Precision
Tunable Laser Source
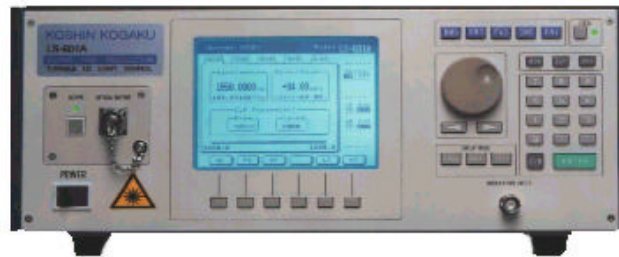
LS-601A-15S1
LS-601A-16S1
LS-601A-56S2

INSTRUCTION MANUAL

Koshin TLS Manual
Part No. 22-000601
V. 2.0

Thank you for selecting the Koshin LS601 Series Tunable Laser Source. This manual provides the information that will allow you to begin using your TLS quickly.

The information in this manual includes:

SAFETY

Summary

To ensure thorough understanding of all functions and to ensure efficient use of this product, please read the manual carefully before using. Note that Koshin Kogaku and dBm Optics bear absolutely no responsibility for incorrect or inappropriate use of this product.

If the equipment is used in a manner not specified by Koshin Kogaku or dBm Optics, the protection provided by the equipment may be impaired.

Warning Labels

Warning labels are applied to Koshin Kogaku products in locations where specific dangers exist. Pay careful attention to these labels during handling. Do not remove or tear these labels. If you have any questions regarding warning labels, please ask your nearest Koshin Kogaku dealer (addresses and phone numbers listed at the end of this manual).

> **DANGER**   Indicates an imminently hazardous situation, which will result in death or serious personal injury.
>
> **WARNING**   Indicates a potentially hazardous situation, which will result in death or serious personal injury.
>
> **CAUTION**   Indicates a potentially hazardous situation which will result in personal injury or damage to property (including the product.)

Basic Precautions

Please observe the following precautions to prevent fire, burn, electric shock and personal injury.

1. Use a power cable rated for the voltage in question. Be sure, however, to use a power cable conforming to safety standards of your nation when using a product overseas.
2. When inserting the plug into the electrical outlet, first turn the power switch OFF and then insert the plug as far as it will go.
3. When removing the plug from the electrical outlet, first turn the power switch OFF and then pull it out by gripping the plug. Do not pull on the power cable itself. Make sure your hands are dry at this time.
4. Before turning the power ON, check that the supply voltage matches the voltage requirements of the product.

5. Be sure to plug the power cable into an electrical outlet, which has a safety ground terminal. Grounding will be defeated in you use an extension cord which does not include a safety ground terminal.
6. Be sure to use fuses rated for the voltage in question.
7. Do not use this product with the case open.
8. Do not place objects on top of this product. Also, do not place flowerpots or other containers containing liquid (such as chemicals) near this product.
9. When the product has ventilation outlets, do not stick or drop metal or easily flammable objects into the ventilation outlets.
10. When using the product on a cart, fix it with belts to avoid its falling.
11. When connecting the product to peripheral equipment, turn the power OFF.

Safety Marks

The following safety marks can be found on Koshin Kogaku products.

CAUTION – REFER TO MANUAL

PROTECTIVE CONDUCTOR TERMINAL

EARTH (GROUND) TERMINAL

Precautions When Disposing Of This Product

When disposing of harmful substances, be sure to dispose of them properly by abiding by local laws.

Harmful substances:
1. PCB (polycarbon biphenyl)
2. Mercury
3. Ni-Cd (nickel cadmium)
4. Other (Items possessing cyan, organic phosphorous and hexadic chromium and items which may lead cadmium or arsenic—excluding lead in solder).

Examples: fluorescent tubes, batteries

Environmental Conditions

This product should only be used in an area, which satisfies the following conditions:

1. An area free from corrosive gas
2. An area away from direct sunlight
3. A dust-free area
4. An area free from vibrations

Environmental Conditions

5. Product placement

Keep at least 10 centimeters of space between the rear panel and any other surface
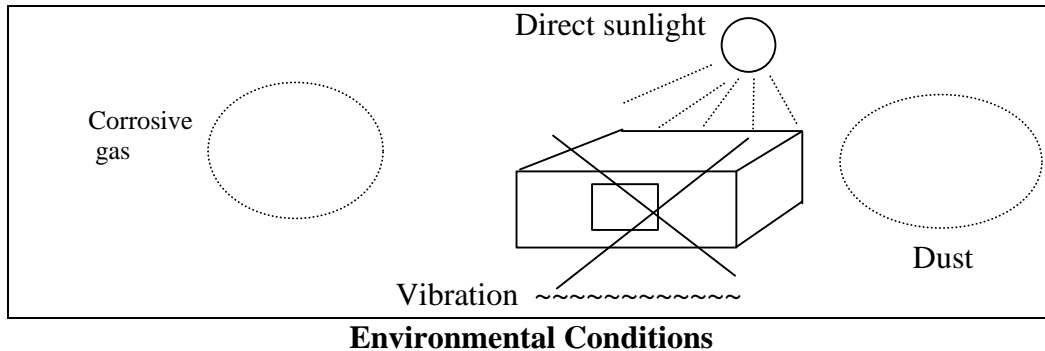
Product Placement
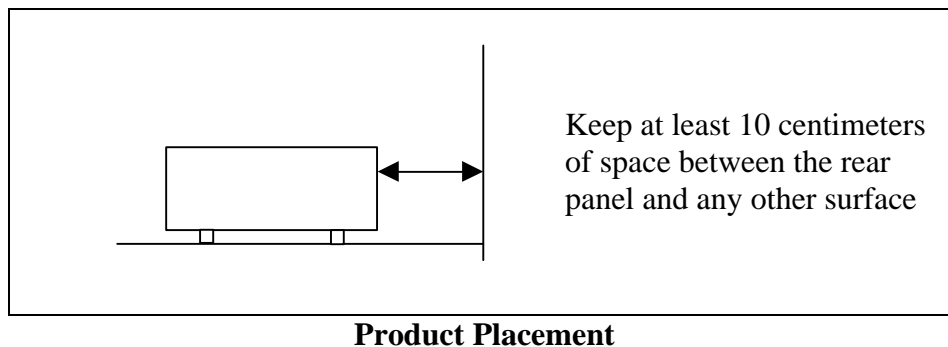
This product can be used safely under the following conditions:

1. Altitude of up to 2000 m
2. Installation categories II
3. Pollution degree 2

CAUTIONS ON USING THE LS-601A

Information for the Safety of Laser Used in the LS-601A

Laser Type		Fabry Perot-Laser
Laser Class		IIIb: 21CFR 1040.10 (USA) 3A: IEC 825+A1(Non-USA)
Permissible Output Power		< 10mW
Beam Diameter		9 µm
Numerical Aperture		0.1
Wavelength	LS-601A-15	1520 - 1590nm
	LS-601A-16	1580 - 1650nm
	LS-601A-56	1525 - 1630nm

Laser Warning Labels

The following laser warning labels are used on this instrument.

