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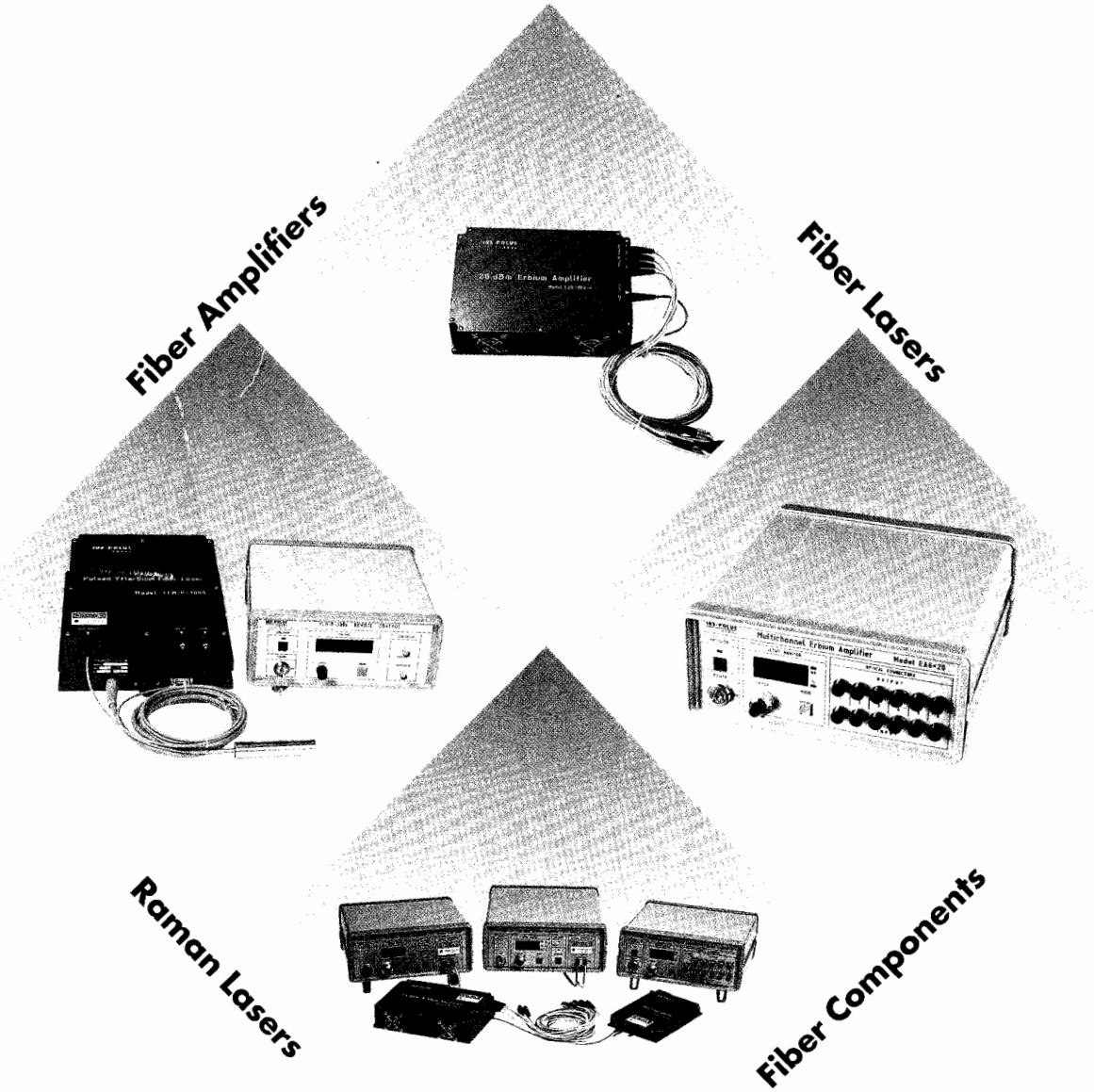
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IPG LASER

Model EAD-40-C Instrumentation Erbium Doped Fiber Amplifier

Instruction Manual

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CAUTION !!!

