TECHNICAL OVERVIEW

High Performance Laser Interferometer Positioning for VMEbus Systems

Keysight 10895A Laser Axis Board
Keysight 10896B Laser Compensation Board
Keysight 10897B High Resolution Laser Axis Board
Keysight 10898A High Resolution Dual Laser Axis Board
Keysight E1708A Remote Dynamic Receiver
Keysight E1709A Remote High Performance Receiver

Flexible System Design Components

- Laser Axis Boards
- Environmental Compensation
- Dynamic Receivers

Keysight Technologies, Inc. offers the most complete and highest performance laser interferometry electronics available for the 32-bit industry standard backplane, the VMEbus. Products include two laser axis boards that measure the movement of a system, a very flexible laser compensation board that accounts for environmental factors affecting the measurement, and a specialized receiver intended for the most demanding sub-nanometer resolution measurements of moving systems. Typical applications for a VMEbus based positioning system are IC manufacturing equipment (wafer steppers, step and scan tools, and E-beam lithography systems), precision machine tools, and custom stages. The precision and accuracy of position measurements are vital to the performance of these systems. A laser interferometer positioning system, when built into these types of equipment, measures the position and controls the motion of the platform with more accuracy than any other available method.

KEYSIGHT TECHNOLOGIES

Performance Features

- Resolution up to 0.3 nm depending upon the optics and electronics selected
- Target velocities up to 500 mm/s with plane mirror interferometers or 1000 mm/s with linear interferometers
- Up to 10 MHz data update and transfer rates
- Flexible methods for compensating errors due to environmental effects
- Industry standard VMEbus electronics to simplify system design

Product Summary

Keysight 10895A Laser Axis Board

(see page 3)

- Register programmed position measurement board for VMEbus
- Position may be read over the VMEbus or via hardware outputs
- Multiple axis capability

Keysight 10896B Laser Compensation Board

(see page 7)

Improves system accuracy by compensating for changes in wavelength of light (WOL) and for changes induced by thermal expansion.

- Two WOL compensation methods:
  a) Sensor to measure temperature and pressure of air and account for humidity for automatic calculation of WOL correction
  b) Direct measurement of changes in WOL using a Keysight 10717A Wavelength Tracker
- Supports up to four material temperature sensors to compensate for thermal expansion

Keysight 10897B High Resolution Laser Axis Board

(see page 10)

- Offers same features as 10895A
- Laser Axis Board
- Improves measurement resolution (up to 0.3 nm with a high resolution interferometer)
- Allows measurement of systems moving at higher speed (up to 1 m/s with linear interferometers)
- Dramatically reduces data age uncertainty allowing extremely accurate measurement and control of moving systems
- Flexible cabling for rapid system design

Keysight 10898A High Resolution Dual Laser Axis Board

(see page 14)

- Two high resolution axis measurement capacity on one board
- Resolution up to 0.31 nm
- 2.7 m/s plane mirror slew rate capability
- Sub-nanosecond variable data age
- 5 MHz dual-channel data transfer

Keysight E1708A Remote Dynamic Receiver and E1709A remote High Performance Receiver

(see page 17 and 20)

- Targeted for applications that require sub nanometer measurement resolution of systems in motion
- Doubles the number of axes per application
- Accurate displacement measurements at 2 m/s with linear optics (1 m/s with plane mirror optics)

Keysight 10895A Laser Axis Board

– Keysight's first VME AxisBoard

– High reliability

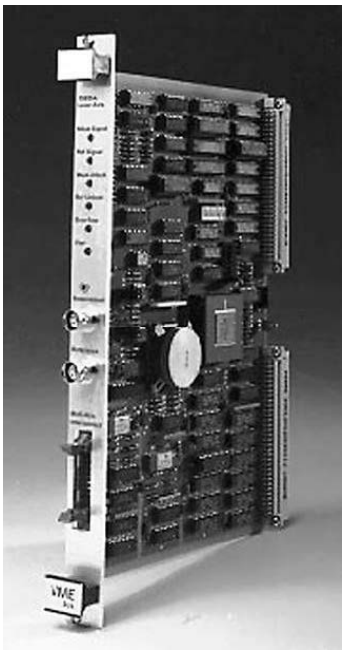
Fast and Easy Data Access

The 10895A is a register-programmed position axis board that provides a 32-bit position word in fractional wavelengths. The position word is readable over the VMEbus and available from a real-time hardware output. The 10895A's standard VMEbus interface makes controlling the board easy and high speed data sampling possible.

For open-loop applications the position word can be read over the VMEbus from a control processor. For closed loop applications the position word can also be read over the VMEbus from a control processor and then a software difference equation can be used to produce a motor drive signal. Or a custom VMEbus servo board can be designed that reads the real-time position hardware output directly from the P2 connector of the 10895A. The custom VMEbus servo board then processes the position information using a difference equation and produces a motor drive signal.

Speed System Integration

The 10895A Laser Axis Board is a 6U-size board that complies electrically and mechanically with Revision C.1 of the VMEbus specifications. Measurement input signals to the 10895A can be either through its front panel or through the board's VMEbus P2 connector. For a multiaxis system, a multiaxis interconnect cable is available as an option.