Affixed on top of the instrument
(see 'a' on top of the instrument)

Affixed on top of the instrument
(see 'b' on top of the instrument)

Class IIIb laser product label: For the U.S.A. only

Affixed on front of the instrument
(see 'c' on top of the instrument)

Affixed on front of the instrument
(see 'd' on top of the instrument)

Class 3A laser product label: For all countries except the U.S.A.

Affixed on front of the instrument (see 'e' on top of the instrument)	Affixed on front of the instrument (see 'f' on top of the instrument)

Class IIIb laser warning label: For the U.S.A. only

Class 3A laser product label is provided as a standard accessory.

A class 3A laser product label that corresponds to the country where this instrument is used must be affixed on top of the instrument as marked with 'c'.

Class 3A Laser Product Label

The position for each label on the product is shown below.

TOP VIEW

FRONT VIEW

OPTICAL OUTPUT PART DETAIL
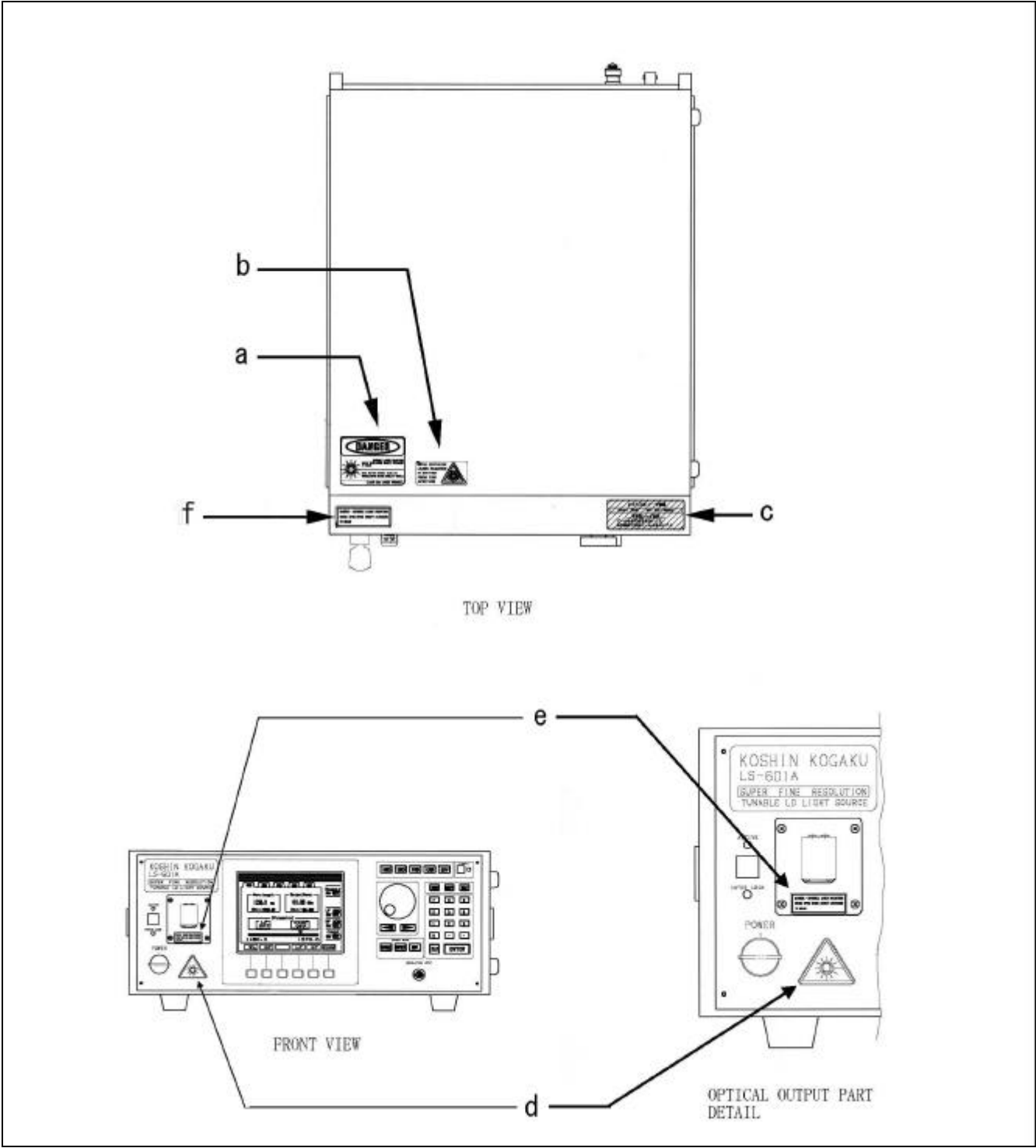
Warning on the Laser

1. Never attempt to emit a laser beam when no fiber is connected to the optical output connector on the front panel.

Lit while the laser is emitted.

Toggles the optical output on or off.
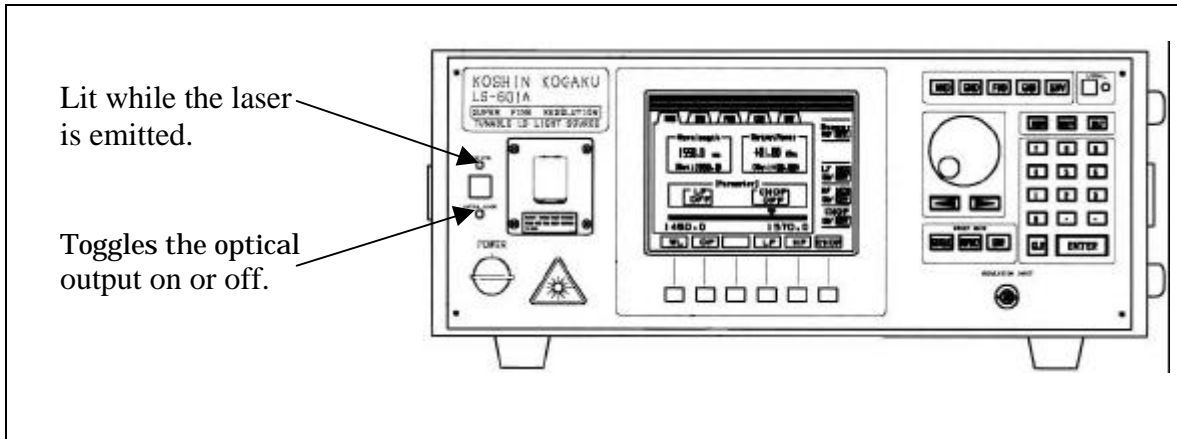
2. Never attempt to look into the optical output connector to observe the emitted laser beam. While the laser beam is emitted, never attempt to look into the optical fiber cord at the end, because an invisible light is emitted. The invisible light may seriously damage your eyesight.

