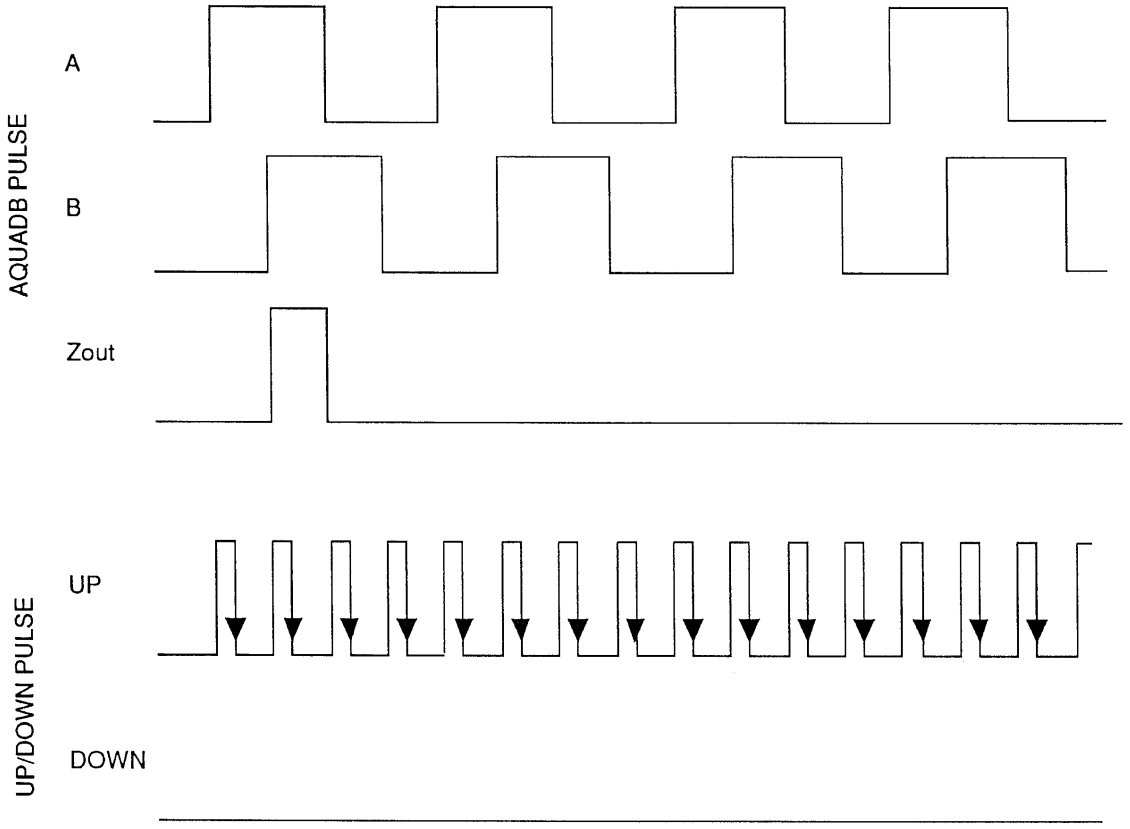
The major part of the AQuadB option is the AQuadB Board, which emulates the output of devices such as optical encoders, inductosyns, and glass scales, but with laser interferometry to provide greater accuracy. The board outputs data in one of two user selective machine control compatible formats: AQuadB pulses or Up/Down pulses. The pulses are differential TTL (transistor-transistor logic) outputs that conform to RS-422 specifications. These formats are shown in Figure 1.

The AQuadB pulses are made up of two signals: A and B, plus an optional marker signal: Z. A and B signals are continuous square wave signals that are 90 degrees out of phase (producing quadrature feedback). The lead/lag relation of these signals indicates axis direction. The Z(out) or zero signal serves as a synchronized pulse to match the timing requirements of the machine control.

The Up/Down format emulates an incremental encoder so the pulses can be counted by an external counter. The Up/Down pulses are at four times the frequency of the AQuadB pulses.

The AQuadB interface has an error output to notify the machine control about measurement errors, such as absence of reference or measurement signals, accumulator overflow, unstable laser, excess velocity, and software errors.

The firmware on the Control and Interface Board allows the ZYGO 2/20 to become a standalone unit without the need for host computer control with the AQuadB option. The firmware also allows the user to set up a customized AQuadB interface with the Diagnostician or the host computer for each measurement axis. This customized interface can account for the selected resolution, individual axis measurement parameters, wavelength compensation, dead path error, and systematic machine inaccuracies.



AQuadB Output Data Formats

Figure 1

AQuadB Features

OUTPUT RATE Output scaled and compensated AQuadB pulses at a maximum rate of 1.25 Megahertz or Up/Down pulses at a maximum rate of 5.0 Megahertz.

REAL-TIME OUTPUT The maximum delay from measurement to pulse output for all axes is 1 microsecond at the maximum output rate (1.25 MHz); this includes the time necessary for scaling and compensating the measurement data.

RESOLUTION VERSATILITY The resolution may be set in metric (micrometers) or English (microinches) units. The maximum resolution for a single pass interferometer is 0.0025 micrometer (0.1 microinch) and 0.00125 micrometer for a double pass interferometer. The AQuadB option allows for resolution-velocity trade-off; the greater the resolution, the less the velocity, and vice versa.

WAVELENGTH COMPENSATION The wavelength of the laser may be automatically compensated for the changing refractive index of air before the measurement is output as pulses.

DEAD PATH COMPENSATION Dead path is the difference in distance in air between the measurement and reference optical elements and the polarization beamsplitter when the interferometric measurement is initiated. Dead Path may be automatically compensated for in each axis.

AXIS CALIBRATION Each axis in the measurement system may be automatically compensated for systematic errors, such as cosine error or fixed machine inaccuracies.

Refractive Index of Media (RIM)

The standard ZYGO 2/20 system firmware includes a feature called Refractive Index of Media or RIM; this provides the ZYGO 2/20 with the ability to adjust measurements for the effects that changing media (usually air) will have on the wavelength of the laser beam. Some type of refractive index compensation is necessary for AQuadB systems; it may be accomplished by using either a Zygo Wavelength Compensator (dynamic compensation) or using a default index setting (nondynamic compensation) via software.

In a typical AQuadB system, one axis would serve as the RIM axis; it consists of a Measurement Board connected to a Wavelength Compensator. The RIM axis provides a dynamic value used in the computation of the AQuadB scale factor; this ensures a real-time, compensated AQuadB output.

If a Wavelength Compensator is not used, the user enters a refractive index default value for each AQuadB axis; this will provide nondynamic RIM compensation. Thus, with or without the Wavelength Compensator, the output from the AQuadB Board may be scaled (measurement data is calibrated to the selected resolution unit) and compensated (adjusted for measurement errors caused by wavelength variations). When using RIM with AQuadB, a host computer is not required.

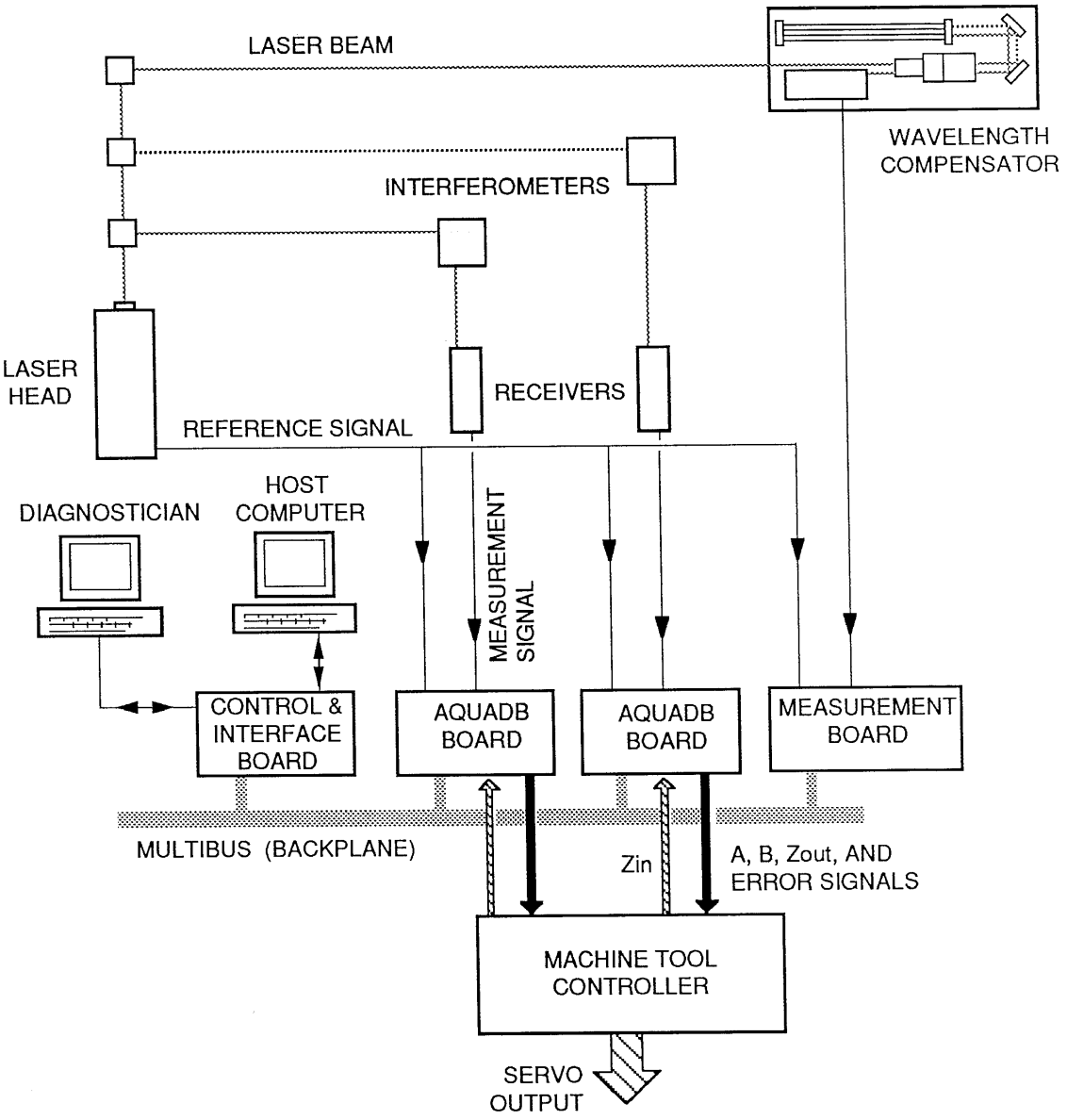
RIM compensation is optional for non-AQuadB Board (Measurement Board) systems. In a typical non-AQuadB system, the RIM feature converts the reading from the Measurement Board to an "index" value for the host computer to read. In a non-AQuadB setup the user may use more than one Wavelength Compensator and assign the specific output index values to individual axes or the entire system. When using RIM with a non-AQuadB system, a host computer is required; but, the programming required to convert the measurement data from the Wavelength Compensator to an index value is eliminated.

In both AQuadB Board and non-AQuadB Board systems with one or more Wavelength Compensators, the highest numbered axis is assigned as the RIM axis and used in all scale factor computations. During operation, the software monitors the RIM function, and if an error occurs pulse output is disabled and an error signal is enabled.

Typical Application

A typical AQuadB application is shown in Figure 2. The refractive index of air is monitored by the Wavelength Compensator connected to a standard Measurement Board. The Control and Interface Board uses the measurement from this board to calculate a system compensation factor (refractive index of media). The AQuadB Boards provide position feedback to the machine tool controller as scaled and compensated AQuadB pulses.

The Diagnostician or host computer is used to set up the AQuadB option and store necessary operational parameters into memory located on the Control and Interface Board.