Improve system reliability by using the Keysight 10895A, which has demonstrated a Mean Time Between Failures of more than 400,000 hours.

The 10895A uses the Keysight 10790A/B/C Receiver Cable and 10791A/B/C Laser Head Cable. Operation of the laser axis board is straightforward, and the operating manual provides complete thorough documentation. Installation of the laser head and optics is covered in the Laser and Optics User's Manual, available with the laser head as Option AV4.

Specifications

VMEbus Position Output

Data Format
Units: fractions of a wavelength
2's Complement: 32-bit parallel binary
Positive Logic Least Significant Bit (or one count) equals resolution
Data Rate Over Backplane >100 kHz

Data Age and Sample Ambiguity
After a sample operation, the value in the position register will reflect an actual position that occurred 0.1 to 1.4 µs before the sample operation was initiated.

Sample Delay
The position register may be read 1.5 µs after a sample operation.

P2 Connector Hardware Position Output

Data Format
Units: fractions of a wavelength
2's Complement: 32-bit parallel binary
Positive Logic Least Significant Bit (or one count) equals resolution

Data Update Rate
5517A: 1.5–2.0 MHz
5517B: 1.9–2.4 MHz
5517C: 2.4–3.0 MHz
(Hardware included to synchronize to slower clocks)

Data Age
5517A: 2.1–4.1 µs
5517B: 1.8–3.3 µs
5517C: 1.5–2.7 µs

Data Age is dependent on the laser head reference signal (split-frequency) and on knowing exactly when, in relation to the rising edge of the Error Clock, the Position Error lines are sampled—call this time ΔT.

$$\text{Data Age} = 0.34\ \mu s + \Delta T\ \mu s + \frac{4.0 \pm 0.5}{\text{Reference (in MHz)}}\ \mu s$$

Additionally, the Data Age may vary up to 0.1 µs typically and up to 0.25 µs in a worst-case situation as a result of the reference frequency varying over time.

General Information

VME Compliance
Complies with VME
Specification Rev. C.1
6U size
A16 Data Transfer Cycles
A24 Data Transfer Cycles
D16 Data Transfer Cycles
D32 Data Transfer Cycles
D08 (O) Interrupt Acknowledge Cycles

Power Requirements
5 Vdc +0.25 V/–0.125 V at less than 2.8 A

Cooling Requirements
19 linear meters (60 linear feet) per minute minimum for 0–40°C operation
76 linear meters (250 linear feet) per minute minimum for 0–55°C operation

Cables
10790A/B/C Receiver Cable
10791A/B/C Laser Head Cable

Axis Cabling:

Specify	for
Option 002	2 axis system
Option 003	3 axis system
Option 004	4 axis system
Option 005	5 axis system
Option 006	6 axis system

Weight: 0.45 kg (1 lb)

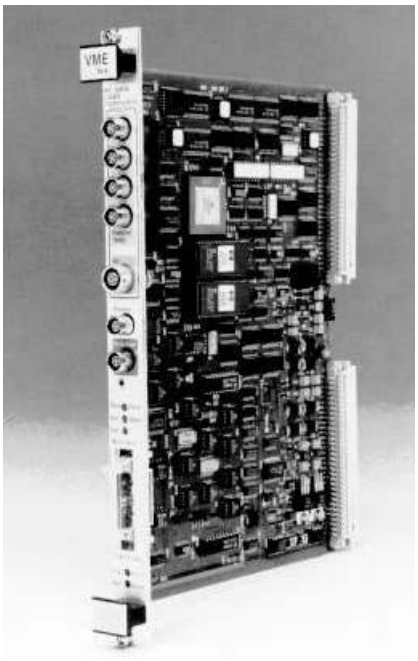
System Performance with the Keysight 10895A

			Maximum Axis Velocity* Laser Head		
Optics	**Resolution**	**Range**	**5517A**	**5517B**	**5517C**
Linear or Single Beam	l/64 or 10.0 nm (0.4 µ in)	±10.6 m (34.8 ft.)	406 mm/sec (16 in/sec)	508 mm/sec (20 in/sec)	711 mm/sec (28 in/sec)
Plane Mirror	l/128 or 5.0 nm (0.2 µ in)	±5.3 m (17.4 ft.)	203 mm/sec (8 in/sec)	254 mm/sec (10 in/sec)	356 mm/sec (14 in/sec)
High Resolution	l/256 or 2.5 nm (0.1 µ in)	±2.65 m (8.7 ft.)	102 mm/sec (4 in/sec)	127 mm/sec (5 in/sec)	178 mm/sec (7 in/sec)

* Maximum axis velocity depends on the combination of laser head and optics used for the axis.

Keysight 10896B Laser Compensation Board

- Calculate absolute wavelength of light
- Monitor changes in wavelength of light
- Monitor stage temperature effects



Improve system accuracy and repeatability using Keysight 10896B VMEbus laser compensation electronics.