3. Never attempt to look into the optical output connector or the end of optical fiber cord to observe the emitted laser beam using an optical instrument. Your eyesight may be seriously damaged.

4. Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

5. Do not attempt to open the unit. Only Koshin Kogaku representatives should service the unit. Koshin Kogaku assumes no responsibility for any damage caused by unauthorized service.

INTRODUCTION

Summary

The LS-601A series are external-cavity tunable semiconductor lasers, consisting of a Fabry-Perot laser diode as a gain media and a highly efficient interference band pass filter as a wavelength selector. The LS-601A series have the following features:

- **High output power**
- **Wide tunable range**
- **High step speed**
- **Fine l resolution**
- **High suppression of spontaneous emission**
- **90 dB optical shutter**
- **Stable output power and wavelength stability**
- **Competitive price**

> *NOTE:* In order to get optimal performance from this instrument, the optical reflection through the measurement system must be minimized. An angle-polished optical fiber cable is attached to this equipment and is recommended for use in the entire system.

Accessories

Your LS-601A was shipped with the following standard accessories:

Standard Accessories

Items		Quantity	Note
Power cable		1	
Fuse	TDU-5A (T-5A, 250V)	2	For use in Japan and U.S.A.
	TDI-5A (T-5A, 250V)	2	For use in all countries except Japan and U.S.A.
Angle-polished optical fiber cable		1	Angle-polished (one side only) (Green connector: angle-polished)
Instruction manual		1	

Power Supply

Ensure the power switch is off prior to plugging in the unit to the power outlet.

To replace the fuse:

1. Turn off the power switch.
2. Pull power cord plug from the AC line connector.
3. Remove the fuse holder under the AC line connector on the rear panel using a small screwdriver
4. Replace fuse with new fuse with the following requirements:
   Slo-Blo T5A 250V

WARNING: To protect against electrical shock, ensure that earth ground is connected prior to connecting to the AC line and following any routine maintenance.

Environment And Precaution For Use

To maximize long-term performance of this instrument, the following environmental safeguards should be considered:

1. Avoid dust and direct sunlight—the optical performance of the unit may be compromised by long-term exposure to direct sunlight and dust.
2. Avoid excess vibration—vibration can compromise the mechanical integrity of the unit.
3. Avoid areas that may have exposure to corrosive gasses.

Do not block fan vents. If unit is racked, make sure it has proper ventilation.

Do not orient this unit vertically—always operate horizontally. Do not put anything on top of this equipment.

The safe operation temperature range is 10-35°C, but specifications are guaranteed only over the 15-30°C range.

Allow one hour for warm-up if instrument is maintained at room temperature. If unit has been exposed to storage temperature extremes, allow for an additional hour for each 10°C.

Keep original packing material for transport or shipment. If original packing is not available, make sure at least 3 inches of packing material secures instrument on all sides.

Use both side handles when moving this instrument.

Handle

Front ⟹   ⟸ Rear
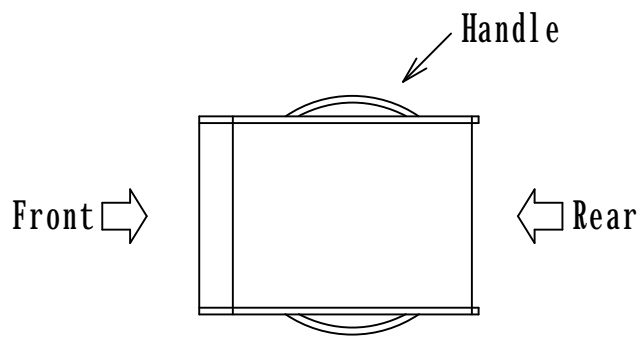
It is recommended that the optical connector be cleaned periodically. If optical performance declines, it may be improved by cleaning the optical connector.

Cleaning Procedure

1. Loosen screws (1,2) and remove them.

2. Pull the optical bulkhead connector out about 2 inches (5 cm). Be careful with the optical fiber—do not force the fiber, as a break, crimp or severe bend will require factory repair.

3. Remove the adapter and clean the fiber optic end face. A CLETOP type cleaning system is recommended.

4. Replace the bulkhead connector, again being careful not to bend, crimp or break the fiber.

5. Tighten up screws (1,2).

Specifications

Key Specification	LS-601A-15	LS-601A-16	LS-601A-56
Wavelength range	1520-1590 nm	1580-1650 nm	1525-1630 nm
Wavelength resolution	<0.1pm normal; 0.001pm μ-Fine^{TM} mode		
Mode-hop free tuning	Full tuning range		
Absolute λ accuracy	<±10pm, typical ±5pm		
λ repeatability	<±3pm, typical < ±1pm		
λ stability	<±0.8pm (<±100MHz), 1 hour		
Tuning speed	0.1pm/40msec; 1pm/50ms; 10pm/55ms; 100pm/160ms; 1nm/600ms; 10nm-100nm/800ms		
Linewidth (coherence control off)	<100KHz (30kHz line, ±30kHz chirp)		
Linewidth (coherence control on)	Up to 50MHz		
Output power--full band	>+4dBm	>+4dBm	>+0dBm
--main band			>+2dBm (1540-1620 nm)
Attenuation	Yes, standard, from full power to −30dBm, 0.01dBm resolution		
Power Stability	±0.03dB, 1 hour; ±0.001dB, 30 seconds		
Automatic Power Control (APC)	Yes, standard		
Optical power flatness	<±0.2dB, <±0.1dB typical (<±0.4dB without APC)		
Side Mode Suppression (SMSR)	>50dBc, >55dBc typ. (typically 40pm from center λ)		
Signal to Source Spontaneous Emission ratio (SSE)	>70dB, typically <80dB		
Signal to Total Source Spontaneous Emission ratio (STSE)	>65dB typical total power		
RIN typ	<-160dB/Hz		
Optical Shutter	Yes; >90dB isolation; off time <80ms		
External HF modulation	10-120MHz (<+10dBm)		
Built-in LF modulation	200Hz – 300kHz		
Connector	FC-PMF; extinction ratio >18dB		
Trigger output	Yes; trigger pulse on each λ step after settle in sweep mode		
Remote interface	GPIB (IEEE-488)		
Power	100-240 VAC (<200VA)		
Environmental- Operating	+10°C to +35°C (+10°F to +35°F), <80% RH non-condensing		
Environmental- Storage	-10°C to +50°C (+10°F to +35°F), <80% RH non-condensing		
Size	350mmW × 415mmD × 147mmH (13.78″ x 16.33″ x 5.78″)		
Weight	15 kg (33 Lbs)		
Output Stabilization time	80ms from optical power off to optical power on (using Beam Block Shutter^{TM})		
Warm up time	90 minutes		
Laser Safety	Class 3B (FDA 21 CFR 1040.10); Class 3A (IEC 825-1; 1993)		
Auto wavelength calibration	Yes, standard; auto-cal every 0.6nm (approx. 2 sec)		
Recalibration period	2 years		

NOTE: Specifications are subject to change without notice.