The IPG Laser Model EAD-40-C is a Class IIIB laser product.

Amplifier emits more than 40 mW of the invisible laser radiation in the optical band near 1550 nm.

The direct viewing of the beam emitted from both output and input connectors is dangerous for eyes. Don't look at connectors during the device is ON.

Avoid a skin irradiation of the beam emitted from the output and input fiber connector.

Do not open the device. Inside there is invisible hazardous laser radiation emitted by pump laser diodes at 965 nm

Read this manual completely before you start operation with device.

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1. Summary

IPG Laser has developed the EA-series of erbium doped fiber amplifiers to meet the growing interest and requirements in high power amplifiers. The Erbium amplifier has become a key component in optical telecommunications and in numerous areas of laser technology. Compact, efficient, diode-pumped high power amplifiers are in high demand in distributed fiber optical networks including CATV , as well as for instrumentation and in very high capacity telecommunications. Powerful erbium fiber amplifier systems operating in the eye safe spectral window have enormous potential for applications in dynamic ranging and remote sensing.

IPG Laser was the first company which developed and made commercially available high power erbium fiber amplifiers and lasers using direct diode pumping. These include the most powerful (up to 40 dBm at present) diode pumped Erbium fiber amplifiers, CW fiber lasers and pulsed eye-safe fiber lasers for ranging.

IPG Laser manufactures EA-series amplifiers in two versions, *modular and bench-top*. *EAM Modules* are separate stand-alone, compact, ready-to-use, board mountable packages which can be directly inserted into the users apparatus and network. They are driven by an external DC power supply and the operational regime is set externally through a control port. The pump diode current and temperature are controlled and stabilized by built-in electronics. *EAD Bench-Top Devices* are instruments for laboratory use. They have their own AC (100-240V, 50/60 Hz) power supply and include the control/display electronics and air cooling. The operation regime is set on the control panel and operational parameters,

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input and output optical power, pump diode current and temperature are panel displayed.

The main features of ***IPG Laser*** Erbium Doped Fiber Amplifiers are

- ***very high saturation power***
- ***direct diode pumping***
- ***extended optical bandwidth***
- ***saturated output power vs. wavelength flattening***
- ***low noise figure***
- ***low PMD***
- ***high conversion efficiency and low power consumption***

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EAD-40-C is a bench-top type, high-power erbium doped fiber amplifier. The amplifier delivers > 40 mW output power. The device is a ready-to-use instrument which includes pump diodes and control electronics. The optical scheme of the amplifier is based on a proprietary ***IPG Laser*** Erbium/Ytterbium codoped fiber and pump coupling technique. Pump laser diodes operating around 965 nm are used in the amplifier. The input and output optical isolators are installed in order to prevent external feedback into the amplifier. Standard FC/APC connectors are installed at the input and output ports of the amplifier.

The amplifier **EAD-40-C** is an air cooled, AC power supply device. The operation of the amplifier is controlled from the front panel. The front panel includes a power on/off key, display, control knob, emission on/off and control keys. A safety interlock connector is fitted on the rear panel which should be used according to local laser safety regulations. The status of the safety interlock is monitored on the display.

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2. Accessories

Please check the included accessories according to Table 1.

Tab. 1

Items	Quantity	Note
Main power cord with plug	1	For connecting **EAD-40-C** to 100-240 V AC
Power ON/OFF security keys	2	for switching ON/OFF electrical power
Safety interlock connector	1	
Instruction Manual	1	

3. Power Supply

Power supply voltage is **100-240 V AC (50/60 Hz).** The operation voltage is set on the rear panel of the device.

IMPORTANT: Before supplying the power make sure that the setting is correct.

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4. Environment and Precautions

- Always use your amplifier device in conjunction with properly grounded power source.
- Do not expose the device to high moisture environment.
- Amplifier has fans in the rear panel for active cooling. Make sure that there is sufficient air flow to cool the device, any objects that cover the ventilation holes must be removed.
- Damage will result to most receivers and power meter sensors when exposed to the total power output of amplifier. Ensure that the power input to all test instruments are well within the specifications at all time.
- All unused optical ports must be covered at all times to prevent accumulation of dust. Use connectors after an appropriate cleaning.