Compensating for environmental effects increases system accuracy

Every laser-interferometer positioning system depends on the laser's wavelength of light (WOL) as its basic scale length. However, in air the laser's WOL depends on the air's index of refraction, which is a function of air temperature, pressure, relative humidity, and gas composition. The 10896B Laser Compensation Board can be used with both the 10897B High Resolution Laser Axis Board and the 10895A Laser Axis Board to increase the accuracy and repeatability of the laser interferometer positioning system by compensating for the changes in WOL due to changes in your system's operating environment.

The 10896B can perform WOL compensation in different ways. For all compensation schemes, the 10896B's firmware automatically produces a compensation number that adjusts the position measurements of all axes in the system.

For greatest accuracy and repeatability, a 10717A Wavelength Tracker can be used to provide measurement repeatability up to ±0.14 parts per million (ppm). This technique uses an additional laser axis and tracks changes in the air's index of refraction.

Another technique uses environmental sensors to measure the values of air temperature and pressure and account for ambient humidity. The 10896B then uses these values to calculate the appropriate WOL compensation number using Edlen's equation.

The 10751C/D Air Sensor can be used to provide an accuracy up to ±1.4 ppm. Alternatively, you can use your own environmental sensors to send information to the 10896B. The 10896B also allows you to compensate for thermal expansion of objects under control by measuring their temperature and correcting back to a standard temperature. This allows you to further improve positioning accuracy by compensating for all environmental effects. Again, you have a choice of material temperature sensors. You can use sensors purchased from Keysight (the 10757D/ E/F Material Temperature Sensor) or your own temperature sensors.

The 10896B is a single-width front panel, 6U-size board. It uses advanced surface mount technology to provide reliable, compact electronics.

The 10896B supports a wavelength tracker, an air sensor, and up to four temperature sensors. Any of the four temperature sensor inputs can be programmed for use with custom sensors. For design flexibility, the sensor input signals can be routed to the front panel or the board's VMEbus P2 connector.

Specifications

Environmental Sensors

10717A Wavelength Tracker
10751C/D Air Sensor
10757D/E/F Material Temperature Sensor (up to four)

Resolution
Wavelength Tracker: 5 nm
Analog Sensor Inputs: 76.3 m

Backplane I/O Characteristics

All backplane I/O signals are TTL compatible. Refer to the Keysight 10896B manual for further details

Sensor inputs: ±2.5 volts

General Information

VME Compliance
Complies with VME
Specification Rev. C.1
Single width
6U size

A16 Data Transfer Cycles
A24 Data Transfer Cycles
D08 (OE) Data Transfer Cycles
D16 Data Transfer Cycles
D08 (O) Interrupt Acknowledge Cycles

Power Requirements
+5 Vdc +0.25 V/–0.125 V at less than 2.8 A
+12 Vdc +0.6 V/–0.36 V at less than 0.4 A
–12 Vdc –0.6 V/+0.36 V at less than 0.4 A

Cooling Requirements
19 linear meters (60 linear feet) per minute minimum for 0–40°C operation
76 linear meters (250 linear feet) per minute minimum for 0–55°C operation

Cables (if system includes 10717A):
10880A/B/C Receiver Cable
10881A/B/C/D/E/F Laser Head Cable

Axis Cabling (if system includes 10717A):

Specify	for
Option 002	2 axis system
Option 003	3 axis system
Option 004	4 axis system
Option 005	5 axis system
Option 006	6 axis system

Weight: 0.45 kg (1 lb)

Ordering Information
For ordering information please see the Price List.

Compensation Environment:
Pressure: 760 mm ±25 mm Hg
Relative Humidity: 50% ±10%
Temperature: as shown

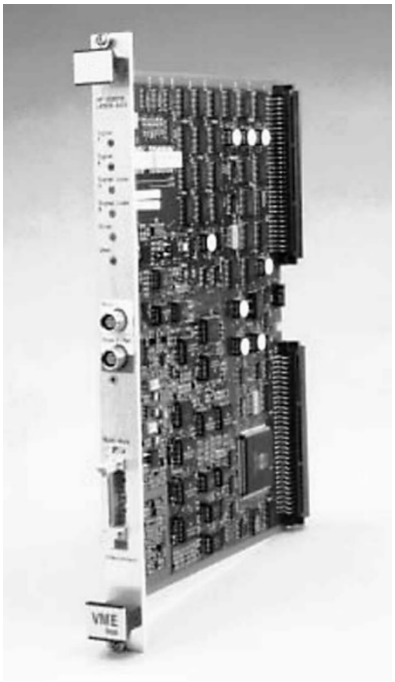
	Measurement Accuracy*		
	±0.1°C	**±1.0°C**	**±5.0°C**
No compensation** (@20°C)	±9.0 ppm	±9.9 ppm	±14.0 ppm
10751C/D Air Sensor (@20°C and 10886A)	±1.5 ppm (typical)	±1.6 ppm	±1.7 ppm
Wavelength Tracking Compensation***	±0.15 ppm	±0.19 ppm	±0.44 ppm

Measurement in Vacuum	±0.1 ppm	±0.1 ppm	±0.1 ppm
Measurement in Vacuum with factory Calibration of Laser Head to MIL STD 45662	±0.02 ppm	±0.02 ppm	±0.02 ppm

*These accuracy specifications include the laser head term, but exclude electronics accuracy and interferometer nonlinearity terms.
**No compensation means that no correction in compensation number occurs during environmental changes.
***System accuracy equals these values (measurement repeatability) or a calibrated laser head plus accuracy of initial compensation value.