Laser class	IIIb: 21CFR 1040.10
	3A: IEC 825+A1

High Speed Tuning

This equipment has some specific features that allow the unit to operate in a high-speed mode. To get the highest possible step speed, disable the Automatic Power Control (APS) and the monitor output features and engage the high speed. Set time should be set to the 0. The monitor output feature is only available via GPIB, and so the fastest possible sweep times are only achievable in remote operation.

The table at the bottom of this page shows the typical setting time of a wavelength vs. the wavelength tunable step under GPIB control.

GP-IB Command Setting

• HS1: "High Speed Mode" ON
• MON0: "Indication Control" function OFF
• APS0: "APS" function OFF

Tuning Times

Wavelength Tunable Step (nm)	Wavelength Setting Time (ms)
0.0001	40
0.001	48
0.01	55
0.1	160
1.0	600
10.0	800

Panels and Operating Procedures

Front Panel Explanation
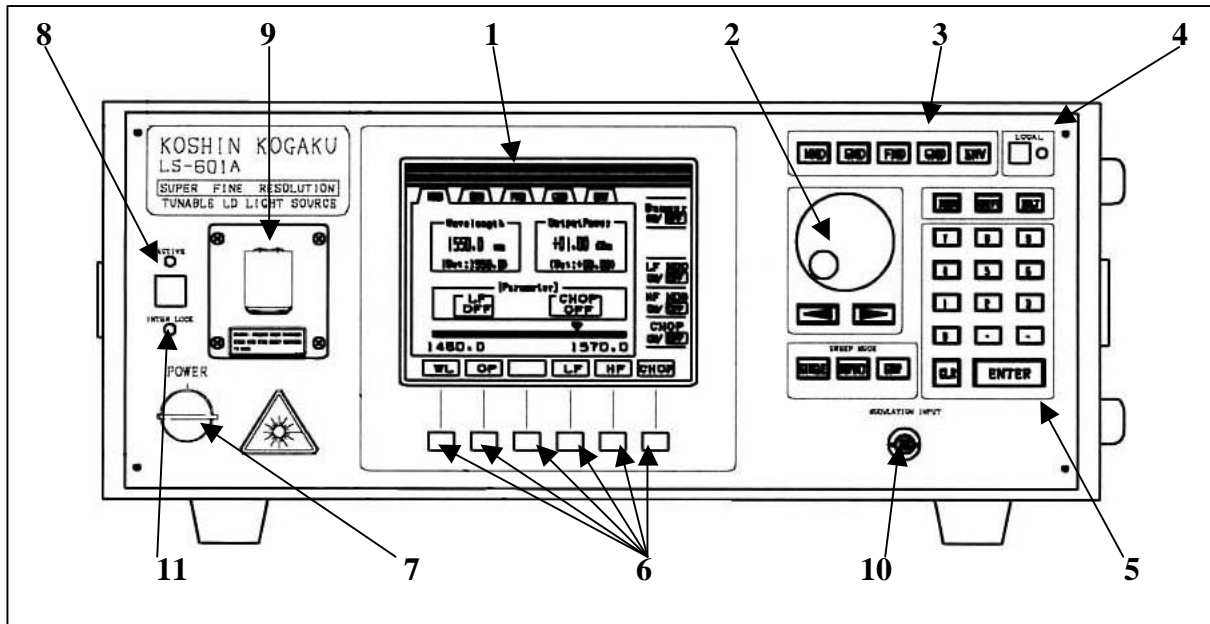
1. LCD UNIT DISPLAY

There are five modes on LCD unit display.

1) <u>Normal Mode (NMD)</u>

This is an ordinary mode. This mode is for the use of setting of a wavelength and an output power. This mode is set after power on sequence.
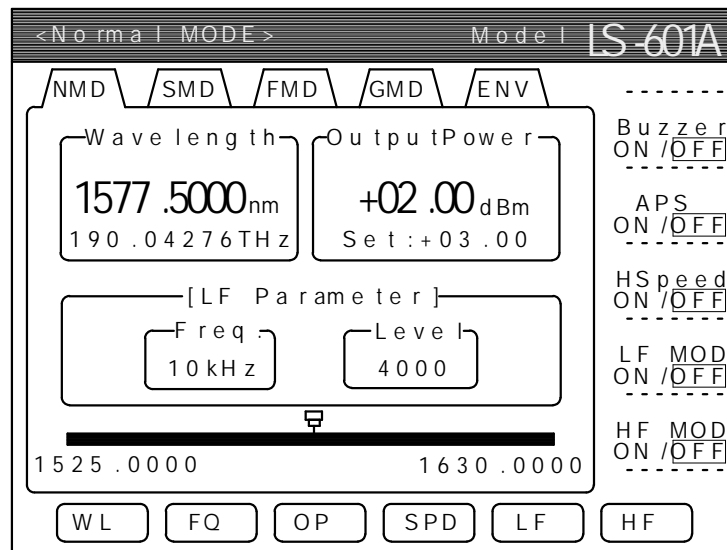
2) **Sweep Mode (SMD)**

This mode is for the use of automatically sweeping after the start and end wavelengths,
interval wavelength and time have been set. Furthermore, this mode is changeable
between "wavelength sweep" and the "frequency sweep."

```
<Sweep MODE>                    Model LS-601A
 /NMD\ /SMD\ /FMD\ /GMD\ /ENV\        - - - - - - -
                                         Buzzer
   Start WL      : 1525.0000nm       ON /OFF
   End WL        : 1630.0000nm           - - - - - - -
   Interval WL  :   00.1000nm          APS
   Set Time     :   05.0sec          ON /OFF
                                         - - - - - - -
   ┌Wavelength┐ ┌OutputPower┐          HSpeed
                                     ON /OFF
    1525.0000 nm   +00.00 dBm            - - - - - - -
                                         LF  MOD
                                     ON /OFF
   ▯▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬            - - - - - - -
                                         HF  MOD
 1525.0000    [ STOP ]  1630.0000     ON /OFF
                                         - - - - - - -
  ( STT ) ( END ) ( ITVL ) ( ST IM ) (      ) (W /F )
```

3) Fine Resolution Mode (FMD)

This mode is for the use of further fine setting of the wavelength than normal mode.