AQuadB Application

Figure 2

DESCRIPTION

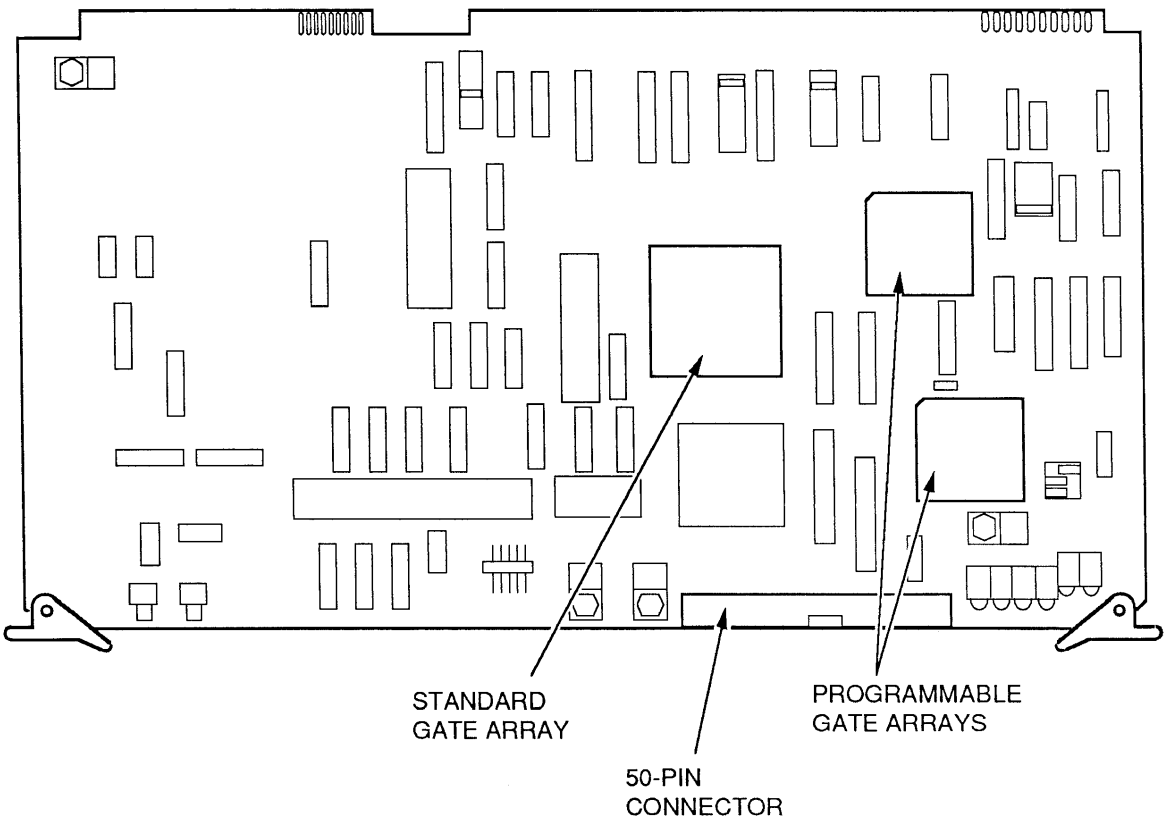
AQuadB Board

The AQuadB Board is part of the ZYGO 2/20 system electronics. It is mounted in the card cage of the Controller or Coupler and is compatible with the Multibus standard. One AQuadB Board is required for each axis of measurement. The AQuadB Board includes a major portion of the electronics of the standard Measurement Board; it combines an electrical reference signal from the Laser Head with a measurement signal from the Receiver to generate the measurement data as a 32-bit binary word. However, in addition, the board converts the 32-bit data into compatible AQuadB or Up/Down pulses. Most of the additional measurement electronics required to perform the conversion are incorporated into two programmable gate arrays.

The AQuadB Board yields AQuadB or Up/Down scaled and compensated pulses from incoming reference and measurement signals. The board samples the measurement data, converts it to the selected measurement units, compensates for dead path error in each measurement axis, compensates the laser wavelength for the changing refractive index of air, and then outputs the pulses.

The output pulses are accessed at a 50-pin connector on each board, which may be linked to the back panel of the electronics. The frequency output rate of the pulses is jumper selectable, providing for five different maximum frequencies.

An AQuadB Board is shown in Figure 3. For detailed information about the AQuadB connections and jumper settings, see the "AQuadB Board Setting" section.



AQuadB Board

Figure 3

ZYGO 2/20 Firmware

The ZYGO 2/20 Control and Interface Board contains the firmware necessary to operate the AQuadB option; it is stored in EPROM and NVM. The firmware allows various AQuadB operational parameters to be selected and stored into memory and provides for laser wavelength compensation. With the AQuadB option, the ZYGO 2/20 can be operational with or without being controlled by an external computer.

Operational parameters for the AQuadB Boards are stored in NVM. During the initial setup, the user should change default parameter values by sending commands through the Diagnostician or a host computer. With viable parameters saved in NVM, the ZYGO 2/20 can run as a standalone unit.

On power-up, pulses are *not* output from the ZYGO 2/20 until the laser is stabilized. During this period of time, the host computer should not issue any commands other than ";" (laser stability report), and the Diagnostician should not issue any commands other than selecting a monitor that has a laser stability indicator (Axes Monitor or AQuadB Monitor).

At power-up the ZYGO 2/20 retrieves setup information stored in NVM. If the setup data has been prearranged by the user, the AQuadB option will start generating pulses when the laser becomes stable.

The firmware provides for three capabilities necessary for the AQuadB option:

1) *Scale factor*, used during the calculation of the pulsed output to increase the measurement accuracy of each measurement axis. This factor is comprised of various user software selected factors: resolution, calibration, refractive index of media, and interferometer type. This capability is implemented independently for each AQuadB axis.

2) *Dead path factor*, used during the calculation of the pulsed output to adjust the measurement for dead path error in the measurement axis. This capability is implemented independently for each AQuadB axis.

3) *Refractive Index of Media* (RIM)*, used during the calculation of the pulsed output to adjust for refractive index of media changes during the measurement. It is either a user supplied default value or a value automatically computed from a Wavelength Compensator connected to a Measurement Board. The RIM value is used to calculate the scale factor and the dead path factor. This capability is implemented simultaneously for all AQuadB axes; it may be used with or without the AQuadB Board.

   To use the scale factor, dead path factor, and refractive index of media, commands must be entered through the Diagnostician AQuadB Monitor or a host computer using Group 4 Commands. For an explanation of the AQuadB Monitor, see the "Diagnostics" section. For a listing of the Group 4 commands, see OMP-0220, Chapter 12.

* Refractive Index of Media or RIM capability measures the effect the media, usually air, has on the wavelength of the light beams.

For the AQuadB option or RIM function to be utilized the user must enter parameters into the ZYGO 2/20. These parameters then become part of the ZYGO 2/20 firmware and are used in system equations that are transparent to the user. These equations and calculations provide the real-time automatic scaling and compensation of the output measurement.

The interaction of the user selectable parameters with the AQuadB output is represented by two basic equations:

$$A = NS$$

where:

- A is AQuadB measurement output data.
- N is ZYGO 2/20 32-bit measurement data adjusted with the deadpath factor (calculated from the dead path length and the RIM calculation).
- S is the scale factor (see below).

$$S = \frac{jkc}{n}$$

where:

- S is the scale factor.
- j is a fixed factor which converts the ZYGO 2/20 wavelength units into the proper measurement units (metric or English).
- k is a resolution factor derived from the user selected resolution.
- c is a user selected calibration factor (default setting of 1).
- n is the refractive index of media or RIM. RIM is determined from the initial refractive index of media (IRIM), measurement cell length, and RIM measurement sign parameters.

Error and Status Detection

The AQuadB option has error detection capabilities to detect both hardware and software errors and status conditions. Errors are detected by AQuadB Board hardware and C/I Board firmware. All errors generate an output error signal on the AQuadB Board, which is sent to the machine control over axis specific hardware lines. Some of these errors are indicated by LED's on the AQuadB Board.

Error and status detection from the AQuadB Board is provided via an 8-bit status register; which is identical to the status register on the Measurement Board. To

identify the status and error, the status register must be be read using a host computer and software over the IEEE-488 or RS-232 Control interface with the ":" command. These errors do not disable pulse output. Additional information about the status register is provided in OMP-0220, Chapter 6.

The following errors and status conditions are monitored:

accumulator overflow error (measured displacement greater than ± 5.2 meters)
maximum velocity error (motion velocity of object too high)
no measurement signal from receiver
no reference signal from laser head
null-occurrence status (when displacement data has changed sign)

Error and status detection from the C/I Board firmware monitors both software and hardware errors. When an error is detected pulse output is disabled. To identify the specific condition, the AQuadB/RIM status report must be read using a host computer and software over the IEEE-488 or RS-232 Control interface with the "A150" command.

The following errors and status conditions are monitored via software:

software initialization state (not ready to generate AQuadB output)
laser stability status
scale factor invalid
bad RIM computation
RIM axis measurement error
AQuadB not in 32-bit mode
RIM axis not in 31-bit mode
AQuadB measurement error

Note:

The software detected errors may also be identified on the Diagnostician AQuadB Monitor; refer to Appendix B.

A general procedure for recovering from an error is find the source of the problem, fix it, and restart the system.

AQuadB Specifications

Output Format: Phase Quadrature (AQuadB) or Up/Down Pulses; TTL differential line driver output, pulse width from .1 to 1.6 µsec based upon the selection of JN13.

Maximum Output Rate: 1.25 MHz (AQuadB) or 5.0 MHz (Up/Down).

Number of Measurement Axes: 1 to 6 depending on electronics with 1 or more axes configured for wavelength compensation. (Only the highest numbered RIM axis is used for AQuadB wavelength compensation.)

Maximum Output Resolution:

	Single Pass	Double Pass	Four Pass
Representation	$\lambda/254$	$\lambda/508$	$\lambda/1016$
Metric	≤ 0.0025 µm	≤ 0.00125 µm	≤ 0.000625 µm
English	≤ 0.1 µin	≤ 0.05 µin	≤ 0.025 µin

Velocity:

MAXIMUM: 1.8 m/sec (single pass interferometer)
0.9 m/sec (double pass interferometer).

Trade-off between velocity and resolution.

Acceleration Limit: No limit with electronics and processing; optics mounting may affect the measurement acceleration limit.

Response Time from Measurement to Output: from 1 µsec to 16 µsec, based upon selection of JN13.

Wavelength Compensation: Manually input factors for each axis or automatically compensate for all axes in real-time.

Dead Path Compensation: Manually input dead path distance for each axis, the system automatically compensates. The limit of dead path distance for each interferometer varies as follows: single pass ± 5300 mm, double pass ± 2650 mm, and four pass ± 1325 mm.

Calibration Adjustment: Manually input a factor to automatically compensate the measurement for systematic errors (such as Cosine error on a linear slide) at each axis.

Error Output: RS-422 level error signal from any measurement axis for hardware and software errors.

INSTALLATION

This procedure explains how to install an AQuadB Measurement Kit in either the Controller or Coupler. For detailed information about the various jumpers, refer to the section entitled "AQuadB Board Settings". Refer to Figure 4.

1. Loosen the thumbscrews on the front panel of the Controller or Coupler and remove the panel.

2. Remove the two circuit board locking plates, located on each side of the card cage. Each locking plate is secured with two screws.

3. Check the position of JN1, JN12 and JN13 jumpers on the AQuadB Board. Set these jumpers to the desired position for the board being installed. JN1 determines the address of the board, JN12 determines the output mode, and JN13 determines the frequency output. See Table 2.

4. Insert the AQuadB Board into a card cage slot. It is recommended to insert the axis 1 board nearest to the C/I Board, and place subsequent boards in order. Push on the board ejectors to seat the board, reasonable force is necessary.

   Note:

   If trouble is experienced when seating a board into the card cage, try bending the board slightly when pushing it in.

5. Connect the receiver connector P202 to the receiver port J202 for that particular axis.

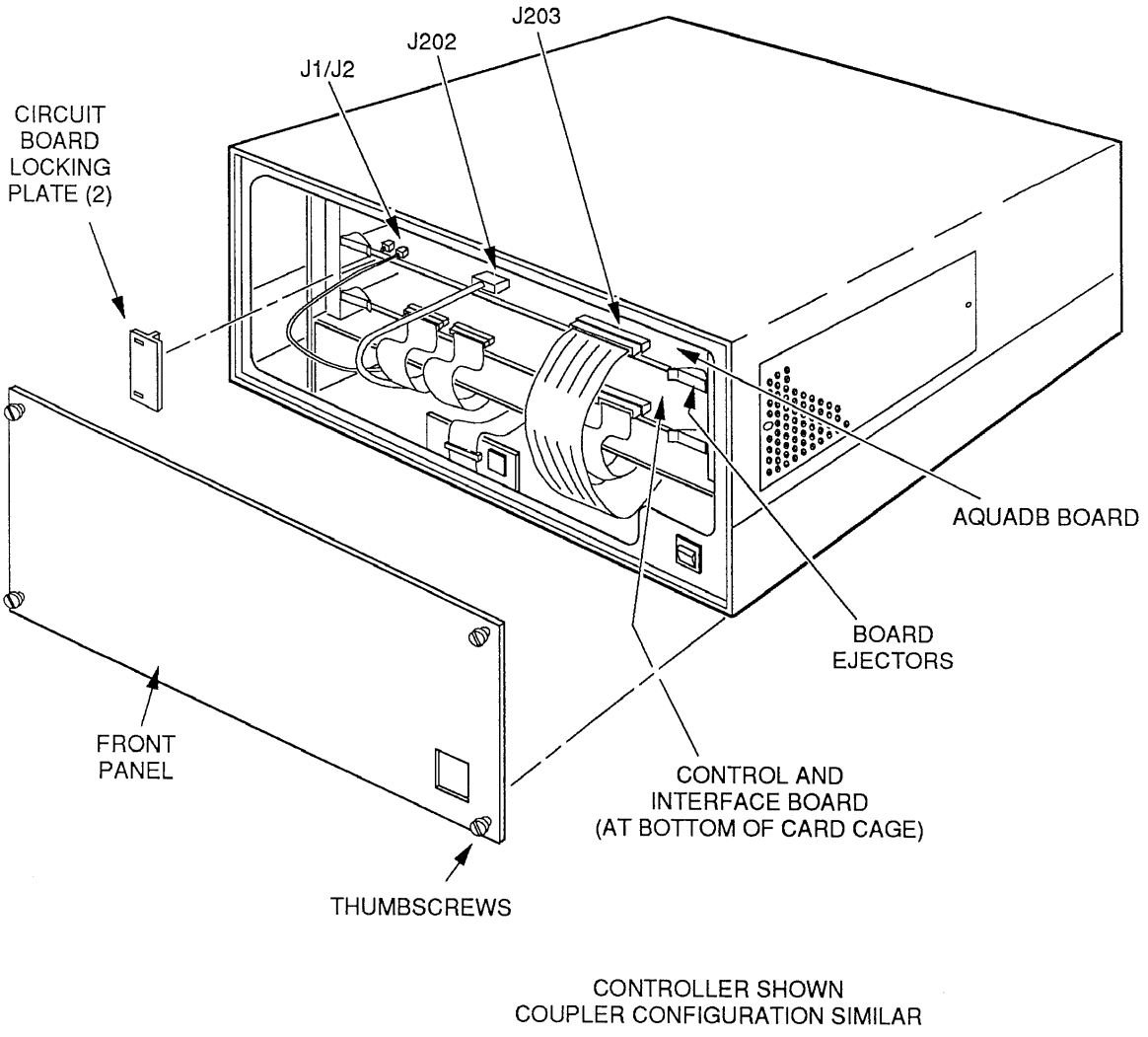
6. Connect the reference laser cable to J1 on the first axis board. If additional boards are used, connect sequential jumper cables between J2 on the first board and J1 on the next board. Every board in the series should be consecutively linked together in this fashion.