Keysight 10897B High Resolution Laser Axis Board

- Highest resolution
- 10 MHz data transfer
- Low variable data age



Get the highest positioning accuracy and repeatability available with the Keysight 10897B High Resolution Laser Axis Board for VMEbus.

High Performance for Advanced Applications

The new 10897B High Resolution Laser Axis Board provides the highest performance ever offered by Keysight Technologies. The improved position resolution—compared to previous laser systems—and low noise offer the ultimate positioning repeatability and accuracy for advanced products such as IC fabrication equipment. The Keysight 10897B provides measurement resolution up to λ/2048, or 0.3 nm (3 Angstroms), the highest resolution commercially available.

The 10897B is tested at frequencies equivalent to 700 mm/s plane mirror slew rates, double that of the 10897A. To provide unsurpassed positioning accuracy for dynamic measurements, the 10897B provides dramatically reduced data age ambiguity compared with previous Keysight systems. Data age ambiguity, the unknown variation in data age, has been reduced to less than 1 ns. This provides high accuracy when compensating moving systems for the delay between the position measurement and the time the position information is available. This improved dynamic accuracy is especially important for E-beam machines and step and scan IC fabrication cameras.

The 10897B contains an onboard, low-pass filter which may be enabled to provide more stable operation in low signal-to-noise conditions. This filter is programmable to provide the most stable positioning for your specific application. The 10897B High Resolution Laser Axis Board is a register-programmed position axis board that provides a 36-bit position word in fractional wavelengths. The position word is readable over the VMEbus and is also available from a real-time hardware output on the A and C rows of the P2 connector. The 10897B offers very high data rates to provide high bandwidth, high-performance closed loop positioning for critical applications.

Flexible VMEbus Electronics Speed System Integration

The 10897B High Resolution Laser Axis Board is a 6U-size board that complies electrically and mechanically with Revision C.1 of the VMEbus specifications. The 10897B's standard VMEbus interface speeds system integration, saving valuable time and money. The heart of the 10897B is a proprietary, CMOS IC specifically designed for this application. Surface mount technology is used to provide a compact, reliable design.

To further simplify and speed system layout, the 10897B also offers programmable signal routing. Cable routing is flexible; the reference and measurement signals can come from either the front panel connectors, the rear P2 connector, or the multiaxis interconnect cable. The 10897B uses the Keysight 10880A/B/C Receiver Cable and 10881A/B/C/D/E/F Laser Head Cable.

Specifications

VMEbus Position Output

Data Format
Units: fractions of a wavelength
2's Complement: choose any 32 of 35 bits to read
Positive Logic Least Significant Bit (or one count) equals resolution

Data Rate Over Backplane
>100 kHz

Sample Data Age and Delay
Fixed: After a synchronous sample operation, the value in the position register will reflect the actual position that occurred approximately X ns before the sample operation was initiated. There are two user-selectable values of X, 290 ns and 790 ns.

Variable (typically)
<800 ps over the full power supply voltage specification, and <60 ps/°C.

Delay
When X=290 ns is selected, the position data is available to be read on the VMEbus 600 ns after the sampling operation. For X=790 ns, position data is available on the VMEbus 100 ns after the sampling operation.

P2 Connector Hardward Position Output

Data Format
Units: fractions of a wavelength
2's Complement: 36-bit parallel binary
Positive Logic Least Significant Bit (or one count) equals resolution

Data Update Rate
10 MHz (Hardware included to synchronize to slower clocks)

Data Age
Fixed: There is a 1190 ±20 ns time lag between actual position and the position at the hardware output lines (located on rows A and C of P2 connector).

Variable (typically)
<800 ps over the full power supply voltage specification, and <60 ps/°C.

General Information

VME Compliance
Complies with VME
Specification Rev. C.1
6U size

A16 Data Transfer Cycles
D16 Data Transfer Cycles
A24 Data Transfer Cycles
D32 Data Transfer Cycles
D08 (O) Interrupt Acknowledge Cycles

Power Requirements
5 Vdc +0.25 V/–0.125 V at less than 3.5 A
+12 V ±0.5 V at less than 0.1 A
–12 V ±0.5 V at less than 0.025 A

Cooling Requirements
19 linear meters (60 linear feet) per minute minimum for 0–40°C operation
76 linear meters (250 linear feet) per minute minimum for 0–55°C operation

Cables
10880A/B/C Receiver Cable
10881A/B/C/D/E/F Laser Head Cable

Axis Cabling:

Specify	for
Option 002	2 axis system
Option 003	3 axis system
Option 004	4 axis system
Option 005	5 axis system
Option 006	6 axis system
Option 007	7 axis system

Weight: 0.45 kg (1 lb)