NOTE: Manufacturer will not be responsible for the damage sustained by the device as result of use dirty or incompatible connectors.

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5. Specifications

1.Optical characteristics

N	Characteristic	Test condition	Symbol	Min.	Typ.	Max	unit
1	Mode of operation				Single channel		
2	Polarization				random		
3	Nominal output power	Pin = -3 dBm λ=1550 nm	Pout		16		dBm
4	Maximum output power	Pin = -3 dBm λ=1550 nm	Pout max		17	17.2	dBm
5	Wavelength range			1530		1570	nm
6	Output power equalization	λ=1533-1567 nm				±0.3	nm
7	Noise figure	λ=1540-1567 nm Pin = -3 dBm	NF		5.0	5.5	dB
8	Output power instability	long term (over 8h) short term (60 sec)				3.0 0.5	%
9	Polarization sensitivity of saturated output power					0.3	dB
10	Residual pump at input/output ports					-30	dBm
11	Input/output return loss			45			dB
12	Input/output isolation			40			dB

2.Optical cables and connectors

N	Characteristic	Min	Typ.	Max	Unit
1	Type of fiber		SMF-28™		
2	Type of connectors		FC/APC		
3	Input / Output pigtail length	1.5			m

3.Control outputs

N	Characteristic	Min	Typ.	Max	Unit
1	Input power		Display, GPIB, RS-232		
2	Output power		Display, GPIB, RS-232		
3	Pump current		Display, GPIB, RS-232		
4	Temperature		Display, GPIB, RS-232		

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4.Electrical Characteristics

N	Characteristic	Min	Typ.	Max	Unit
1	AC supply voltage	100		240	V
2	Power Consumption		30		W

5.General characteristics

N	Characteristic	Min	Typ.	Max	Unit
1	Operating temperature range	0		+40	°C
2	Storage Temperature	-20		+60	°C
3	Warm-up Time to full power stabilization			5	min
4	Humidity	0		95	%
5	Weight		5.5		kg
6	Package size	Rack 2Ux374,5			mm

6.Certification

Test data shipped with each amplifier

- Serial number
- Manual with test sheet

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6. External Layout

The operating controls, indicators and connectors of the **EAD-40-C** front and rear panels are listed in Table 2.

Table 2.

1.	**EMERGENCY STOP** button	Button to emergency shutdown the power
2.	**POWER** key	Key to turn ON and OFF the power
3.	**DISPLAY**	Used to display gain, current input and output power
4.	**MENU** button	Used to call menu
5.	**SELECT** button	Used to select the features
6.	**ENTER** button	Used to enter into submenu
7.	**EMISSION** button with indicator	When pressed the current through the pump laser diodes can be turned ON and OFF. When the indicator light, the drive current is supplied to the pump diodes
8.	**ESC** button	Used to save parameters and return from submenu
9.	**ENCODER** knob	Used to set gain (AGC mode), output power (APC mode) and current (ACC mode)
10.	**IN**	Input optical port
11.	**OUT**	Output optical port
12.	**Fans**	Cooling fans
13.	**GP-IB** connector	To connect to GP-IB interface of computer
14.	**RS-232** port	To connect to computer
15.	**AC-LINE Plug-in**	To connect to AC-line (it includes fuses and main switch)
16.	**SAFETY INTERLOCK** connector	When shorted , emission operation is possible. Otherwise, the emission is disabled.