7. In the Controller based configuration, connect the axis 1, 50-pin ribbon cable, labeled P201, to J203 on the AQuadB Board. Connect additional ribbon cables for each of the other axes in the same way. In addition, attach the "AQuadB Interface" labels on the Controller back panel over the words "Servo Interface".

8. In the Coupler based configuration, a 50-pin ribbon cable is connected to J203 on the AQuadB Board. Connect additional ribbon cables for each of the other axes in the same way.

9. Reinstall the circuit board locking plates.

10. Reinstall the Controller front panel. The Coupler front panel can not be reinstalled due to the ribbon cables.



AQuadB Board Installation

Figure 4

AQUADB INTERFACE

The AQuadB Interface is used to connect the ZYGO 2/20 system to machine controls that require micrometer or microinch pulsed feedback. The measurement data is accessed via a 50-pin, flat ribbon connector at the edge of the AQuadB Board and output as AQuadB or Up/Down pulses. All signals are RS-422 compatible output (differential TTL output).

In a Controller based configuration, the AQuadB Interface is accessed at one of two locations: The Controller back panel (through D-type, 50-pin connectors for each axis) or at each AQuadB Board J203 connector. In a Coupler based configuration, the AQuadB Interface is accessed at each AQuadB Board J203 connector. AQuadB and Up/Down output use the same signal lines, switched via a jumper (JN12).

The key features of the AQuadB Interface are summarized here:

- The AQuadB pulses are made up of two signals: A and B. A and B signals are quadrature pulses. The lead/lag relation of these signals indicates axis direction. The output associated with directional movement may be switched via a jumper (JN12). An additional signal, Zout, serves as a marker signal for the machine control. The Z(out) signal is generated from a Zin signal from the user's equipment. Refer to Figure 5.

- The Up/Down pulses are made up of two signals: Up and Down. Only one signal pulses with unidirectional motion; the other is set low. A change in direction is indicated when the pulses switch to the other signal. The output associated with directional movement may be switched via a jumper (JN12). Four Up/Down pulse wavelengths are equivalent to one AQuadB pulse wavelength. If required, the Up/Down pulses can be output with the Zout index signal. Refer to Figure 5.

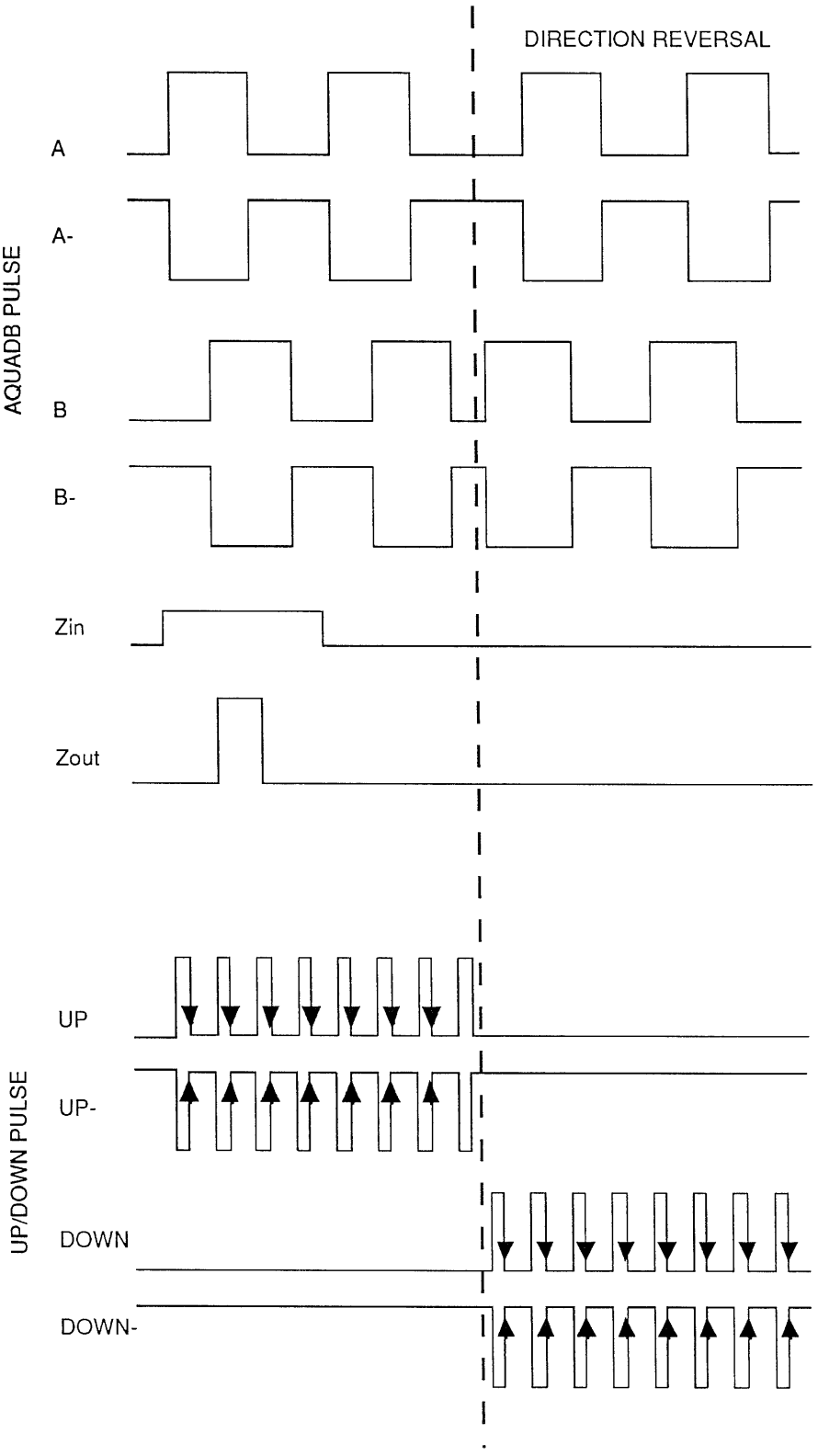
- The measurement information is output as scaled and compensated pulses in metric or English resolution units. The resolution units are user selectable via the Diagnostician or a host computer; this unit must be greater than or equal to 0.0025 micrometer (metric) or 0.1 microinch (English). The relationship between the resolution unit and the pulsed output is shown in Figure 6.

- The maximum frequency output rate of the pulses is jumper selectable (JN13). The are are five rates available for the AQuadB and Up/Down output. At each setting, the pulse output rate will not exceed the preset value even if the motion velocity exceeds the maximum allowance for the given resolution. This feature matches the output to the requirements of the machine control. The frequency output also affects the response time. This data is summarized in Table 1.
- The user may trade off resolution for velocity. Any decrease in the resolution requirements will yield a proportional increase in the maximum velocity. The frequency of the output may be limited by the user's choice of resolution and velocity. Velocity and resolution trade-off AQuadB output is shown in Figure 7.

AQuadB Rate	Up/Down Rate	Response Time all axes
1.25 MHz	5.0 MHz	1 µs
625 kHZ	2.5 MHz	2 µs
312.5 kHz	1.25 MHz	4 µs
156.25 kHz	625 kHz	8 µs
78.125 kHz	312.5 kHz	16 µs

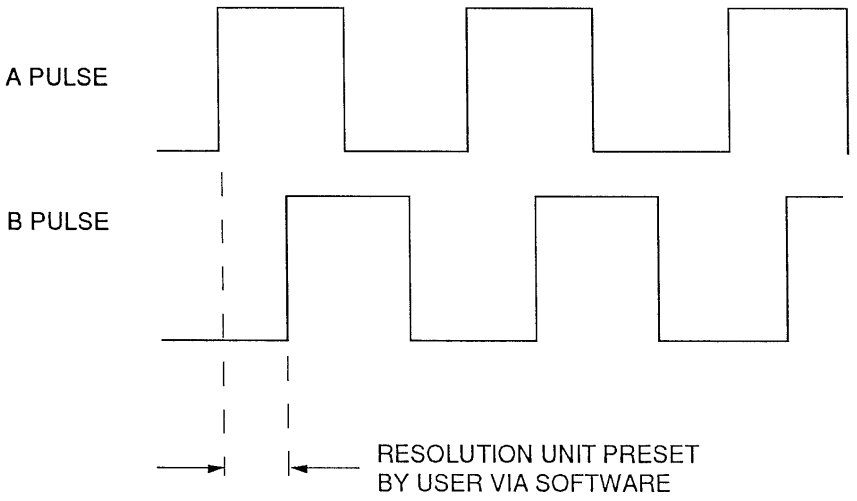
Output Rate and Response Time

Table 1

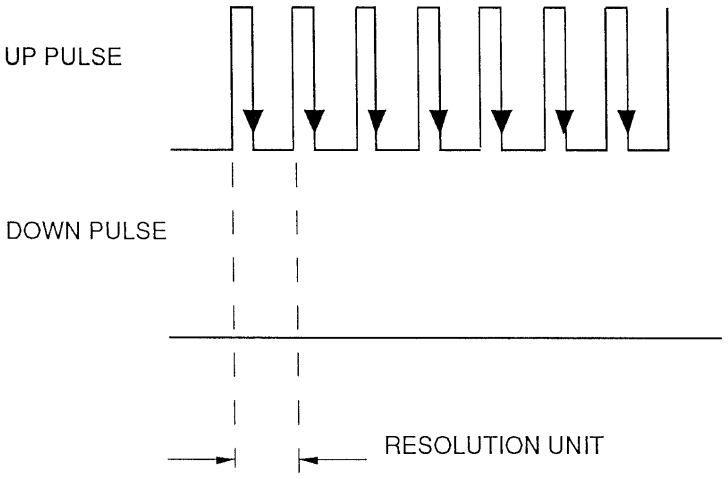


AQuadB Output

Figure 5



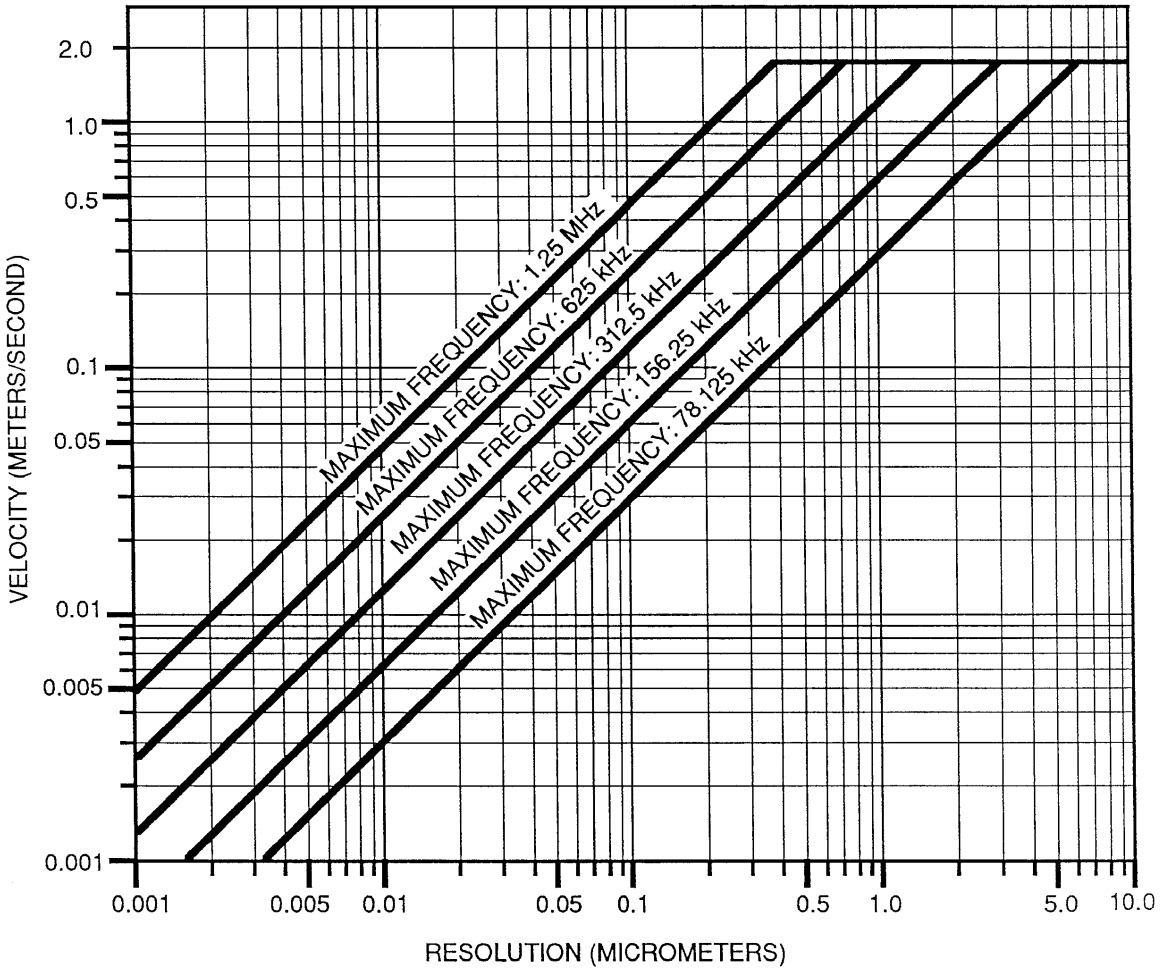
EACH TRANSITION OF A OR B REPRESENTS ONE RESOLUTION UNIT.
PULSE B LEADS A WHEN MOTION IS IN THE OPPOSITE DIRECTION .