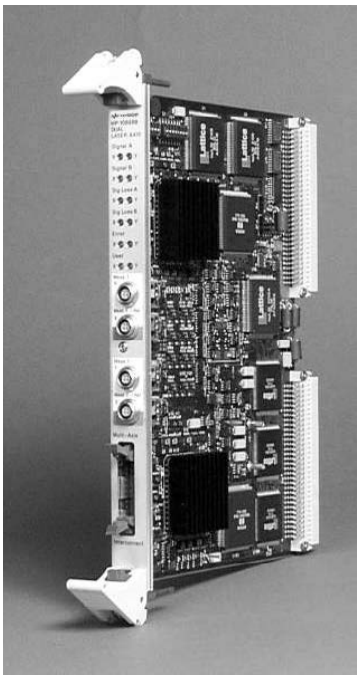
System Performance with the Keysight 108978

			Maximum Axis Velocity* Laser Head			
Optics	**Resolution**	**Range**	**5517A**	**5517B**	**5517C**	**5517D†C**
Linear or Single Beam	l/512 or 1.2 nm (0.05 µ in)	±21.2 m (69.9 ft.)	406 mm/sec (16 in/sec)	508 mm/sec (20 in/sec)	711 mm/sec (28 in/sec)	1000 mm/s (39.4 in/s)
Plane Mirror	l/1024 or 0.6 nm (0.025 µ in)	±10.6 m (34.8 ft.)	203 mm/sec (8 in/sec)	254 mm/sec (10 in/sec)	356 mm/sec (14 in/sec)	500 mm/s (19.7 in/s)
High Resolution	l/2048 or 0.3 nm (0.012 µ in)	±5.3 m (17.4 ft.)	102 mm/sec (4 in/sec)	127 mm/sec (5 in/sec)	178 mm/sec (7 in/sec)	250 mm/s (9.84 in/s)

* Maximum axis velocity depends on the combination of laser head and optics used for the axis.
† Keysight 10780C or 10780F receivers used at this velocity must have serial prefix 3546 or higher.

Keysight 10898A High Resolution Dual Laser Axis Board

- Resolution to 0.31 nm
- 2.7 m/s plane mirror slew rate capability
- Sub-nanosecond variable data age
- 5 MHz dual-channel data transfer



Dual Axis VME Board for Advanced Applications

The Keysight 10898A Dual Laser Axis Board provides the same resolution of the 10897B High Resolution Laser Axis Board with increased slew rates and reduced noise. The increased stage velocity limits and low noise compared to previous laser systems offer the premium positioning repeatability and accuracy for advanced products such as IC fabrication equipment. Like its predecessor the 10897B, the 10898A provides measurement resolution to (/2048 (0.3 nm) with the high resolution plane mirror interferometer.

The 10898A is tested at frequencies equivalent to 2700 mm/s plane mirror slew rates. Both the 10897B and 10898A provide superior dynamic positioning measurements accuracy as required for e-beam and step-and-scan semiconductor exposure systems. The dynamic positioning accuracy has been improved by reducing the variable data-age to less than 1 nanosecond for most applications. Systems can compensate for data-age, the constant time lag between triggering a measurement and receiving the data, but not for variable data-age, the portion that changes and translates directly into stage position error. For example, a stage moving at 500 mm/s with 800 ps of variable data age has a minimum 0.4 nm position error due to variable data age.

The 10897B and the 10898A have a low-pass filter with programmable coefficients that may be enabled to provide optimal operation in low signal-to-noise conditions.

The 10898A Dual Laser Axis Board provides a 35-bit position word in fractional wavelengths. The position word is available over the VMEbus and from a real time hardware output on the A and C rows of the P2 connector. The 10898A offers high data rates for wide bandwidth, high-performance closed-loop applications. also offers solutions to get the high-speed multiaxis position data into your DSP engine for precision positioning.

Flexible VMEbus Electronics Speed System Integration

The 10898A Dual Laser Axis Board is a 6U-size board that complies electrically and mechanically with Revision C.1 of the VMEbus specifications. The 10898A's standard VMEbus interface speeds system integration, saving valuable time and money. The heart of the 10898A are proprietary bipolar and CMOS ICs specifically designed for high-precision dynamic closed-loop measurements. Surface mount technology is used to provide a compact, reliable design. To further simplify and speed system layout, the 10898A also offers programmable signal routing. Cable routing is flexible; the reference and measurement signals can come from either the front panel connectors, or the multi-axis interconnect cable.

Specifications

VMEbus Position Output

Data Format
Units: fractions of a wavelength
2's Complement: choose any 32 of 35 bits to read
Positive Logic Least Significant Bit (or one count) equals resolution

Data Rate Over Backplane
>100 kHz (minimum) VMEbus cycle rate

Sample Data Age and Delay
Fixed With respect to the rising edge of the 10 MHz P2 clock pin immediately after assertion of one of the asynchronous sample pins of P2, the value in the position register will reflect the actual position that occurred approximately N ns before. N= 262 ns or 762 ns, user selectable.

Variable (typical)
<800 ps over the full power supply voltage specification and <40 ps/°C.