4) GPIB Address Mode (GMD)

This mode allows you to set the GP-IB address.

```
<G P - I B  A d d r e s s  M O D E>      M o d e l  LS-601A

 N MD \  / S MD \  / F MD \  / G MD \  / E N V \        · · · · · ·

    ┌─────────────────────────────────────┐
    │  G P - I B  a d d r e s s  :   2    │       · · · · · ·
    └─────────────────────────────────────┘
                                                  · · · · · ·

                                                  · · · · · ·

                                                  · · · · · ·

                                                  · · · · · ·
  ┌───────┐ ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐
  │ G P I B │ │     │ │     │ │     │ │     │ │     │
  └───────┘ └─────┘ └─────┘ └─────┘ └─────┘ └─────┘
```

5) Environment Mode (ENV)

This mode allows you to set environmental variables. Parameters which can be set are the buzzer [ON]/[OFF], the unit indication mode of optical power [LIN]/[LOG], "internal low frequency modulation" [ON]/[OFF], Modulation Frequency and Modulation Level), and the "APS" function.

```
<E n v i r o n m e n t  M O D E>        M o d e l  LS-601A

 NMD \  / SMD \  / FMD \  / GMD \  / ENV \          - - - - - - -

    ┌─────────────────────────────────────┐
    │  B u z z e r       :  ON /OFF       │        - - - - - - -
    └─────────────────────────────────────┘
    ┌─────────────────────────────────────┐
    │  OP  D ISP ( L IN / LOG )  :  L IN / LOG  │    - - - - - - -
    └─────────────────────────────────────┘
       ┌──────── LF  parameter ─────────┐
       │ f requency   range: 10kHz     │          - - - - - - -
       │ modu lation  level:  4000     │
       └───────────────────────────────┘          - - - - - - -
    ┌─────────────────────────────────────┐
    │  Au to  Power  Set  :  ON /OFF     │         - - - - - - -
    └─────────────────────────────────────┘
  ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐
  │ BUZZ │ │ LNLG │ │ FREQ │ │ MODU │ │ APS │ │ ZERO │
  └─────┘ └─────┘ └─────┘ └─────┘ └─────┘ └─────┘
```

2. **ROTARY KNOB (DIAL)**

   The knob for adjusting wavelength or optical power continuously.

3. **FUNCTION KEY FOR THE MODE SETTING**

   Keys for selecting an operational mode.

4. **LOCAL SWITCH AND REMOTE LED**

   The switch for changing the remote state into the local state. The LED indicates that this equipment is in the remote state.

5. **NUMERIC ENTRY KEYS**

   Keys for setting numerical data.

6. **SOFT FUNCTION KEY**

   Keys for various functions, which are then indicated on the LCD unit display**.**

7. **POWER SWITCH**

   The switch for turning the power ON/OFF.

8. **BEAM SHUTTER SWITCH AND ACTIVE LED**

   The switch for turning the beam shutter ON/OFF. The shutter is open when the LED is lit.

9. **OPTICAL OUTPUT**

   The optical connector for optical output.

10. **MODULATION INPUT (BNC 50 W)**

    An input connector for an external high frequency modulation.

11. **INTERLOCK LED**

    This LED lights up when the feature of the interlock is working.

WARNING: This equipment belongs to laser class 3A according to IEC 825 + A1. Because the optical beam is invisible, do not stare into the beam or view directly with optical instruments.

Rear Panel Explanation
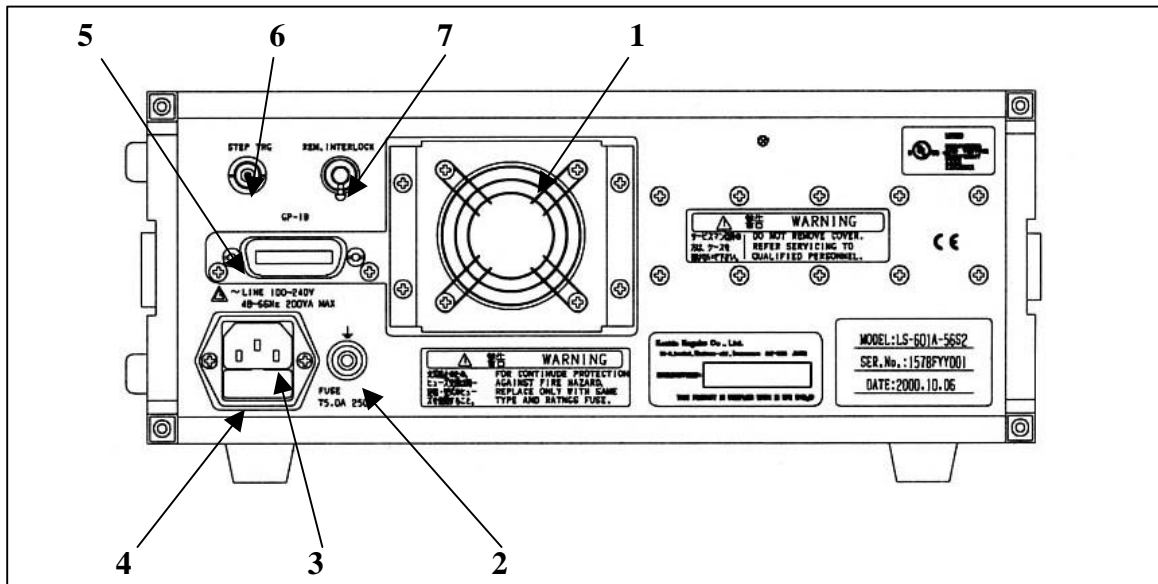
1. COOLING FAN

This equipment has one low-noise fan. Do not block the fan vent; this will cause degraded performance and possibly damage the unit.

2. GROUND CONNECTING TERMINAL

A terminal for the connection of a ground wire.

3. AC LINE INPUT

4. FUSE HOLDER

Be sure to use the fuse that suits the requirement. (See the "Power Supply" section for details.)

5. GPIB CONNECTOR

A connector for GPIB interfaces cables.

6. OUTPUT TRIGGER SIGNAL (BNC TTL LEVEL)

An output connector for the trigger. A trigger pulse is generated for at each step. Once the wavelength is set the trigger is pulsed, there is zero delay for the trigger and trigger pulses are 5 μs at 5V.

7. REMOTE INTERLOCK CONNECTOR

This is to protect a user from the damage when using a class IIIb laser source. The use of this system is specified with class IIIb laser sources by 21 CFR1040.10 (USA). If the short circuit at this BNC connector is opened, the laser is switched off immediately and cannot be switched on until it is closed again.

Panel Operating Procedures

Introduction to Operation

"<< SELF TEST IN PROGRESS >>" is indicated on the LCD unit display when the power switch is depressed. Then, after a moment, the mode that has been set is first displayed and then the unit is ready to operate. (In the beginning, the normal mode (factory default) is first indicated. This modification of starting mode and any parameter can be changed freely by rewriting of the system memory).

This equipment has five modes:

1. Normal Mode	This is the basic mode.
2. Sweep Mode	This mode allows automatic wavelength sweeping.
3. Fine Resolution Mode	This mode allows automatic wavelength sweeping with very high wavelength resolution.
4. GPIB Address Mode	This mode allows the user to set the GPIB address.
5. Environment Mode	This mode is for the use of setting environmental parameters including buzzer, internal modulation, automatic power control setting (APS) and linear/log scale.