EACH PULSE COUNT REPRESENTS ONE RESOLUTION UNIT.
UP/DOWN SIGNALS REVERSE WITH DIRECTION CHANGE
(UP PULSE LOW AND DOWN PULSE COUNTS).

Resolution Unit

Figure 6



The sloped lines on the graph represent the five user selectable frequency output choices, as selected via jumper JN13. As shown above, the AQuadB resolution and velocity are inversely proportional. The frequency output may be limited by the user's choice of resolution and velocity.

Each line represents the frequency of the "A" and "B" signal during AQuadB output. There are four resolutions units in each complete cycle.

Resolution and Velocity Trade-off

Figure 7

AQuadB Board Settings

The AQuadB Board is factory set for:

- Proper address for each individual axis, if a complete system is purchased with circuit boards installed.
- AQuadB output format with Zout positioned when both A and B are high.
- Maximum frequency AQuadB output rate of 1.25 MHz.

Figure 8 shows the location of the jumpers that control the interface settings of the AQuadB Board. Listed below are the user selectable jumpers and the function of each.

WARNING!

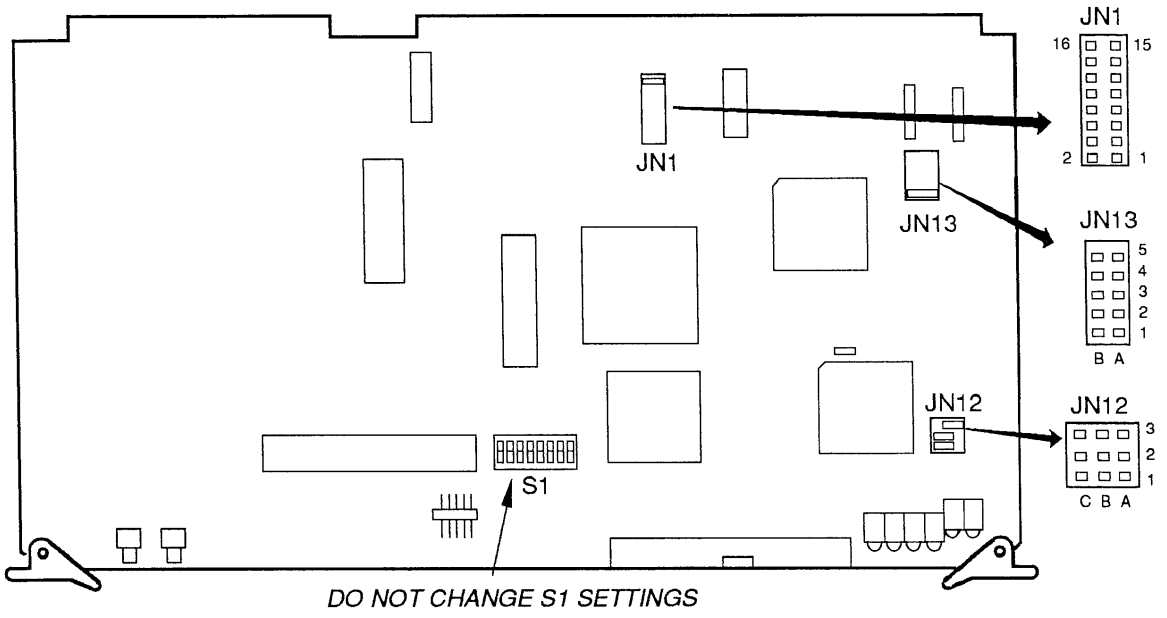
Do not change the factory settings of S1 DIP switch; changing settings will corrupt measurement data. Do not change the position of any jumper without referring to this section.

JN1: Selects the AQuadB Board Address as shown in Table 2.

JN12: Selects the output mode and the position of the Zout signal. The are are four modes: AQuadB, Up/Down, reverse AQuadB,and reverse Up/Down. The Zout signal may be synchronized to the pulses in one of two ways: when A and B are high, and at the first available quadrant (the first quarter that comes along). Refer to Figure 9.

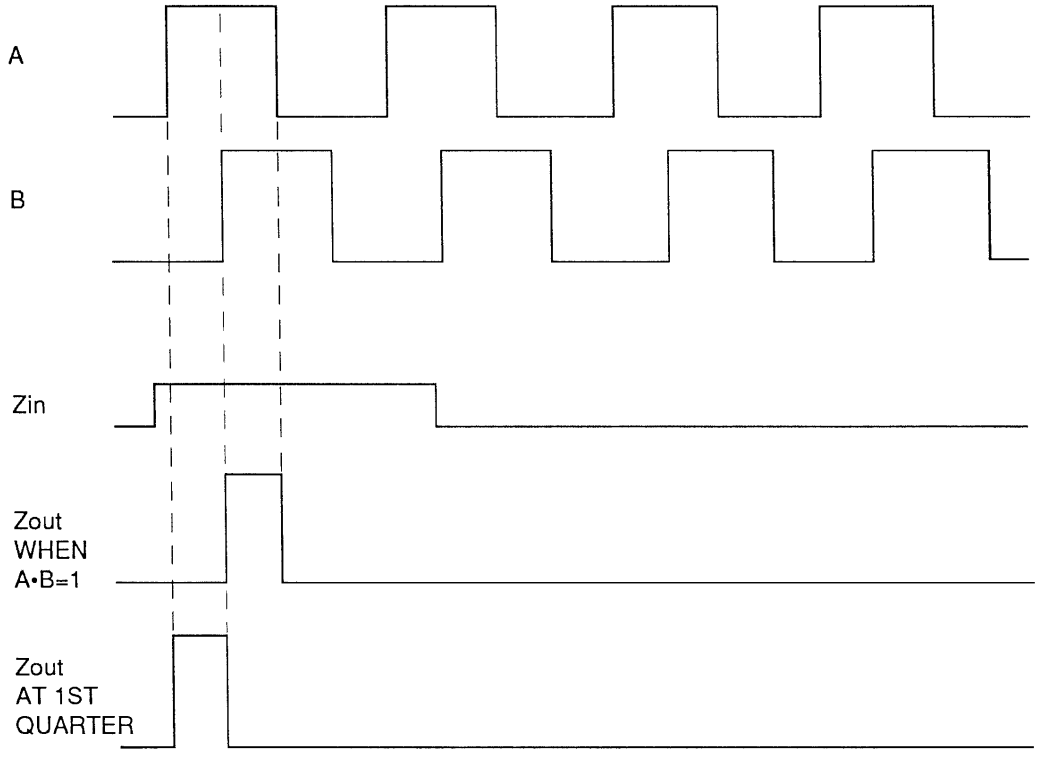
JN13: Selects the maximum output data frequency.

Table 2 provides a comprehensive listing of the factory settings for all the jumpers on the AQuadB Board.



AQuadB Board - Jumper Locations

Figure 8



Zout Synchronization

Figure 9

Jumpers - Factory Settings

Jumpers with only 2 pins are designated IN or OUT.

Jumper	Pins	Jumper	Pins
JN1	see below	JN8	1-2
JN2	IN	JN9	2-3
JN3	no jumper	JN10	9-10, 11-12, 13-14, 15-16
JN4	7-8	JN11	no jumper
JN5	none	JN12	see below
JN6	2-3	JN13	see below
JN7	1-2		

JN1 Settings - Address Selection

Axis	Pins	Base Address
*1	15-16	FE0000
2	13-14	FE0040
3	11-12	FE0080
4	9-10	FE00C0
5	7-8	FE0100
6	5-6	FE0140

JN12 Settings - Output Mode Selection

Jumper Positions	J203 pins 23/25	J203 pins 27/29	J203 Zout pins 33/35
*B1-C1 B2-C2 B3-C3	A out	B out	when A*B=1
B1-C1 B2-C2 A3-B3	B out	A out	when A*B=1
B1-C1 A2-B2 B3-C3	Up	Down	when A*B=1
B1-C1 A2-B2 A3-B3	Down	Up	when A*B=1
A1-B1 B2-C2 B3-C3	A out	B out	at any 1st quarter
A1-B1 B2-C2 A3-B3	B out	A out	at any 1st quarter
A1-B1 A2-B2 B3-C3	Up	Down	at any 1st quarter
A1-B1 A2-B2 A3-B3	Down	Up	at any 1st quarter

JN13 Settings - Frequency Output Selection

Pins	AQuadB Rate	Up/Down Rate
*1A-1B	1.25 MHz	5.0 MHz
2A-2B	625.0 kHz	2.5 MHz
3A-3B	312.5 kHz	1.25 MHz
4A-4B	156.25 kHz	625.0 kHz
5A-5B	78.125 kHz	312.5 kHz

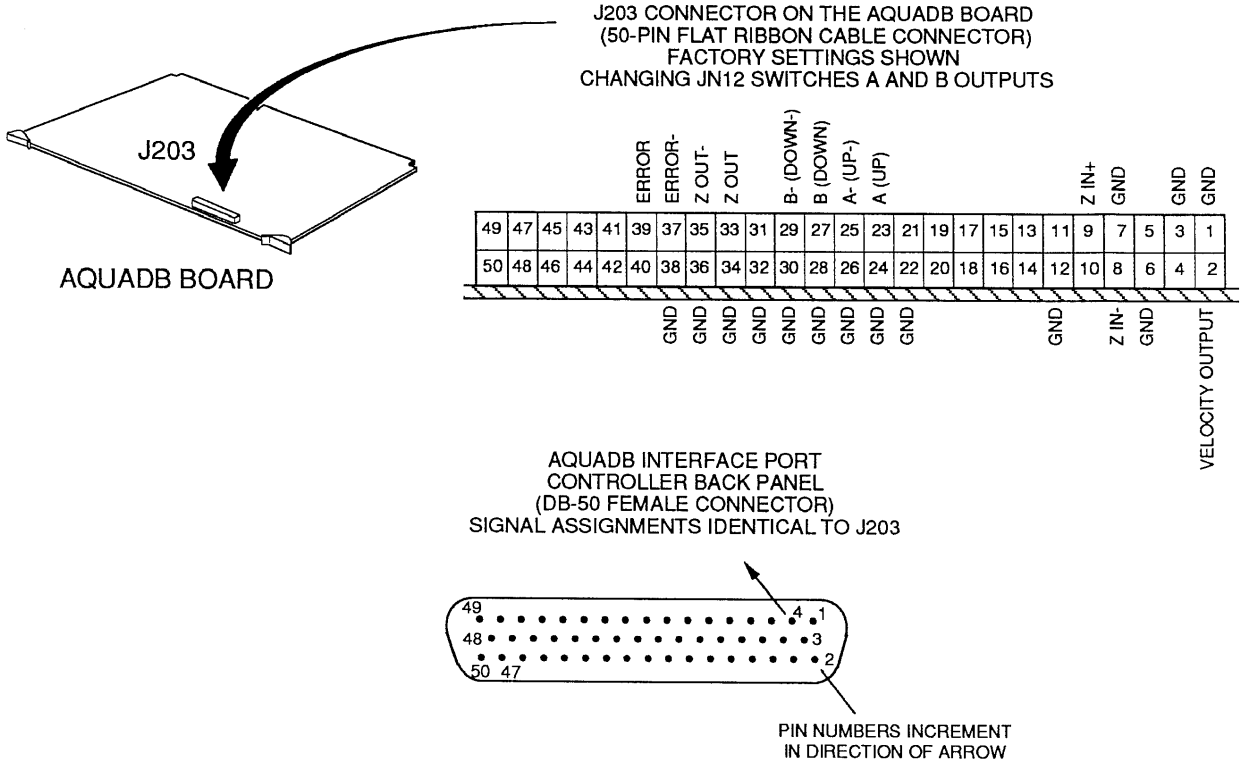
* Denotes the factory settings for JN1, JN12, and JN13.

AQuadB Board Jumper Settings

Table 2

AQuadB Signals

Refer to Figure 10 for AQuadB Interface connector detail and signal assignment. All AQuadB output signals are dual polarity driven signals (differential output) to protect against noise interference. The Zout is generated from an input signal Zin, which originates at a device located on the user's machine to define the zero point. The Zout signal is synchronized to the A and B (or Up and Down) outputs by the AQuadB Board. The Zout can be set so that the signal is true when both A and B are true, or at the beginning of the next quadrant. Outputs and input signals conform to RS-422 specifications. Refer to Table 3 for a summary of the AQuadB Interface Signals.