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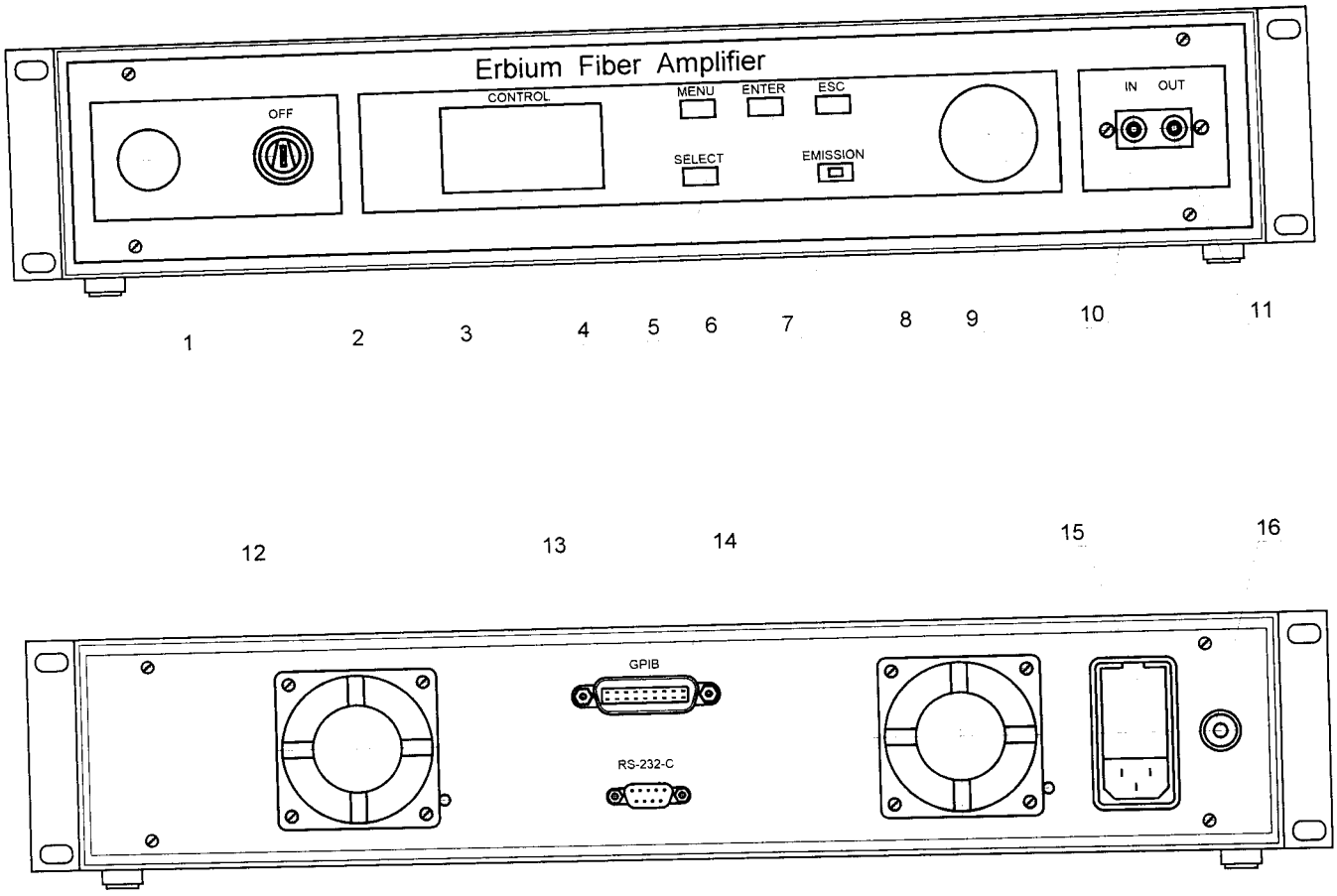


Fig. 1

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7. Preparations for use

Certification

IPG Laser certifies that this instrument has been thoroughly tested and inspected, and found to meet published specifications prior to shipping.

NOTE: Upon Receiving your device check the packaging and parts for any possible damage that may have occurred in transit. If damage is apparent please contact IPG Laser immediately.

Operation

1. Connect an input signal to the input port of the amplifier.
A standard FC/APC connector is installed at the input.

2. Connect the output connector to the measurement setup.
A standard FC/APC connector is installed at the output.

NOTE: Clean carefully the output connector facet to avoid the optical damage when the amplifier emits high optical power.