Delay
When N=262 ns is selected, the position data is available to be read on the VMEbus 600 ns after the sampling operation. For N=762 ns, position data is available on the VMEbus 100 ns after the sampling operation.

P2 Connector Hardware Position Output

Data Format
Units: fractions of a wavelength
2's Complement: 32-bit parallel binary
Positive Logic Least Significant Bit (or one count) equals resolution

Data Update Rate
10 MHz using a single channel, 5 MHz using both channels
Hardware included to synchronize to slower clocks.

Data Age
Fixed There is 1062 ns +/- 1 ns time lag between position information at Meas1 and Meas2/Ref connectors and the digital data at the P2 hardware output lines.

Variable (typical)
<800 ps over the full power supply voltage specification, and <40 ps/°C.

General Information

VME Compliance
VMEbus Specification
Electrical Rev. C.1
Mechanical 6U size, VME64X

A16 Data Transfer Cycles
D16 Data Transfer Cycles
A24 Data Transfer Cycles
D32 Data Transfer Cycles
D08 (O) Interrupt Acknowledge Cycles

Power Requirements
5 Vdc +0.25 V/-0.125 V, < 4.5 A
+12 V ±0.5 V, < 0.2 A

Operating Temperature
0-40°C with 19 linear meters (60 linear feet) per minute minimum for cooling.

Recommended Cables
N1250A/B Receiver Cable with N1251A/B Laser Head Cable

Axis Cabling:

Specify	for
Option 002	2 board group
Option 003	3 board group
Option 004	4 board group
Option 005	5 board group

Option 006	6 board group
Option 007	7 board group

For board groups >7, consult factory
High-speed Data Handling
Consult factory for multi-axis highspeed data handling.

Documentation option
Option 101 (Operating Manual- English)

Weight: 0.45 kg (1 lb)

System Performance with the Keysight 10898A

			Maximum Axis Velocity* Laser Head				
Optics	**Resolution**	**Range**	**5517A**	**5517B**	**5517C**	**5517D†C**	**10898A Maximum**
Linear or Single Beam	l/512 or 1.2 nm (0.05 µ in)	±21.2 m (69.9 ft.)	406 mm/sec (16 in/sec)	508 mm/sec (20 in/sec)	711 mm/sec (28 in/sec)	1000 mm/s (39.4 in/s)	5400 mm/s
Plane Mirror	l/1024 or 0.6 nm (0.025 µ in)	±10.6 m (34.8 ft.)	203 mm/sec (8 in/sec)	254 mm/sec (10 in/sec)	356 mm/sec (14 in/sec)	500 mm/s (19.7 in/s)	
High Resolution	l/2048 or 0.3 nm (0.012 µ in)	±5.3 m (17.4 ft.)	102 mm/sec (4 in/sec)	127 mm/sec (5 in/sec)	178 mm/sec (7 in/sec)	250 mm/s (9.84 in/s)	

* Maximum axis velocity depends on the combination of laser head, optics, receiver and electronics used for the axis.
Consult with your local Keysight Field engineer to optimize the Keysight system configuration for your application.

Keysight E1708A Remote Dynamic Receiver

- For use with the Keysight 10897B
- For moving systems

The E1708A Dynamic Receiver is designed for use in the most demanding applications requiring sub-nanometer resolution measurements of systems in motion. The receiver extends the performance of the 10897B High Resolution Laser Axis Board for VMEbus by providing system performance consistent with the high resolution and low variable data age of the 10897B.

The E1708A uses an optical fiber to transport the beam from a remote sensor assembly to the electronics. The E1708A improves measurement accuracy and repeatability by enabling you to mount heat dissipating electronics away from the measurement area. The fiber optic cable also allows mounting design flexibility and easier access to the receiver attenuation and squelch adjustments.

As the Doppler shift caused by motion of the system stage changes the measurement frequency, the E1708A ensures minimal phase processing errors. The receiver also provides immunity to errors induced by changes in measurement signal power level.

Keysight E1707A and E1708A Dynamic Receivers provide more accurate positioning data for moving systems.

Specifications

Optical Output

Data Format
Units: fractions of a wavelength

Sensitivity
2.2 µW (E1708A with 2-m cable, 5 µW with 10-m fiber cable)

Alignment Tolerances
Roll: ±3°
Pitch: ±l°
Yaw: ±1°

The E1708A is self-aligning when the remote sensor is mounted to the following optics: Keysight 10715A, 10716A, 10717A, 10719A, 10721A, 10735A, or 10736A.