AQuadB Interface Connector and Signal Assignment

Figure 10

Signal	Input Output	Standard Pin #	Reverse (1) Output Pin #
A or Up	output	23	27
A- or Up-	output	25	29
B or Down	output	27	23
B- or Down-	output	29	25
Zout	output	33	-
Zout-	output	35	-
Error	output	39	-
Error-	output	37	-
Zin	input	9	
Zin-	input	8	
Velocity	output (analog)	2	-
Ground	-	1,3,6,7,12,22,24,26,28,30,32,34,36,38	

(1) Reverse output indicates the signals output when JN12 is changed to reverse the sign convention. All other pin numbers are the same.

AQuadB Signals

Table 3

AQuadB Signal Description

A/B Two square wave differential TTL outputs quadrature to each other. The phase relationship between A and B is indicative of the direction of motion. Every logic level transition of the A and B outputs represents a displacement of one resolution unit going by. A and B output may be interchanged by changing jumper JN12 position to yield the required convention between motion direction and phase relationship of the outputs.

Up/Down Two differential TTL pulse outputs. Each Up pulse represents a displacement of one resolution unit in one direction, while each Down pulse represents a displacement in the opposite direction. The Up and Down pulses may be interchanged by changing jumper JN12 position to yield the required convention between motion direction and Up/Down outputs.

Up and Down are pulses of positive polarity. The minimum pulse width is 100 nanoseconds when the maximum frequency of 5 megahertz is selected. The pulse width increases by a factor of two for each subsequent decrease in the maximum pulse frequency (as selected by JN13).

Zin A TTL differential positive pulse input, the positive transition of which determines the axis zero position. The positive transition of Zin is detected by the AQuadB Board and is used to generate a Zout signal or zero marker pulse for the machine tool controller. The minimum pulse width of Zin has to be greater than 200 nanoseconds when the maximum frequency is selected. The minimum pulse width requirement increases by a factor of two for each subsequent decrease in the pulse frequency (as selected by JN13).

Zout A TTL differential positive pulse output initiated by Zin and synchronized to the A/B outputs. The pulse width of Zout equals exactly one resolution unit (one quarter of the A or B signal period). There are two output modes of Zout as determined by the position of jumper JN12: output in the next quarter of A and B following the rising edge of Zin or output in the first quarter when A and B are high.

Error A TTL differential logic level output. When high it signals the machine tool controller that an error condition has occurred. The Error line goes high whether an axis hardware error condition is detected by the AQuadB Board or a software or system error is detected by the ZYGO 2/20 firmware.

Velocity An analog voltage output that is proportional to the motion velocity of the measured object. The Velocity Output is designed to be used as velocity feedback to a machine control. The linear voltage range is + 9 volts and is scaled to 0.06 V/cm/sec (volts/centimeter/second) for a single pass interferometer or 0.12 V/cm/sec for a double pass interferometer. Refer to OMP-0220, Chapter 5, for a figure representing this relationship.

OPERATION

For general operation and programming information, and host computer control of the ZYGO 2/20, refer to the ZYGO 2/20 Operation and Reference Manual, OMP-0220, Chapter 6.

Setup Guidelines:

- On power-up the ZYGO 2/20 retrieves setup information stored in non-volatile memory (NVM) on the C/I Board. If the setup parameters have been entered previously by the user, the AQuadB option can start generating pulses when the laser becomes stable.
- Turn off AQuadB operation mode before configuring the setup or the output pulses will be corrupted. Use the **MODE0 1<cr>** command with the Diagnostician AQuadB Monitor and the **A31 0 1 <terminator>** command with a host computer.
- Store the system parameters in NVM after the setup table has been modified. From this time on, the ZYGO 2/20 will power-up with the desired parameters. Use the **STORE<cr>** command with the Diagnostician AQuadB Monitor and the **= <terminator>** with a host computer.

Operation Guidelines:

WARNING!

When the laser is unstable, do not use the Diagnostician or host computer to command the ZYGO 2/20 or the system will crash. This prevents inaccurate data from being sent to the controller during warm-up.

- Pulse generation is automatically enabled at power-up when the system has been properly configured with setup information and the laser has stabilized.
- Pulses are disabled and the error signal enabled when the software detects AQuadB or RIM errors.
- On power-up pulses are *not* output from the ZYGO 2/20 until the laser is stabilized. The host computer should not issue any commands other than ";" (laser stability report), and the Diagnostician should not issue any commands other than selecting a monitor that has a laser stability indicator such as the Axes Monitor or AQuadB Monitor.
- For ZYGO 2/20 commands to execute properly the following conditions must be true:

  1) The reference signal must be present. The red "REF" AQuadB Board LED should be lit. (The laser signal cable should be connected at J1 on the AQuadB Board.)

  2) The measurement signal must be present. The red "MEAS" AQuadB Board LED should be lit. (The receiver cable should be connected at J202 on the AQuadB Board and the receiver green LED should be lit.) For testing purposes, the measurement signal may be obtained by placing the AQuadB Board into the test mode. To enable the test mode use the **V[n]** host command or the **TE[n]** Diagnostician Axis monitor command. To disable the test mode use the **H[n]** host command or the **CL[n]** Diagnostician Axis monitor command.

  3) AQuadB sampling must be enabled. The AQuadB sampling is enabled automatically upon power-up after the laser becomes stable. To enable AQuadB sampling use the **A124[n]** host command.

AQuadB/RIM Preparation

Before using the AQuadB or RIM option, the user must know the application requirements. These requirements are highlighted in the hypothetical system as detailed below. This information will be extracted and used in two sample setup sessions, one with a host computer, and the second with the Diagnostician. Application requirements are entered during setup and and stored in memory for future use.

Hypothetical system:

Axis 1 AQuadB measurement using a Differential Plane Mirror Interferometer (DPMI) with F_2 as the measurement beam, the dead path distance is 96.2 millimeters, and no calibration is necessary.

Axis 2 AQuadB measurement using a Linear Interferometer with F_1 as the measurement beam, the dead path distance is 14.3 millimeters, and a calibration factor of 0.996 to compensate for a fixed cosine error.

Axis 3 RIM using a Wavelength Compensator with a measurement cell length of 279.2 millimeters. The initial value of the refractive index of air as determined from a lookup table is 1.00026; the acceptable change in the refractive index of air is ± 0.00004. The base of the Wavelength Compensator is mounted parallel to the base of the Laser Head.

Other criteria The machine control requires a resolution of 0.005 micrometers and output no faster than 750 kilohertz. Because of changing environmental conditions it is recommended to have real-time wavelength compensation.

Note:

Prior to entering these parameters into NVM, the user must know: the dead path distance for each AQuadB axis, if the dead path is zero, negative, or positive; if F_1 or F_2 is used as the measurement beam; if the interferometer is a single, double, or four pass interferometer; and if the Wavelength Compensator sign is minus or plus. Without this information the AQuadB/RIM setup will be inaccurate. Guidelines for determining these characteristics are provided on the next page.

Guidelines for determining AQuadB parameters:

1. To determine the dead path distance for each AQuadB axis the user must calculate the difference between the measurement path and the reference path. Refer to OMP-0220, Chapter 11, the section titled "Dead Path Error", for a complete explanation of dead path and how to determine this distance.

2. To determine if the deadpath is positive or negative use the Diagnostician Axes Monitor. When movement is away from the interferometer and the counts are positive, use positive; when the counts are negative, use negative.

3. To determine if the axis measurement path (Lambda) is F_1 or F_2 use the Diagnostician Axes Monitor. When movement is away from the interferometer and the counts are positive, use F_2; when the counts are negative use F_1. Refer to OMP-0220, Chapter 10, Table 10-1.

4. All of Zygo's interferometers are double pass except the Linear Interferometer.

5. If using a Zygo Wavelength Compensator, set the "sign" parameter as minus if the base of the Wavelength Compensator is parallel to the base of the Laser Head. If the compensator base is perpendicular to the laser base, use plus.

Table 4 shows a comparison listing of the common Diagnostician Commands and the host computer commands.

Diagnostician Command	Host Computer Command
MODE	A31
UNITS	A38
TYPE	A30
STORE	=
FETCH	I3
START	A120
PASS	A36
AQuadB commands:	
RESOLUTION	A32
CALIBRATION	A33
DEAD PATH	A34
DRIM	A35
LAMBDA	A37
RIM commands:	
LOW LIMIT	A33
HIGH LIMIT	A32
CELL LENGTH	A34
IRIM	A35
SIGN	A37

Similarity Between Diagnostician and Host Commands

Table 4

Host Software Control

The AQuadB option requires that system parameters (resolution unit, dead path distance, calibration factor, and RIM) for each AQuadB measurement axis be entered into NVM. This may be accomplished through a host computer or the Diagnostician terminal. The host commands that support this function are called Group 4 AQuadB and RIM Commands.

Note:

Host computer command groups 1, 2, and 3 must also be used with the AQuadB option for normal operation; group 4 commands exclusively support the setup and debugging of the AQuadB and RIM options.

Group 4 Commands are comprised of seven command sets: A3x, A6x, A9x, A12x, A15x, A18x, and A21x. The most commonly used sets are A3x for entering user parameters and A9x for reading user parameters. In addition, commands A150, A180, and A210 are frequently used. Most of the other command sets and commands are used for nonoperational AQuadB testing; these commands should be used only by the advanced user.

AQuadB commands may be entered through either the IEEE-488 Interface or the RS-232 Interface. Once the system parameters are entered and stored into memory, the ZYGO 2/20 can operate as a standalone unit without the need for a computer to command its every function.

Note:

All information on controlling the ZYGO 2/20 with a host computer is located in the ZYGO 2/20 Operation and Reference Manual, OMP-0220, Chapter 6. AQuadB commands are fully described in the ZYGO 2/20 Operation and Reference Manual, OMP-0220, Chapter 12; these commands are summarized in Appendix A of this manual. Entering AQuadB system parameters from the Diagnostician is described in the section entitled "AQuadB Setup using the Diagnostician".

AQuadB Setup with a Host Computer

This section shows a typical use of a host computer to set up the AQuadB option with user selectable parameters (the application requirements are described in the "AQuadB/RIM Preparation" section) and then save the setup information in memory. All commands must be followed by the proper terminator. Refer to the guidelines in the "AQuadB/RIM Preparation" section for information on dead path, pass, lambda, and sign. The same results may be obtained using the Diagnostician.

1. Connect the ZYGO 2/20 electronics to the machine control and the host computer using the RS-232 or GPIB interface. Configure the two AQuadB Boards as axis 1 and 2, and the Measurement Board as axis 3.

2. Install and align the optical components.

3. Check the position of the jumper settings on both AQuadB Boards:
   a. JN1 should be set for the proper address.
   b. JN12 should be set for the desired output mode. Position JN12 (B1-C1, B2-C2, B3-C3) for AQuadB output when A*B=1.
   c. JN13 should be set for the desired frequency output. Position JN13 (2A-2B) for a maximum output of 625 kHz.

   Refer to the section titled "AQuadB Board Settings".

4. Turn on and warm-up the ZYGO 2/20 and the computer; wait for the Laser Head to stabilize. The laser condition may be monitored by sending the **;** command from the host computer. (There is a ready indicator light on the Laser Head.)

5. Set up common system parameters by sending the following commands over the host interface:
   a. **A31 0 1** [sets all axes (0) to off (1)]
   b. **A38 2** (It may not be necessary to use this command as the factory setting is metric, using this command may set the system to English)

6. Set up axis 1 by sending the following commands:
   a. **A30 1 2** [sets axis 1 as AQuadB type (2)]
   b. **A32 1 .005** (sets axis 1 resolution to .005 µm)
   c. **A33 1 1** (sets axis 1 calibration to 1.0)
   d. **A34 1 96.2** (enters axis 1 dead path of +96.2 mm)

e. **A35 1 1.00027** (enters a default RIM of 1.00027 for axis 1, this value will be used if the Wavelength Compensator is not used)
f. **A36 1 2** [identifies axis 1 interferometer as a double pass (2)]
g. **A37 1 2** [identifies axis 1 measurement path as F2 (2)]

7. Set up axis 2 by sending the following commands:
   a. **A30 2 2** [sets axis 2 as AQuadB type (2)]
   b. **A32 2 .005** (sets axis 2 resolution to .005 μm)
   c. **A33 2 .996** (enters axis 2 calibration factor of .996)
   d. **A34 2 14.3** (enters axis 2 dead path of +14.3 mm)
   e. **A35 2 1.00027** (enters a default RIM of 1.00027 for axis 2, this value will be used if the Wavelength Compensator is not used)
   f. **A36 2 1** [identifies axis 1 interferometer as a single pass (1)]
   g. **A37 2 1** [identifies the measurement path as F1 (1)]

8. Set up axis 3 by sending the following commands:
   a. **A30 3 3** [sets axis 3 as RIM type (3)]
   b. **A32 3 1.00022** [sets axis 3 lowest acceptable index to 1.00022 (1.00022 = 1.00026 - .00004)]
   c. **A33 3 1.00030** [sets axis 3 highest acceptable index to 1.00030 (1.00030 = 1.00026 + .00004)]
   d. **A34 3 279.2** (enters axis 3 measurement cell length of 279.2 mm)
   e. **A35 3 1.00026** (sets axis 3 initial refractive index value to 1.00026)
   f. **A36 3 2** [identifies axis 3 interferometer as a double pass (2)]
   g. **A37 3 1** (sets axis 3 as minus, since the base of the compensator is parallel to the base of the laser)

9. Turn on the AQuadB functions for continuous compensation by sending **A31 0 3** [(sets all axes (0) to continuous mode (3)]

10. Save the above user parameters by sending **=**. The setup is now stored in NVM; from now on at power-up the AQuadB output will automatically start as soon as the laser becomes stabilized. Wait approximately one minute for the laser to restabilize.