Explanation for Each Mode of Operation

Normal Mode

Setting for a wavelength/ frequency	Press the '[WL]/[FQ]' key. Set the numeric keys or rotary knob or ⇐/⇒ key. Press the '[ENT]' key.
Setting an optical output power	Press the '[OP]' key. Set the numeric keys or rotary knob or ⇐/⇒ key. Press the '[ENT]' key.
Setting the high speed mode (ON/OFF)	Press the '[SPD]' key, every time changing ON and OFF. While high speed mode is on, the line width is widened into about 10 MHz.
Setting for the internal low frequency modulation (ON/OFF).	Press the '[LF]' key, every time changing ON and OFF.
Setting for the external high frequency modulation (ON/OFF).	Press the '[HG]" key, every time changing ON and OFF.
Changing into another mode.	Sweep mode: Press the '[SMD]' key. Fine resolution mode: Press the '[FMD]' key GPIB address mode: Press the '[GMD]' key Environment mode: Press the '[ENV]' key

Sweep Mode

Setting Parameters	Press the '[W/F]' to select the sweep mode (wavelength or frequency).
	Press the '[STT]'', '[END]', '[ITVL]' and '[STIM]' key for setting the "start," "end," "interval wavelength" and "sweep time," respectively (see below for explanation).
	Press the '[SINGLE]' or '[REPEAT]' key for sweeping automatically.
	Press the '[SHIFT]' + '[SINGLE]' keys to perform the "single step" operation.
	To cancel a sweep operation press the '[STOP]' key until the '[STOP]' message is indicated on LCD unit display.
	[STT]: the start wavelength [END]: the end wavelength [ITVL]: the wavelength interval (each step) [STIM]: the dwell time at each wavelength [W/F]: changing the sweep mode (wavelength/frequency)
Changing into another mode	Normal mode: Press the '[NMD]' key. Fine resolution mode: Press the '[FMD]' key GPIB address mode: Press the '[GMD]' key Environment mode: Press the '[ENV]' key

Fine Resolution Mode

Setting for a wavelength/frequency	Press the '[WL]/[FQ]' key. Set the numeric keys or rotary knob or ⇦/⇨ key. Press the [ENT] key.
Setting for an optical output power	Press the '[OP]' key. Set the numeric keys or rotary knob or ⇦/⇨ key. Press the '[ENT]' key.
Setting the "high speed mode" (ON/OFF)	Press the '[SPED]' key, every time toggling between ON and OFF. While "high speed mode" is on, the line width is widened into about 10 MHz.
Setting for the internal low frequency modulation (ON/OFF)	Press the '[LF]' key, every time toggling between ON and OFF.
Setting for the external high frequency modulation (ON/OFF)	Press the '[HF]" key, every time toggling between ON and OFF.
Changing into another mode	Normal mode: Press the '[NMD]' key Sweep mode: Press the '[SMD]' key GPIB address mode: Press the '[GMD]' key Environment mode: Press the '[ENV]' key

GPIB Address Mode

Setting for a GPIB address	Press the '[GPIB]' key. Set the numeric keys or the rotary knob. Press the '[ENT]' key. *NOTE: The address is memorized permanently.*
Changing into another mode	Normal mode: Press the '[NMD]' key. Sweep mode: Press the '[SMD]' key Fine resolution mode: Press the '[FMD]' key Environment mode: Press the '[ENV]' key

Environment Mode

Setting for buzzer	Press the '[BUZZ]' key. Choose the '[ON]/[OFF]' key. Press the '[ENT]' key.
Setting the optical output indication	Press the '[LNLG]" key. Choose the '[LIN]/[LOG]' key. Press the '[ENT]' key. *NOTE*: LIN: The optical output is indicated by [W]. LOG: The optical output is indicated by [dBm].
Setting for the parameter of the internal low frequency modulation Frequency Modulation level	 Press the '[FREQ]' key. Set the rotary knob or ⇦/⇨ key. Press the '[ENT]' key. Press the '[MODU]" key. Set the rotary knob or ⇦/⇨ key. Press the '[ENT]' key.

Setting for the APS function	Press the '[APS]' key, then choose the [ON]/[OFF] key.
	Press the '[ENT]' key.
	
	NOTE: [APS function]: "APS," which means Auto Power
	             Set, keeps the level of optical power constant
	             across the wavelength band. This mode slows
	             down the step speed so it is not recommended if
	             sweep speed is critical.

Zero offset of the optical power level	Press the '[ZERO]' key, the zero offset will be set automatically.
Changing into another mode	Normal mode: Press the '[NMD]' key. Sweep mode: Press the '[SMD]' key Fine resolution mode: Press the '[FMD]' key. GPIB address mode: Press the '[GMD]' key

Starting Parameter Modification/Preset

Parameter Modification

To change the preset parameters to something other than the factory configuration, the user must use the MEM function key. Otherwise, whenever a new mode is selected the previous parameters will be lost.

Modification Procedure
- Set the various parameters you want enabled when the equipment is first turned on.
- Press '[MEM]' key.
- <<Change Memory>> is indicated bottom o LCD display.
- Press '[YES]' or '[NO]'.
- When '[YES]' is pressed, current parameters are memorized as new starting parameters.

Starting Parameter Preset

You can set the unit to power up in the factory default state.

Preset Procedure
Press '[SHIFT]' + '[CLR]' keys
<<Inst Preset!>> is indicated bottom of the LCD display
Press '[YES]' or '[NO]'
When '[YES]' is pressed, the instrument is initialized and restarts

GPIB CONTROL

Introduction

This GPIB interface is able to control the "SRQ" interrupt, as well as most of the front panel operations. There are a couple of operations that are only available in Remote operation.

Handling GPIB Cables

Be sure to disconnect the power cable before handling GPIB cables, as unintentional static discharge may damage the instrument.

Set GPIB Address and Confirmation

Set a GPIB address at GPIB Address Mode ('GMD'). The address is set as "02h" initially at the factory, and this address is retained in memory until another value is selected.

GPIB Interface Functions

The following table shows the interface functions for the LS-601A.

Interface Functions

Code	Function	Implemented
SH1, AH1	All "handshake" functions	Yes
T6	Talker function	Yes
L4	Listener function	Yes
SR1	Service request function	Yes
RL1	Remote local function	Yes
PP0	Parallel poll function	No
DC1	Device clear function	Yes
DT0	Device trigger function	No
C0	Controller function	No
E2	Tri-state drive	--

GPIB Commands

Table 3.2—Device Messages and Codes

Device messages which are valid in all operational modes:

Control Item	Control Code	Function
★ Initialize (prearranged)	◆ RST	Initialize to factory default settings
Initialize (normal)	◆ INIT	Initialize to stored settings
★ Parameter memorize	◆ MEM	Rewrite all default settings
Delimiter	● DL0	Set delimiter as '[CR]'+'[LF]'
	DL1	Set delimiter as '[CR]'+'[LF]' (with '[EOI]')
	DL2	Set delimiter as '[LF]'
	DL3	Set delimiter as '[EOI]'
Operational mode	● MD0	Set operational mode as 'NMD'
	MD1	Set operational mode as 'SMD'
	MD2	Set operational mode as 'FMD'
	MD3	Set operational mode as 'GMD'
	MD4	Set operational mode as 'ENV'
	MD?	Query operational mode (MDn, where n=mode #)
Active state	AC?	Query active state (ACn, n=1 is ACTIVE)
Service request	● SQ0	Do not send the 'SRQ'
	SQ1	Send the 'SRQ'
Optical output power	● PD0	Indicate optical power as 'dBm'
	PD1	Indicate optical power as 'µW'
Modulation frequency	FQn	Set a frequency of the internal low frequency modulation n=vvx, where vv is the value, and x is the exponent; 304 is equivalent to 300,000Hz (200Hz-300kHz)
Modulation level	MLn	Set an internal low frequency modulation level; n between 0 and 15
Internal low frequency modulation	● LF0	Internal low frequency modulation OFF
	LF1	Internal low frequency modulation ON
External high frequency modulation	● HF0	External high frequency modulation OFF
	HF1	External high frequency modulation ON
Beam shutter	● ST0	Beam shutter CLOSE
	ST1	Beam shutter OPEN (light on)
LCD back light	BL0	LCD back light OFF
	● BL1	LCD back light ON
Buzzer	BZ0	Buzzer OFF
	● BZ1	Buzzer ON
Optical output power flatness	● APS0	APS OFF
	APS1	APS ON
Wavelength position	SET	Initiate a wavelength auto-calibration
Monitor display	MON0	Wavelength/frequency and optical output power display OFF
	● MON1	Wavelength/frequency and optical output power display ON
High speed mode	HS0	High speed mode OFF
	● HS1	High speed mode ON

Device messages which are valid in the NMD mode (MD0)

Wavelength	♦	WLnnnn.nnnn	Set wavelength (nm)
		WL?	Query wavelength (WLnnnn.nnnn)
Frequency	♦	WFnn.nnnnn	Set frequency (THz)
		WF?	Query frequency (WFnnn.nnnnn)
Optical output power	♦	PWnnn.nn	Set optical power (dBm)
		PW?	Query optical power (OP ±nn.nn)
	♦	PUnnnn.n	Set optical power (µW)
		PU?	Query optical power (OUnnnn.n)
		PS?	Query optical power (set by user)

Device messages which are valid in the SMD mode (MD1):

Control Item	Control Code		Function
SINGLE	♦	SNG	Sweep operation (single)
REPEAT		REP	Sweep operation (repeat)
TRIGGER		TRG	One-step operation (trigger mode: ON)
STOP		STP	Stop sweep operation
Start wavelength		SWnnnn.nnnn	Set a start wavelength (nm)
End wavelength		EWnnnn.nnnn	Set an end wavelength (nm)
Start frequency		SFnnn.nnnnn	Set a start frequency (THz)
End frequency		EFnnn.nnnnn	Set an end frequency (THz)
Interval wavelength		IWnn.nnnn	Set an interval wavelength (nm)
Interval frequency		IFn.nnnnn	Set an interval frequency (THz)
Wavelength/frequency change	●	DOM0	Wavelength sweep operation
		DOM1	Frequency sweep operation
Add end frequency		Ifnnn.nnnnn	Set an end frequency (THz)

Device messages which are valid in the FMD mode (MD2):

Control Item	Control Code		Function
Wavelength	♦	WLnnnn.nnnnn	Set wavelength (nm)
		WL?	Query wavelength (WLnnnn.nnnn)
Frequency	♦	WLnnn.nnnnn	Set frequency (THz)
		WF?	Query frequency (WFnnn.nnnnn)
Optical output power	♦	PWnnn.nn	Set optical power (dBm)
		PW?	Query optical power (OP ±nn.nn)
	♦	Punnnn.n	Set optical power (µW)
		PU?	Query optical power (OUnnnn.n)
		PS?	Query optical power (set by user)

Device messages which are valid in the ENV mode (MD4):

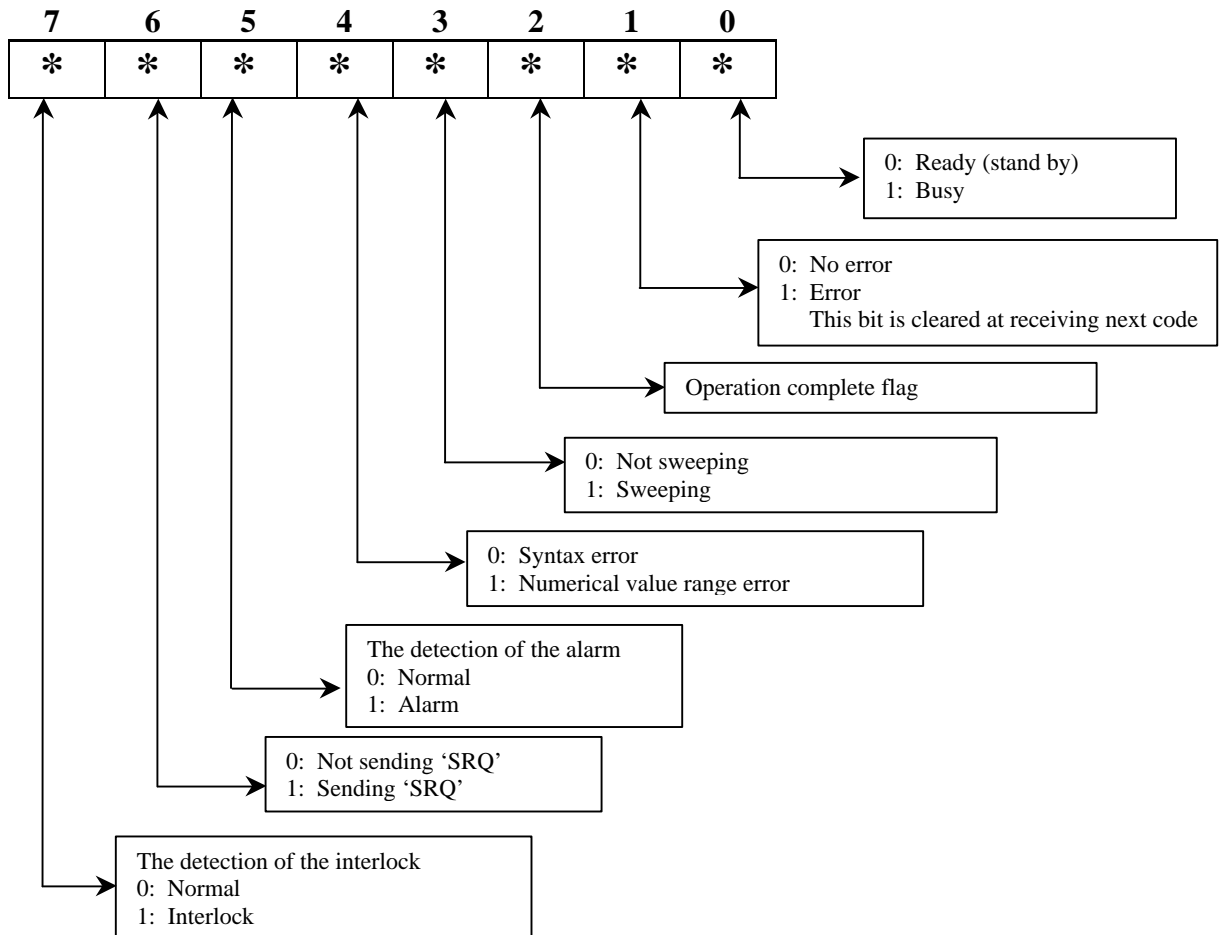| Control Item	Control Code	Function
ZERO modification	PZ	Store the present value as zero

ATTENTION: Only 64 characters/10 commands can be indicated in each line and each command has to be separated with ",(comma)". "INIT", "RST", "MEM", "SNG", "REP", "TRG" and "STP" should be used alone each other.