Electrical Output

Output Signal
Differential square wave at Dopplershifted frequency (100 kHz to 7.2 MHz)

Fixed Data Delay: 86 ns (typical)*
0.15 ns/°C (typical)

Errors due to frequency variations and 3:1 amplitude variations:*
±1.2 nm for linear optics
±0.6 nm plane mirror optics
±0.3 nm for high resolution optics

Signal Strength Monitor
0–8 volts proportional to optical input signal

General Information

Power Requirements
15 Vdc ±1 V at less than 250 mA

Heat Dissipation
0.0 W for remote sensor
3.8 W typical for receiver

Temperature Range
0–40°C operating

Fiber-Optic Cable Length
2 m standard
10 m maximum

Weight
170 g (6.0 oz) for E1708A 26 g (0.9 oz) for remote sensor with 2-m cable

*For input signal power
<150 µW for E1707A
<200 µW for E1708A

Keysight E1709A Remote High Performance Receiver

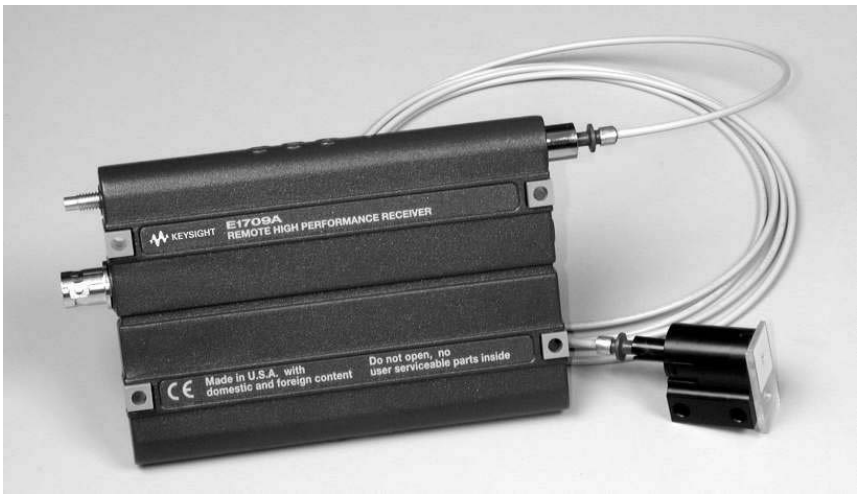
- 0.2 mw sensitivity for increased axes count
- 2 meter/s slew rate capability for increased stage speeds
- Errors limited to ±1LSB over entire frequency range and up to 25:1 amplitude range

The E1709A Remote High Performance Receiver is for use in the most demanding applications requiring sub-nanometer measurement resolution of systems in motion.

The E1709A has up to 11 x the sensitivity of its predecessor, the E1708A, enabling you to more than double the number of axes for your application.

This receiver also has more than double the bandwidth of the E1708A enabling accurate displacement measurements at 2 m/s with linear optics (1 m/s with plane mirror optics).

The measurement signal frequency changes as the stage velocity changes. The E1709A ensures minimal phase processing errors as the frequency changes. The receiver also provides immunity to errors induced by changes in measurement signal power that occur due to small pitch, roll and yaw movements during stage motion. These features help provide the most accurate measurements under system motion. See the 10898A or 10897B datasheets for axis-board information.



E1709A with Option 010

Specifications

Optical Output

Sensitivity (with option 010)

Beam Overlap	90%	50%	20%	10%
ac µw	0.20	0.26	0.46	0.80

Maximum Input
5 mW (Max sensitivity), 50 mW (Max attenuation)

Alignment Tolerances
Roll: + 3° Pitch/Yaw: + 1°

EI709A is self-aligning when remote sensor is mounted to the following optics: Keysight 10715A, 10716A, 10717A, 10719A, 10721A, 10735A, or 10736A.

Electrical Output

Output Signal
Differential square wave at Dopplershifted frequency, 100 kHz to 15.5 MHz (slew rates to 1 m/s with plane mirror optics)

Fixed Data Delay
86 ns (typical)*
0.15 ns/°C (typical)

Errors due to frequency variations and amplitude variations:*
± 1.2 nm for linear optics
± 0.6 nm plane mirror optics
± 0.3 nm for high res. Optics
* Up to maximum input, see above.

Signal Strength Monitor
0-10 volts proportional to optical input signal

General Information

Power Requirements
15 Vdc ± 1 V at less than 267 mA

Heat Dissipation
0 W for remote sensor
4 W typical for receiver

Temperature Range
0–40°C operating

Fiber-Optic Cable Length (sold separately)
2 m plastic (option 010)
Consult factory for glass fiber or different lengths

Weight
190 g (6.7 oz.) for E1709A
26 g (0.9 oz.) for remote sensor with 2-m plastic cable

Recommended Cables
High Performance Receiver Cables

N1250A	5 meters
N1250B	10 meters

Use N1251A or B Laser head cable when using N1250A or B.

Options
010 2 m fiber and remote sensor (same as E1706A)
101 Operating Manual - English

Comparison of Keysight E1708A/E1709A Receivers

Characteristic	E1709A Receiver	E1708A Receiver
Dynamic Range	25:1 to 6:1, depending on the AC/DC ratio	10:1
Sensitivity	.20 -.80 µW (depending on the AC/DC ratio), with 2 meter plastic cable	2.2 µW (E1708A with 2-meter fiber optic cable) 5 µW (10780F with 10-meter fiber optic cable)
Alignment Tolerance	For plastic fiber optic cable (Option 010) Roll: ±3° Pitch: ±1° Yaw: ±1° Keysight remote sensor is self-aligning with some interferometers.	For plastic fiber optic cable Roll: ±3° Pitch: ±1° Yaw: ±1° Keysight remote sensor is self-aligning with some interferometers
Output Signal Frequency (Differential square wave at Doppler-shifted frequency)	100 kHz to 15.5 MHz (slew rates to 1 m/s with plane mirror optics)	100 kHz to 7.2 MHz (slew rate to 500 mm/s with plane mirror optics)
Fixed Data Delay (typical)*	33.2 ns (typical) 0.01 ns/ÞC	86 ns