Sample AQuadB Operations

Once the laser beam is stable, AQuadB pulses will be output by the AQuadB Board. No other actions are necessary to output pulses to a machine controller. However, some user's may desire to perform additional types of system control from a host computer connected to the ZYGO 2/20. Examples of three operations from a host computer are provided.

Clear (zero) the accumulator on an AQuadB Board (stage stationary)

Command	Function
T1	Disable axis 1 accumulator. The accumulator stops counting but is not cleared (value will not change).
A180	Disable all AQuadB (output only - not sampling).
H1	Reset axis 1 accumulator; this clears the accumulator to zero and resets the status register.
-	Wait 1 to 16 microseconds to allow hardware multiplication; refer to Table 1 on page 15.
A120 1	Strobe axis 1 dead path (this loads dead path).
A180	Enable all AQuadB (output only - not sampling); sampling is already enabled.
R1	Enable axis 1 accumulator (starts counting).

Preset the accumulator on an AQuadB Board (stage stationary)

Command	Function
T1	Disable axis 1 accumulator. The accumulator stops counting but is not cleared (value will not change).
A180	Disable all AQuadB (output only - not sampling).

S1 12abc	Preset axis 1 accumulator with a compensated distance value. Sampling must be enabled so that the multiplication will use the value in the accumulator.
-	Wait 1 to 16 microseconds to allow hardware multiplication; refer to Table 1 on page 15.
A120 1	Strobe axis 1 dead path (this loads dead path).
A180	Enable all AQuadB (output only - not sampling); sampling is already enabled.
R1	Enable axis 1 accumulator (starts counting).

Read the accumulator on an AQuadB Board (stage stationary or moving)

Command	Function
-	Ensure that the accumulator is enabled when the stage is moving, otherwise counts will be missed. Command R1 enables axis 1 accumulator.
A123 1	Disable AQuadB output and sampling. Latching the accumulator now will not interfere with AQuadB pulses. AQuadB sampling now will not interfere with the reading of the accumulator.
J1	Latch axis 1 accumulator.
D1	Read axis 1 accumulator.
A124 1	Enable AQuadB output and sampling. Latching now will interfere with the generation of AQuadB pulses. AQuadB sampling now will interfere with the reading of the accumulator.

Diagnostician AQuadB Monitor

The Diagnostician is a diagnostic set-up and monitoring tool specially designed for the ZYGO 2/20 system. The Diagnostician includes an AQuadB Monitor, which is useful for setting up the AQuadB option and troubleshooting.

This section provides a *brief* overview of the Diagnostician AQuadB Monitor and its Menu Screens. It also includes an AQuadB setup example using the Diagnostician.

Note:

To use the AQuadB Monitor, or any one of the Diagnostician monitors, a VDT terminal must be connected to the ZYGO 2/20. Chapter 5 of OMP-0220 describes how to connect a Diagnostician terminal.

All information on the Diagnostician is located in OMP-0220, Chapter 7.

For help on using the Diagnostician AQuadB option, refer to the ZYGO 2/20 Diagnostician Help Monitor (pages 12 and 13 for an on-line listing of the Group 4 host computer commands and page 15 for an on-line listing of error codes).

The AQuadB Monitor supports both the AQuadB option and the RIM function; it is used to set up a customized interface with user selected parameters, to verify these selections, and to actively monitor AQuadB and RIM calculations. Enter the AQuadB Monitor by pressing **<ctl-T>** on the Diagnostician keyboard.

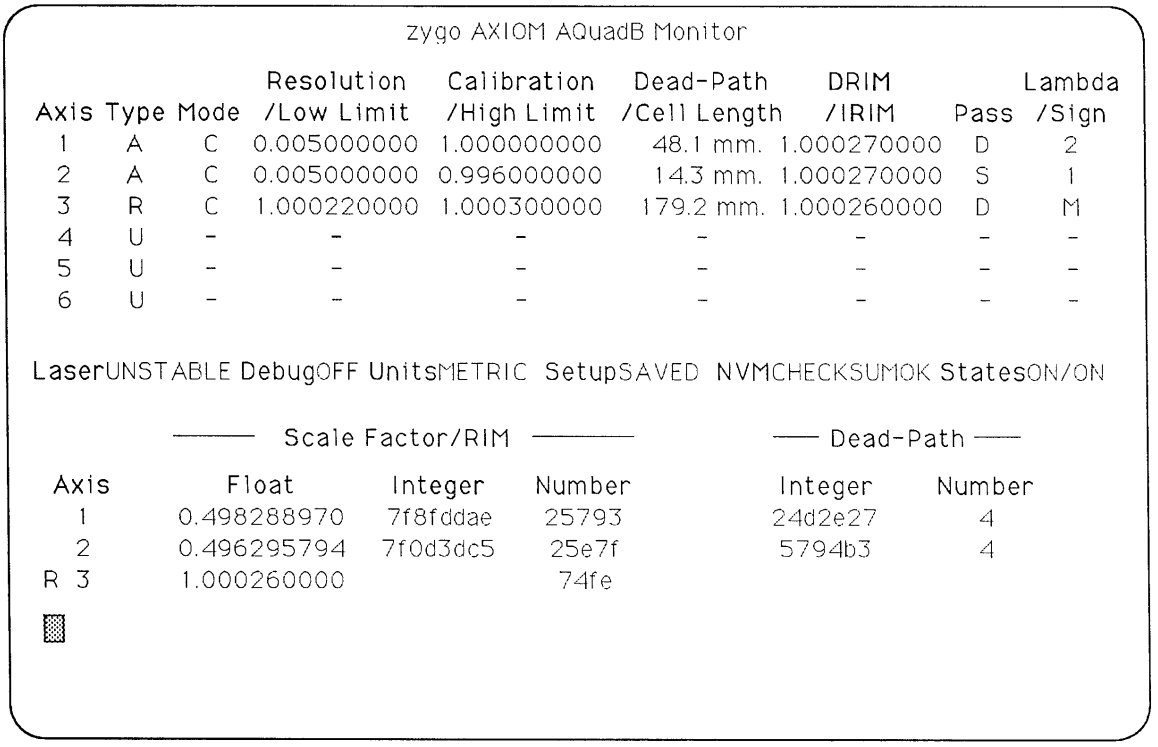
The AQuadB Monitor Display Screen is shown in Figure 11. The display screen has three main parts: the top half is used to display the user selected parameters (as input through the Diagnostician or host software commands), the bottom half serves as an active window that displays real-time calculations, and the center line dividing the two halves displays miscellaneous status information. Fields that appear after a "/" (slash) refer to the RIM function.

The AQuadB Monitor has four pages of menu screens. Common commands and user selected parameters are listed on menu page 1, specific AQuadB and RIM user selected parameters are listed on menu page 2, and hardware and debug commands are listed on menu pages 3 and 4. Most of these commands are identical in function to the commands available to the user through the host computer interface. The menu screens are shown in Figure 12. For the initial setup of the AQuadB option it is necessary for the user to enter parameters into the ZYGO 2/20 using the commands listed on menu pages 1 and 2. The hardware commands listed on menu page 3 are for nonoperational AQuadB system testing. The debug commands on menu page 4 are for use only by an ZYGO 2/20 system expert.

WARNING!

The AQuadB Monitor debug commands are designed for use by a ZYGO 2/20 system expert. Misuse of these commands may cause a system crash or corrupt data output.

See the section entitled "AQuadB Setup Using the Diagnostician" for an example showing the user parameters entered via the Diagnostician. As an alternative, the AQuadB option may be set up using a host computer and the Group 4 commands.

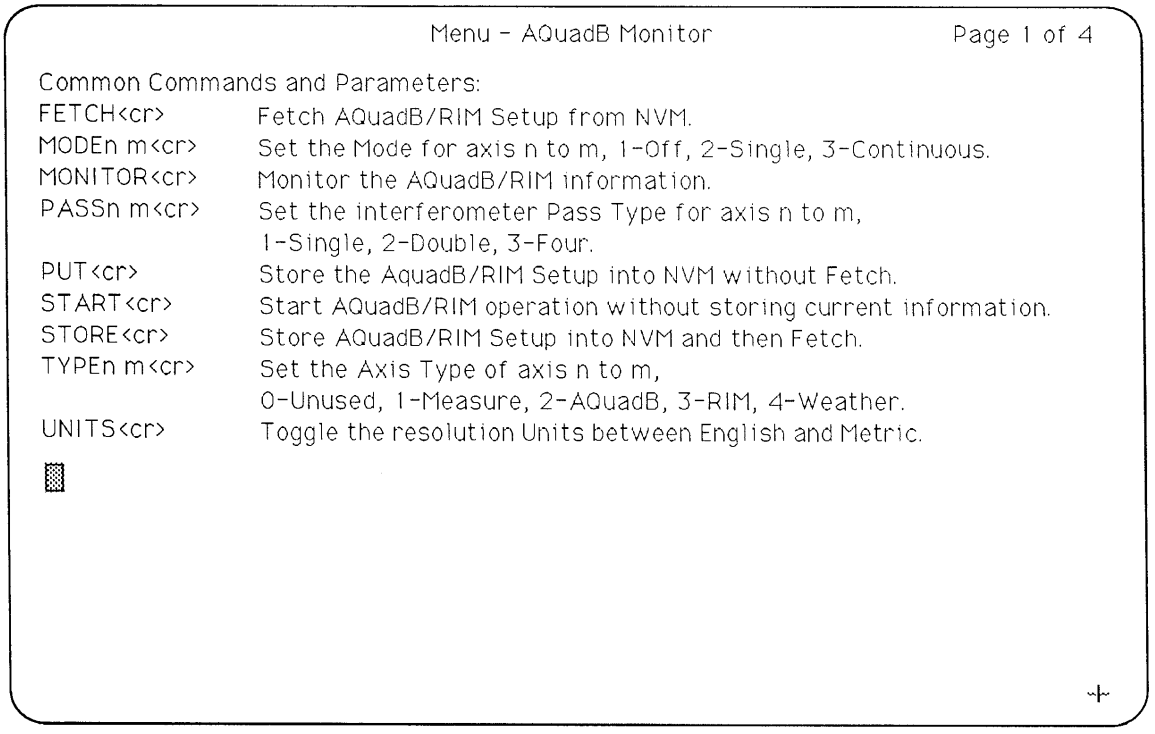


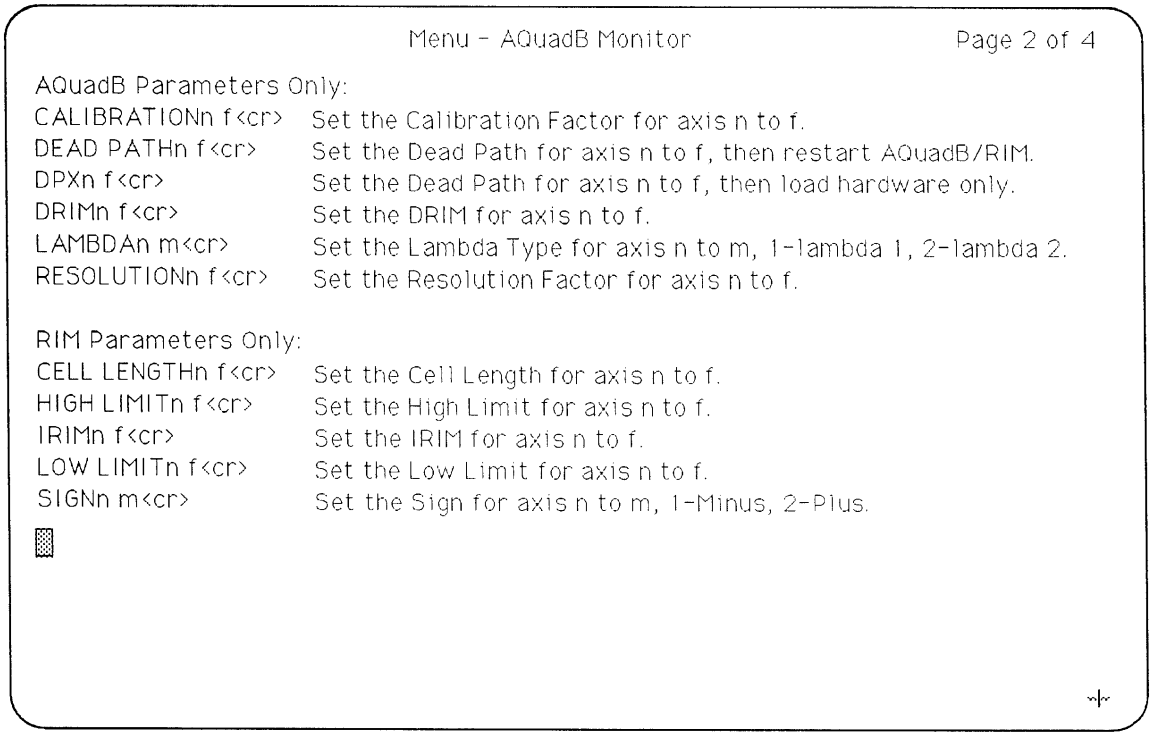
THIS MONITOR PROVIDES INFORMATION FOR BOTH AQUADB AND RIM:

- FIELDS AFTER A "/" REFER ONLY TO RIM.
- THE TOP HALF OF THE SCREEN SHOWS USER SELECTED PARAMETERS AS ENTERED VIA THE DIAGNOSTICIAN OR HOST COMPUTER, OR THAT ARE STORED IN NVM.
- THE BOTTOM HALF OF THE SCREEN IS AN ACTIVE WINDOW, IT DISPLAYS FACTORS USED IN CALCULATIONS.