 ♦ Commands will generate an SRQ upon completion when the SRQ is enabled.
 • Default value.
 ★ Command completion may take up to 3 minutes to complete. These commands should be used only when necessary.

Status Message

The following is status messages of this equipment.

<<STATUS MESSAGE>>

7	6	5	4	3	2	1	0
∗	∗	∗	∗	∗	∗	∗	∗

0: Ready (stand by)
1: Busy

0: No error
1: Error
This bit is cleared at receiving next code

Operation complete flag

0: Not sweeping
1: Sweeping

0: Syntax error
1: Numerical value range error

The detection of the alarm
0: Normal
1: Alarm

0: Not sending 'SRQ'
1: Sending 'SRQ'

The detection of the interlock
0: Normal
1: Interlock

Service Request (SRQ)

This equipment can send service request to controller when the following conditions are met:

Operation Complete

This equipment can send SRQ simultaneously with "operation complete bit (bit2)" of status message when an operation executed by such commands as "RST", "INIT", "MEM", "WL", "WF", "SNG", "PW" and "PU" have been completed normally.

Error Occur

This equipment can send service request simultaneously with the error information of "error state bit (bit1)" and "error type bit (bit4)" when receive the command which has not been defined or designated numerical value is out of range.

Delimiter

This equipment can receive the following four kinds terminator.

**CR+LF**

CR+LF (WITH EOI)

LF

EOI

The delimiter is designated by the "DL" command.

GPIB Operating Procedures

GPIB control is able to execute only from Normal Mode ('NMD'). So if another mode is set, you must change into Normal Mode first. Maximum seek takes about 2 seconds. If you would like to synchronize seek end, use the 'SRQ' interrupt or refer to bit 0 in status message.

NOTE: Sufficient delay is required between IFC (Interface Clear) and REN (Remote Enable).

EQUIPMENT DIMENSIONS
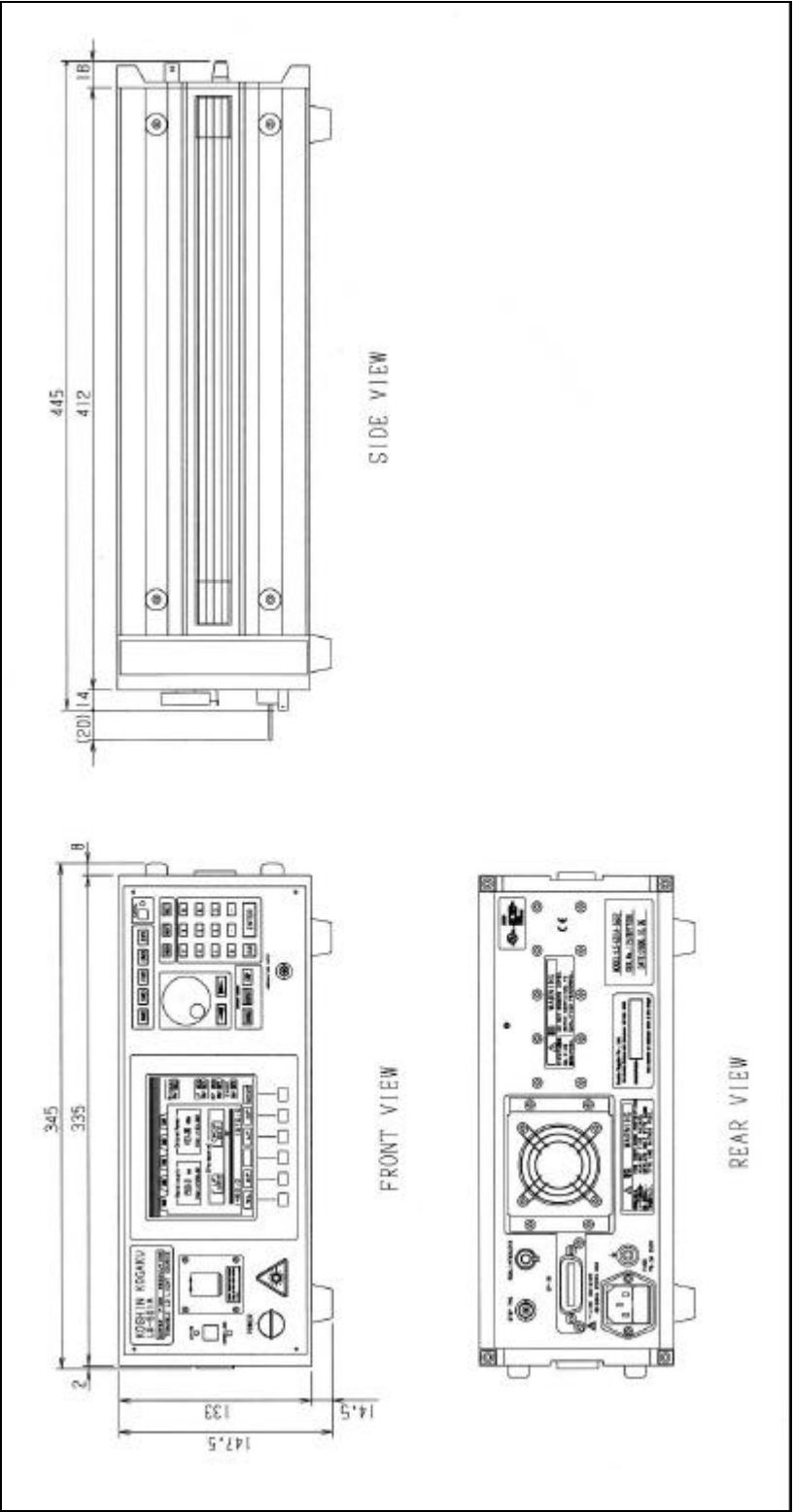
STORAGE/WARRANTY/MAINTENANCE

Recommended Storage Conditions

Temperature: 0 - 45°C
Relative humidity: ≤ 80%

Warranty

This equipment is guaranteed to be free from defects in workmanship and materials for one year from date of shipment.

Maintenance

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