Errors due to frequency variations at fixed temperature*	For 25:1 to 6:1 input amplitude variations and frequency range of 100 kHz to 15.5 MHz < ±1.2 nm for linear optics < ±0.6 nm for plane mirror optics < ±0.3 nm for high resolution optics	For 3:1 input amplitude variations and frequency range of 100 kHz to 7.2 MHz < ±1.2 nm for linear optics < ±0.6 nm for plane mirror optics < ±0.3 nm for high resolution optics
Signal Strength Monitor	0 to 10 volts output, proportional to optical input signal power	0 to 8 volts output, proportional to optical input signal power
Power Requirements	15 Vdc ±1V at less than 267 mA	15 Vdc ±1V at less than 250 mA
Heat Dissipation	0.0 W for remote sensor 4.0 W typical for receiver	0.0 W for remote sensor 3.8 W typical for receiver
Temperature Range	0 to 40° C operating	0 to 40° C operating
Fiber-Optic Cable Length	Option 010: 2m (plastic) Contact Keysight for longer fiber optic cables.	2 m standard (plastic) Contact Keysight for longer fiber optic cables.
Weight	Receiver body:190 g Option 010: Remote sensor with 2 m cable: 26 g	Receiver body:170 g, Remote sensor with 2 m cable: 26 g
Dimensions	Height: 78.1 mm (3.075 in) Width: 115.6 mm (4.552 in) Depth: 19.8 mm (0.780 in)	Height: 78.1 mm (3.075 in) Width: 115.6 mm (4.552 in) Depth: 19.8 mm (0.780 in)
Dimensions (receiver body, mounting area)	4 holes at corners of a rectangle 40.0 mm (1.575 in) high 108.0 mm (4.250 in) wide, centered on receiver body centerline	4 holes at corners of a rectangle 40.0 mm (1.575 in) high 108.0 mm (4.250 in) wide, centered on receiver body centerline

* For ac input signal power:
E1708A: <200 µW
E1709A: <50 µW

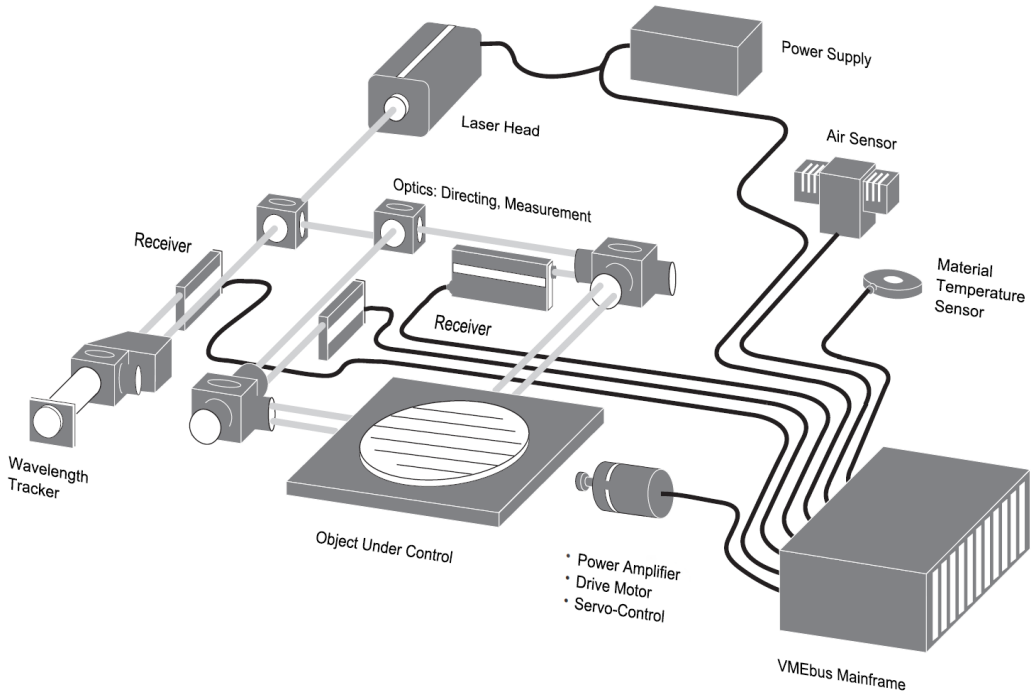
Configuring Your Laser System

Contact your local Keysight sales office for assistance in selecting the components needed for your application.

The basic steps in configuring a system are:

First, determine your system specifications (accuracy, speed, resolution, number of axes).

Then select optics, electronics, laser head, and wavelength compensation components to meet your system requirements.



Learn more at: www.keysight.com

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