AQuadB Monitor

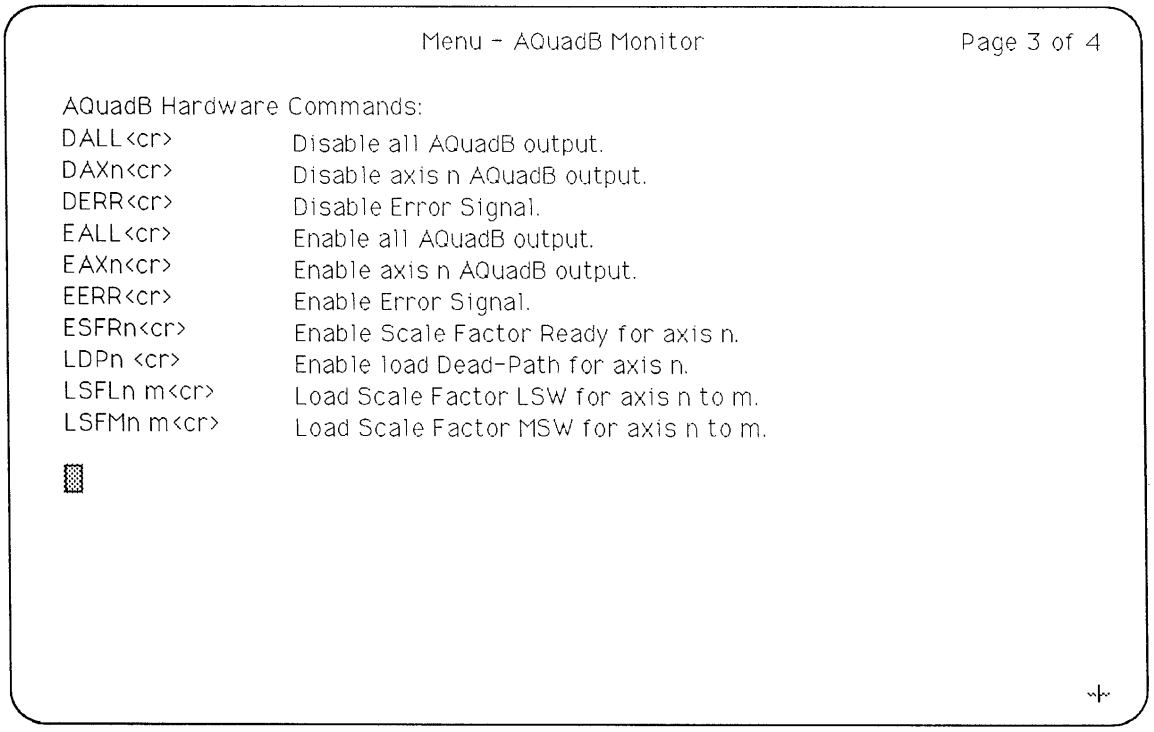
Figure 11

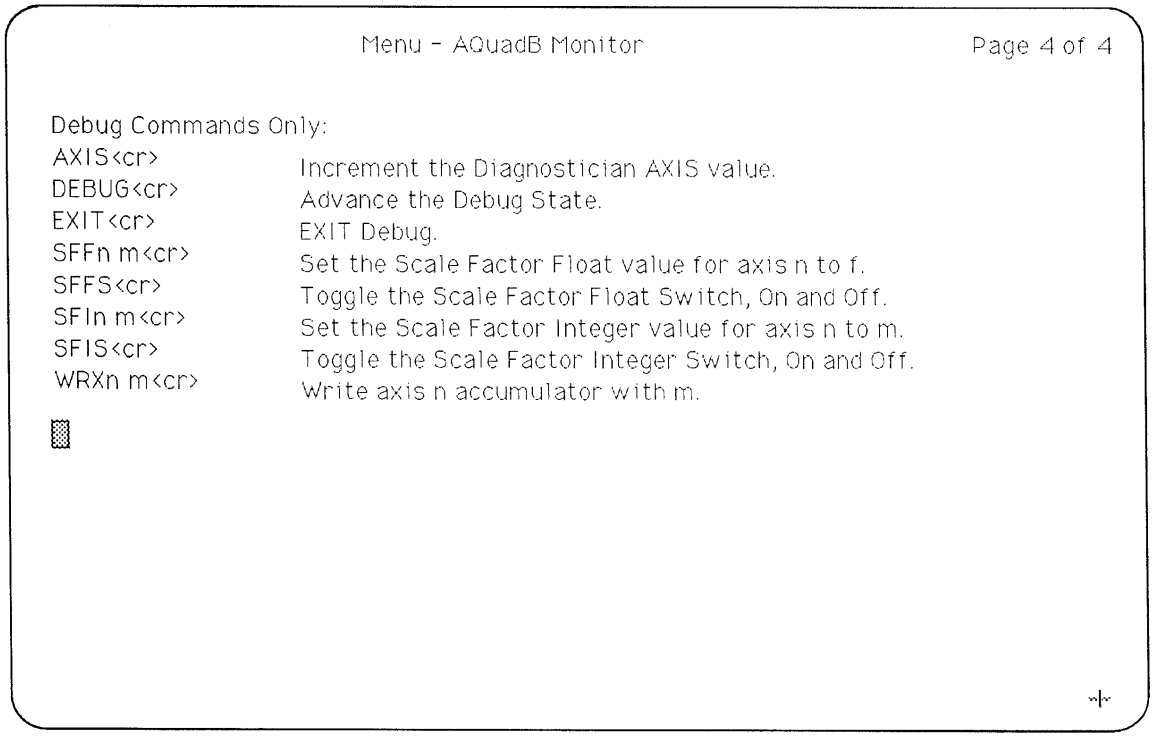




AQuadB Menus (sheet 1 of 2)

Figure 12





AQuadB Menus (sheet 2 of 2)

Figure 12

AQuadB Setup with the Diagnostician

This section shows a typical use of the Diagnostician AQuadB Monitor to set up the AQuadB option with user selectable parameters (the application requirements are described in the "AQuadB/RIM Preparation" section) and then save the setup information in memory. Refer to the guidelines in the "AQuadB/RIM Preparation" section for information on dead path, pass, lambda, and sign. The same results may be obtained using a host computer and Group 3 and 4 commands.

1. Connect the ZYGO 2/20 electronics to the machine control and a Diagnostician terminal. Configure the two AQuadB Boards as axis 1 and 2, and the Measurement Board as axis 3.

2. Install and align the optical components.

3. Check the position of the jumper settings on both AQuadB Boards:
   a. JN1 should be set for the proper address.
   b. JN12 should be set for the desired output mode. Position JN12 (B1-C1, B2-C2, B3-C3) for AQuadB output when A*B=1.
   c. JN13 should be set for the desired frequency output. Position JN13 (2A-2B) for a maximum output of 625 kHz.

   Refer to the section titled "AQuadB Board Settings".

4. Turn on and warm-up the ZYGO 2/20 and the terminal; wait for the Laser Head to stabilize. (There is a ready indicator light on the Laser Head.)

5. Enter the AQuadB Monitor by typing **<ctl-T>**; the laser is stable when the "Laser" field displays STABLE.

6. Set up common system parameters by typing the following commands:
   a. **MODE0 1<cr>** [sets all axes (0) to off (1)]
   b. **UNITS<cr>** (It may not be necessary to use this command as the factory setting is metric, using this command may set the system to English)

7. Set up axis 1 by typing the following commands:
   a. **TYPE1 2<cr>** [sets axis 1 as AQuadB type (2)]
   b. **RESOLUTION1 .005<cr>** (sets axis 1 resolution to .005 μm)
   c. **CALIBRATION1 1<cr>** (sets axis 1 calibration to 1.0)

d. **DEAD PATH1 96.2<cr>** (enters axis 1 dead path of +96.2 mm)
e. **DRIM1 1.00027** (enters a default RIM of 1.00027 for axis 1, this value will be used if the Wavelength Compensator is not used)
f. **PASS1 2<cr>** [identifies axis 1 interferometer as a double pass (2)]
g. **LAMBDA1 2<cr>** [identifies axis 1 measurement path as F2 (2)]

8. Set up axis 2 by typing the following commands:
   a. **TYPE2 2<cr>** [sets axis 2 as AQuadB type (2)]
   b. **RESOLUTION2 .005<cr>** (sets axis 2 resolution to .005 μm)
   c. **CALIBRATION2 .996<cr>** (enters axis 2 calibration factor of .996)
   d. **DEAD PATH2 14.3<cr>** (enters axis 2 dead path of +14.3 mm)
   e. **DRIM2 1.00027** (enters a default RIM of 1.00027 for axis 2, this value will be used if the Wavelength Compensator is not used)
   f. **PASS2 1<cr>** [identifies axis 1 interferometer as a single pass (1)]
   g. **LAMBDA2 1<cr>** [identifies the measurement path as F1 (1)]

9. Set up axis 3 by typing the following commands:
   a. **TYPE3 3<cr>** [sets axis 3 as RIM type (3)]
   b. **LOW LIMIT3 1.00022<cr>** [sets axis 3 lowest acceptable index to 1.00022 (1.00022 = 1.00026 - .00004)]
   c. **HIGH LIMIT3 1.00030<cr>** [sets axis 3 highest acceptable index to 1.00030 (1.00030 = 1.00026 + .00004)]
   d. **CELL LENGTH3 279.2<cr>** (enters axis 3 measurement cell length of 279.2 mm)
   e. **IRIM3 1.00026<cr>** (sets axis 3 initial refractive index value to 1.00026)
   f. **PASS3 2<cr>** [identifies axis 3 interferometer as a double pass (2)]
   g. **SIGN3 1<cr>** (sets axis 3 as minus, since the base of the compensator is parallel to the base of the laser)

10. Turn on the AQuadB functions for continuous compensation by typing **MODE0 3<cr>** [(sets all axes (0) to continuous mode (3)].

11. Save and restart AQuadB Monitor with the above user parameters by typing **STORE<cr>**. The setup is now stored in NVM; from now on at power-up the AQuadB output will automatically start as soon as the laser becomes stabilized. Wait approximately one minute for the laser to restabilize.

TROUBLESHOOTING AND SERVICE

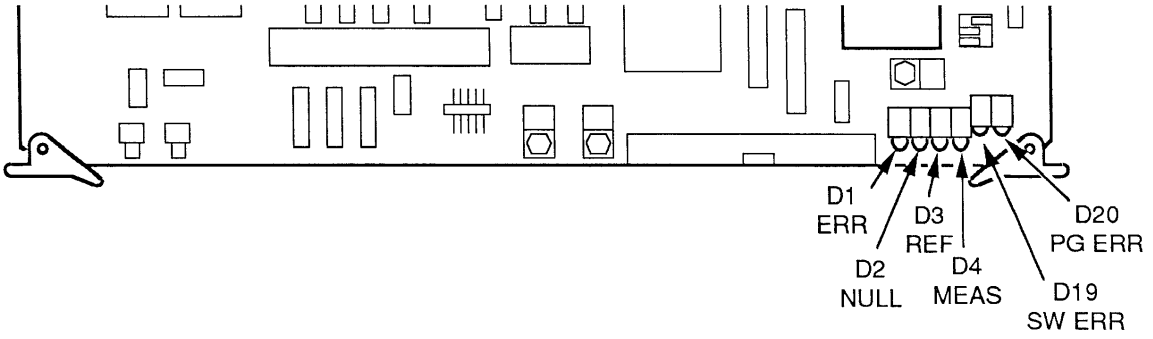
AQuadB Board Indicators

Each AQuadB Board has six indicators that display data particular to the axis to which the board is assigned. Table 5 lists the indicators and their function. Figure 13 shows the location of the indicators.

LED	Color	Indicator	Function
D1	Red	Error	Activates when a hardware detected error occurs. Errors are: accumulator overflow, velocity exceeded, lack of measurement or reference signal, and null-occurrence. Once lit, the LED is latched.
D2	Green	Null	Activates when displacement data reading is around zero or null and when the data changes from + to - or vice versa. Once lit, the LED is latched.
D3	Red	Reference	Activates when a reference signal is present from the laser head.
D4	Red	Measurement	Activates when a measurement signal is present from the receiver.
D19	Red	Software Error	Activates when a software detected error occurs. Errors are: software not ready, scale factor error, RIM range exceeded, AQuadB or RIM measurement error, AQuadB not 32-bit, RIM not 31-bit, and laser unstable. Once lit, the LED is latched.
D20	Red	LCA Not configured	Activates when the programmable logic (LCA) remains in the configure mode.

AQuadB Board LED's

Table 5



AQuadB Board Indicators

Figure 13

AQuadB Board Replacement

This procedure explains how to remove and replace an AQuadB Board in either the Controller or Coupler. For detailed information about the various jumpers, refer to the "AQuadB Interface" section. Figure 14 shows the AQuadB Board connectors.