3. Turn the power **ON** with the **"POWER"** key clockwise.
The device can operate in three operation modes:

- **AGC** (Gain stabilization)
- **APC** (Power stabilization)
- **ACC** (Current stabilization)

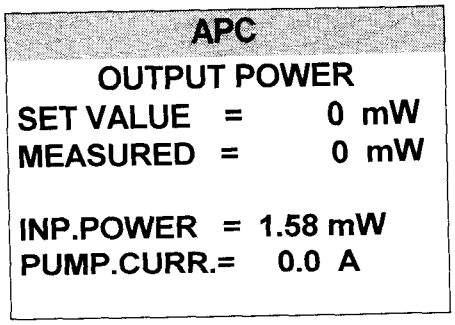
A following information appears on the display in dependence of operation mode:

AGC Mode

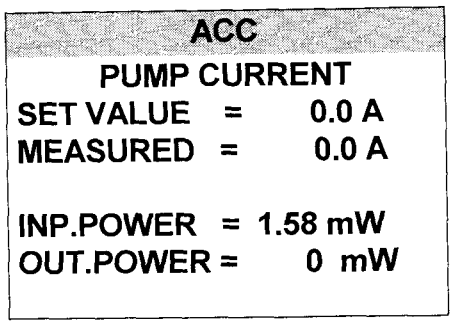
AGC
OPTICAL GAIN
SET VALUE = 19.0 dB
MEASURED = - -. - dB
INP.POWER = 1.58 mW
OUT.POWER = 0 mW

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APC Mode



ACC Mode



To change the mode press the **"MENU"** key to call menu. Choose **"OPERATION MODE"** with **"SELECT"** key and press **"ENTER"**, choose operation mode with **"SELECT"** key and press **"ESC"** twice to return to main screen.

5. Choose for example the power stabilization mode, set the output power by rotary encoder. Press the **"EMISSION"** button. The **"EMISSION"** indicator blinks, the pump current will appear with 2 sec delay and emission indicator should light. **Pressing this key once more, one can stop amplifier emission.** Output power could be changed under operation with rotary encoder.

6. Use **"POWER UNITS"** feature of menu to switch between mW and dBm display units.

7. An input signal control system will shut emission down at input signal power lower than preset level. The warning message **"Low input signal"** is displayed. The default value is 100 μW. To change this value use **"INP. POWER THRESHOLD"** of menu.

NOTE: If value is zero the protection is off.

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8. At the rear panel of the device is placed interlock connector. For normal operation pins must be shortened. If not, LD current is shut down, and device is disabled. Message **"Interlock active"** is displayed. One can use mating gag attached to short cut the interlock connector.

9. The device is protected against overheating. If the temperature of the pump diodes exceeds 60°C, the drive current will cut off automatically, and the warning message **"Overheating"** is displayed. For temperature display use **"TEMPERATURE"** of menu.

NOTE: If the amplifier is overheated , do not use it and call to the IPG Laser or its representative for assistance.

NOTES:

- The best characteristics are achieved at the specified output optical power in power stabilization mode.
- Before switching the main "POWER" key OFF make sure that the "EMISSION" indicator is OFF.

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8. RS232 interface commands

Interface must be set for the next parameters:
9600 Baud, 8 bits data length,1 stop bit, no even/parity check.
Three wires (RxD, TxD, GND) of interface are used.

The command from computer consist of operation code (1 byte) and optional parameter (as ASCII-string), terminated by the "carriage return" ("CR") byte (0D-hex).

Tab. 3

N	Command	Operation code	Example
1	Set pump current	80h	80 31 2E 30 30 0D To set 1.00 A
2	Set output power	81h	81 34 30 0D To set 40 mW
3	Set gain	86h	86 32 31 2E 31 0D To set 21.1 dB
4	Emission ON	8Eh	8E 0D
5	Emission OFF	8Fh	8F 0D
6	Read pump current	82h	82 0D Device return ASCII string. Current value is in A
7	Read output power	83h	83 0D Device return ASCII string. Power value is in mW
8	Read input power	84h	84 0D Device return ASCII string. Power value is in µW
9	Read temperature	85h	85 0D Device return ASCII string. Temperature value is in °C
10	Read current limit	87h	87 0D Device return ASCII string. Limit current value is in A
11	Read output power limit	88h	88 0D Device return ASCII string. Output power limit value is in mW
12	Read minimum gain	89h	89 0D Device return ASCII string. Gain value is in dB
13	Read maximum gain	8Ah	8A 0D Device return ASCII string. Gain value is in dB