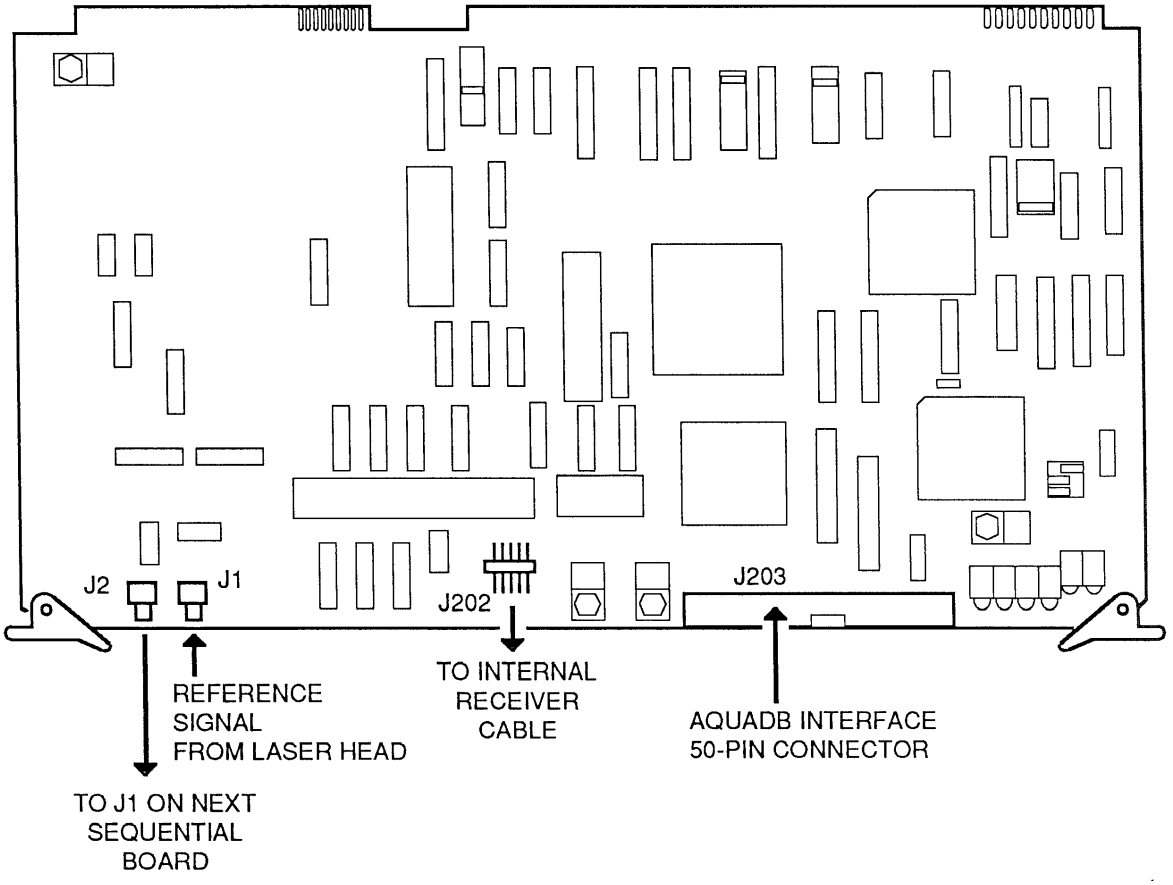
1. Loosen the thumbscrews on the front panel of the Controller or Coupler and remove the panel.
2. Remove the two circuit board locking plates, located on each side of the card cage. Each locking plate is secured with two screws.
3. Disconnect the receiver connector P202 from receiver port J202, unplug the laser signal cables from J1 and J2, and unplug the ribbon cable from J203 on the board being replaced.
4. Release the board from the card cage by grasping the board ejectors and rotating them outward, then remove the board. Reasonable force is necessary to rotate the ejectors.
5. Check the position of the jumpers (JN1, JN12 and JN13) on the replacement board. Set these jumpers to match the position of the removed board jumpers, if necessary.

6. Install the new board in the same card cage slot from which the old one was removed. Reasonable force is necessary to seat the board.

Note:

If it is difficult to seat a board in the card cage, try carefully bending the board slightly when pushing it in.

7. Reconnect the cables removed in step 3.
8. Reinstall the circuit board locking plates.
9. Reinstall the Controller or Coupler front panel.



AQuadB Board Connectors

Figure 14

Appendix A

AQuadB/RIM Host Computer Command Summary

Note:
AQuadB/RIM commands are fully described in the ZYGO 2/20 Operation and Reference Manual, OMP-0220, Chapter 12. This appendix is a *summary* of these commands.

The commands listed herein are the Group 4 host computer commands that apply specifically to the AQuadB and RIM option. Group 4 commands are divided into seven command sets: A3x, A6x, A9x, A12x, A15x, A18x, and A21x. These commands are issued by the user at a host computer and sent over the GPIB or RS-232 control interface to the ZYGO 2/20.

Groups 1, 2, and 3 commands are not listed; these commands are described in the ZYGO 2/20 Operation and Reference Manual, OMP-0220, Chapter 12. Group 1, 2, and 3 commands can be used with the AQuadB interface.

Group 4 commands are presented in the following fashion:

Axx[z]

Variable(s)

[ ] indicate optional variable(s), no brackets indicate required.
n = an axis number: 0 = all axes, 1 = axis 1, 2 = axis 2, and so on.
m = a number from a given list of options.
f = a "floating" point decimal number.

Command

Designated by the letter "A" followed by a number; organized into sets and presented in numeric order.
Group 4 commands are specific for the AQuadB option and RIM (Refractive index of Media) compensation. Many of these commands have dual functions, one for AQuadB and another for RIM.
Syntax: 1 space between the command and the 1st variable, 1 space between multiple variables.

GROUP 4 AQuadB and RIM Command Summary

A3x Commands - Use to Set Up User Parameters

A30 n m Set axis n measurement type m (0-4).
0 - Unused
1 - Standard Measurement
2 - AQuadB
3 - RIM (change in refractive index of media measurement)
4 - Weather (not available)

A31 n m AQUADB: Set axis n mode of operation m (1-3).
1 - Off (disables compensation, but not output)
2 - Single (enables compensation and loads a scale factor once at initial output)
3 - Continuous (enables real-time compensation)
RIM: Set RIM axis n mode of operation m (1-3).
1 - Off (disable RIM function, set refractive index to default)
2 - Single (enables RIM function once at initial output)
3 - Continuous (enables RIM function continuously)

A32 n f AQUADB: Set axis n resolution to f.
Metric f ≥ 0 0.0025 micrometers (enter f in micrometers)
English f ≥ 0.1 microinches (enter f in microinches)
RIM: Set axis n RIM low limit to f.
f ≥ 1.0 and ≤ RIM high limit

A33 n f AQUADB: Set axis n calibration to f.
0.0 ≤ f < 10 (acceptable format is x.xxxxxxx)
RIM: Set axis n RIM high limit to f.
f ≥ RIM low limit

A34 n f AQUADB: Set axis n dead path distance to f.
f is in millimeters (acceptable format is xxxx.xx)
RIM: Set axis n RIM measurement cell length to f.
f > 0 in millimeters (acceptable format is xxx.xx)

GROUP 4 AQuadB and RIM Command Summary

A35 n f AQUADB: Set axis n DRIM (default RIM) to f.
f ≥ 1.0 (acceptable format is x.xxxxxxxxx)
RIM: Set axis n RIM IRIM (initial RIM) to f.
f ≥ 1.0 (acceptable format is x.xxxxxxxxx)

A36 n m Set axis n to interferometer type m (1-3).
1 - Single pass interferometer
2 - Double pass interferometer
3 - Four pass interferometer

A37 n m AQUADB: Set axis n measurement beam Lambda type to m (1-2).
1 - Lambda 1 (0.632991501 micrometers)
2 - Lambda 2 (0.632991527 micrometers)
RIM: Set axis n RIM measurement sign to m (1-2).
1 - Minus
2 - Plus

A38 m Set resolution output unit to m (1-2).
1 - English
2 - Metric

A6x Commands - Use to Read AQuadB Scale Factor Parameters/TESTING

A60 n Read axis n scale factor, AQuadB only.

A61 n Read axis n wavelength unit factor, AQuadB only.

A62 n Read axis n resolution factor, AQuadB only.

A63 n Read axis n calibration factor, AQuadB only.

A64 n Read axis n RIM, RIM only.

A9x Commands - Use to Read User Parameters

A90 n Read axis n axis type.

A91 n Read axis n operation mode.

GROUP 4 AQuadB and RIM Command Summary

A92 n AQUADB: Read axis n resolution.
RIM: Read axis n RIM low limit.

A93 n AQUADB: Read axis n calibration.
RIM: Read axis n RIM high limit.

A94 n AQUADB: Read axis n dead path distance.
RIM: Read axis n measurement cell length.

A95 n AQUADB: Read axis n DRIM.
RIM: Read axis n RIM IRIM.

A96 n Read axis n interferometer type.

A97 n AQUADB: Read axis n Lambda for measurement path.
RIM: Read axis n RIM sign for measurement.

A98 Read unit selection.

A12x Commands - Perform AQuadB Board Hardware Functions/TESTING

A120 [n] Strobe Dead Path of axis [n] to load into the hardware.

A121 [n] Strobe axis [n] to notify that a scale factor is loaded.

A122 [n] Load axis [n] dead path.

A123 [n] Disable output and sampling of AQuadB Board axis [n].

A124 [n] Enable output and sampling of AQuadB Board axis [n].

A125 [n] Reset error signal for axis [n].

A126 [n] Set error signal for axis [n].

A15x Commands - Use to Read Error Status and RIM Axis Value

A150 Read the status and error report.

A151 Read the current computed refractive index of media.

GROUP 4 AQuadB and RIM Command Summary

A18x Commands - Use to Control All AQuadB Boards/TESTING

A180 Disable output of all AQuadB Boards.

A181 Enable output of all AQuadB Boards.

A182 Disable error signals on all AQuadB Boards.

A183 Enable error signals on all AQuadB Boards.

A21x Commands - Use to Perform the Specified Operation

A210 Restart AQuadB and RIM operation using current setup information in memory (not setup information from NVM).

A211 f Turn debug on and load a floating point number f as the constant scale factor for all AQuadB axes.

Appendix B

AQuadB and RIM Error Codes

Error codes are displayed on the Diagnostician AQuadB Monitor screen as a result of error detection from the C/I Board firmware. If there is an error on a particular axis, a two digit number preceded by "E", such as"E05", is displayed in the active window after the axis number.

There are eight possible codes, the meaning of these errors codes are as follows:

Error Code	Meaning
E01	The system is not ready to generate AQuadB output; the firmware is in the processes of initializing the ZYGO 2/20. Normally set during power-up.
E02	The Laser Head is not stable; measurements should not be taken. The laser stability is monitored during both power-up and run-time. Whenever the laser is detected as being unstable, this error is set. Normally set during power-up.
E03	The scale factor is not valid. As entered during setup by the user, the scale factor must be greater than or equal to 0 and less than or equal to 1. This error is also set by an attempt to divide by 0 when an attempt is made to use a DRIM of 0 when the RIM state is off, use RIM of 0 when RIM state is on, or use a resolution of 0.
E04	The user acceptable limit for the refractive index of media has been exceeded. These limits (low and high limits) are entered by the user during setup.
E05	The RIM axis has a measurement error. Indicates a hardware detected error. This error is set whenever the software detects an axis error: accumulator overflow, maximum velocity exceeded, no measurement signal from the receiver, and no reference signal from the laser head.

Error Code	Meaning
E06	AQuadB axis is not in 32-bit mode. The AQuadB Board is always set in the 32-bit mode, this indicates that the board has been tampered with.
E07	Bad RIM axis computation. This error is set when an attempt is made to divide by 0; this happens when the value for the interferometer pass type is defined as 0, or the user defines a cell length of 0.
E08	The AQuadB axis has a measurement error. Indicates a hardware detected error. This error is set whenever the software detects an axis error: accumulator overflow, maximum velocity exceeded, no measurement signal from the receiver, and no reference signal from the laser head.

Appendix C

Special AQuadB Applications

The AQuadB pulsed output is generally used with linear interferometers measuring linear displacement. Below is an example application using the AQuadB interface with an angle interferometer.

In this example, the angle interferometer has a resolution of 0.04 arc seconds, the application requires a pulse resolution of 2.0 arc seconds, and wavelength compensation is not used.

Type the following commands on the Diagnostician AQuadB Monitor:

1. **MODE1 2<cr>** (sets axis 1 mode to single).
2. **TYPE1 2<cr>** (sets axis 1 as AQuadB).
3. **LAMBDA1 1<cr>** (identifies axis 1 measurement path as F1).
4. **PASS1 1<cr>** (identifies axis 1 interferometer as a single pass).
5. **DRIM1 1<cr>** (enters a default RIM of 1 for axis 1; or in other words, no compensation).
6. **DEAD PATH1 0<cr>** (enters axis 1 dead path as 0).
7. **RESOLUTION1 0.002492092524<cr>** [sets axis 1 resolution to the maximum resolution of ZYGO 2/20 for a single pass interferometer ($\lambda/254$)].
8. Verify that the scale factor "float" is 1.000000000. This value should be displayed on the Diagnostician AQuadB Monitor under the "Float" column for axis 1.
9. **CALIBRATION1 .02<cr>** [sets axis 1 calibration factor to .02; this is obtained by dividing the interferometer resolution by the required pulse resolution (.04 arc sec/2.0 arc sec = .02)].
10. Verify that the scale factor "float" is 0.020000000.
11. **STORE<cr>** (stores these values into memory and restarts the ZYGO 2/20). On power-up, pulses will be generated with 2.0 arc second resolution.