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14	Read device status	8B	8B 0D Device return 1 byte and the bits have following information Bit0, Bit1 0 0 – ACC mode 0 1 – APC mode 1 0 – AGC mode Bit2 1 – Interlock active 0 – Interlock passive Bit3 1 – Overheating, 0 – Temperature is OK Bit4 1 – input power to low 0 – input power is OK Bit5 1 – Emission ON 0 – Emission OFF Bit6 reserved Bit7 reserved

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9. GP-IB interface commands

Tab. 4

N	Command	Parameter	Return	Description
1	*CLS			Clear Status Command
2	*ESE	16-bit signed integer value		Standard Event Status Enable Command
3	ESE?		16-bit signed integer value	Standard Event Status Enable Query
4	*ESR?		16-bit signed integer value	Standard Event Status Register Query
5	*IDN		IPG Erbium Fiber Amplifier	Identification Query
6	*OPC		ASCII '1' is always returned	Operation Complete Command
7	*OPC?			Operation Complete Query
8	*RST			Reset Command
9	*STB?		16-bit signed integer value	Read Status Byte Query
10	*TST		16-bit signed integer value	Self Test Query
11	*WAI			Wait Command
12	PUMP?		Current draw in Amperes	Current draw request
13	POUT?		Value of output power in mW	Output power request
14	PIN?		Value of input power in µW	Input power request
15	TEMP?		Value of temperature in deg.	Request for temperature
16	ACC	Pump current value in Amperes		To set current draw. ACC 1.25 – current is 1.25 A. When this value is higher than CURRENT LIMIT, the set value will be limited. ACC mode will be initialized.
17	APC	Output power value in mW		To set output power. APC 190 – power is 190 mW When this value is higher than POWER LIMIT, the set value will be limited. APC mode will be initialized.

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18	AGC	Gain value in dB		To set optical gain value. Gain is limited by the GMIN and GMAX values. AGC mode will be initialized.
19	EMON			Command to initialize emission
20	EMOFF			Command to stop the emission
21	ILIM?		Current value in mA	CURRENT LIMIT value request
22	PLIM?		Power value in mW	POWER LIMIT value request
23	GMIN?		Gain value in dB	Request for the minimum value of the optical gain.
24	GMAX?		Gain value in dB	Request for the maximum value of the optical gain.
25	STAT?		8-bit unsigned integer	Device status request Bit0, Bit1 0 0 – ACC mode, 1 0 – APC mode, 0 1 – AGC mode Bit2 1 – Interlock active, 0 – normal operation Bit3 1 – Overheat, 0 – normal operation Bit4 1 – insufficient input power, 0 – normal operation Bit5 1 – Emission ON, 0 – Emission OFF Bit6 always =1 Bit7(MSB) always = 0

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10. Warranty

All parts of this product are warranted by IPG Laser against defects in material or workmanship for a period of one year from the date of delivery.

In the event of a defect occurring during the warranty period, IPG Laser will repair or replace this product within a reasonable period of time after notification, free of charge, provided that: it is returned to IPG Laser; has not been misused; has not been damaged by an act of God, and that the user has followed the instructions in the operation manual. It is the customer's responsibility to understand operating instructions and specifications prior to operation.

Any unauthorized modification, repair, or attempt to repair, will render this warranty void.

This warranty is effective only for the original purchaser of this product and it is not transferable if it is resold.

All requests for repair or replacement under this warranty must be made as soon as possible after the defect has been noticed and must be directed to IPG Laser or its representative in your area.
Items authorized for return by us must be returned in suitable container.

Any damage noted upon receipt of the unit must be documented for appropriate claim against the carrier.

We reserve the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

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