Grace X Series Laser

Manual for Installation and Operation

（2019/7）

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Foreword

This manual contains all related using information about GRACE X series lasers. The following are the two kinds of warning signs in the manual. Please pay particular attention to the latter content when reading.

This symbol is intended to alert the operator to the danger of exposure to hazardous Visible, Invisible, or Ultra Violet radiation.

This symbol is intended to alert the operator to a potential danger to operator or equipment, or to give the operator important instructions.

Warning! Please carefully read the Installation and Operation Manual before operating laser. Any questions please directly contact us!

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Chapter Four　Brief Introduction of Signal Control of GRACE X Series Laser

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Chapter One　Safe Using Declaration and Caution of GRACE X Series Laser

1.1　Disclaimer for Safe Operation

The operator must carefully read the manual for installation and operation before operating Inngu laser to avoid any accidental harm on body. Inngu laser will not take the legal responsibility for any harm on body caused by that the operator does not operate according to the normal operation specifications of Inngu laser.

1.2　Safety Characteristics

（1）Rocker switch. The laser control panel has rocker switch. Only when the rocker switch is on, the laser may have light.

（2）Laser Signs: Technical parameters like output wavelength, power and pulse width are marked on the surface of laser head. Danger warning sign is posted on the front part of laser head. The triangle label above shows the direction that laser shoots.The strip window below shows laser danger warning.(See as Picture 1)

Picture 1

1.3   Safety Caution

DANGER!   GRACE X Series Laser is a Class IV High Power Laser. Extreme care should be taken when operating because the output laser beam may cause fire and safety hazard. Preventive actions must be taken to prevent the perpendicular incidence and exposure from output or reflected beam on body. Both scattering and reflected beam can cause severe damages on skin and eyes. Proper shielded eyewear must be worn at all times in operation.

Attention: Only person who is familiar with the safety precautions listed in this manual should operate the laser system.

Must know on operation safety of Class IV High Power Laser:

1. Under no circumstances the case of laser cavity shall be opened.

2. The sign should be placed near laser running area for Class IV laser products.

3. Do not stare at the output beam directly. Scattering and reflected beams are hazardous.

4. Protective eyewear must be worn when using laser.(The wavelengths of 355nm has a little high reflectivity.)

5. Equipment integrators should make optical system enclosed to the greatest extent.

6.One principle must be obeyed: The beam path can not at the same height with eyes.

Laser is dangerous compared to ordinary light source due to the special characteristics of laser beam. All laser operators as well as the staff near laser system must definitely be aware of the dangers in using laser. Only familiar with laser devices and fully aware of the coherence and optical intensity of laser beam, laser operators can ensure their safety.

DANGER!   Direct eye contact with the output beam from laser will cause serious damage and even blindness. The most attention should be paid to the safety of eyes.Except main beams, various angles of small beams exit near the laser system.These beams are formed by specular reflection of main beams on polished surfaces(like lens,speculum and other optical components).Although these beams are very weak compared to main beam, they can still do much damage on eyes.The laser beams are strong and can burn clothes and oil on the surface. It can still ignite volatile substances like organic solvents even it has diffused at a distance. Laser beams will also damage on light sensors in optical cameras and luminous diodes. At the same time, it will damage the mediate touch from reflected surface.

1.4　Caution for Packing and Shipping

1. Put all the system units of GRACE X Series Laser in one packing box.

2. There are a GRACE X series laser head, a RSP-320 power adapter, a USB transferring to RS232 data cable, a gold plating DB15 male connector, a DB15 shell, two RG142 radio frequency cables, a test report and a manual of installation and operation involved in laser packing carton.

3.Please reserve related original packing materials after opening the package. If laser is needed to be returned to factory for repair, please use the original packing materials in order to avoid the damage in transportation.

4. If shipping the laser to other places, please use original packing materials, pay attention to placing order and notice that no foam is leaked to the light outlet of laser.

5. For laser shipment, please attach upward labels, shockproof labels and damp-proof labels.

6. The laser is integrated with system. Notice the heat dissipation and ventilation of laser environment and external environment.

7. The laser normally works under the environment of 5 to 40 centigrade. At the same time, please pay attention to the cleanliness of external environment to avoid the obstruction of air passage.

8. Please notice preheating 20 minutes when restarting up if the main switch powers off for a long time(to ensure laser safety).

9. The system parameters can not be modified at random.

10. Do not power off frequently.

11. Advise using voltage-stabilized power(500W) or UPS power(500W).

12.Advise cleaning the strainer every 3 month.

⚠ *Attention: Take care when opening the packing box because there are fragile parts in the laser head.*

⚠ *Attention: Please gently take out and put down when opening the package box in case of damaging the accessories.*

Chapter Two　　Connection Between GRACE X Series Laser and External Control Board

2.1　Control Way of Laser Board Card

The GRACE X series laser usually has two signals to control laser: internal control by GATE signal and external control by PWM signal (Advised).

2.1.1　Internal Control of GATE Signal

Take advantage of high and low electrical level to control the on and off of laser. The frequency and percentage of laser can not be directly controlled. The current, frequency and percentage of laser must be adjusted by laser control software to control the emitted power.

Operation of Internal Control by GATE Signal:

1. Connect GATE Signal;

2. Connect FPS Signal(plug or not);

3. After normally starting up and preheating(Refer to the 3nd chapter of Operation Manual of Grace X Series Laser for the process of start-up), automation or starting-up software can increase and decrease currentas well as adjusting frequency and PWM.

Attention：Under the circumstance of internal control by normal GATE signal, the three LED lights of DIODE, QS-ON and SHT-ON must be on at the interface of software.

Low-electrical-level emitting light is the factory default of GATE signal for GRACE X series laser.

2.1.2 External Control of PWM Signal

Under the circumstance that the current is adjusted to normal working condition, the power of laser emitting light can be controlled by the tunable frequency and pulse width built in marking software.

Operation of External Control by PWM Signal：

1. Connect PWM Signal

2. Connect FPS Signal(plug or not);

3. After normally starting up, increasing current and preheating, the frequency and pulse width in relevant marking software can be adjusted for operation.

Attention：Under the circumstance of external control by normal PWM signal,the five LED lights of DIODE, QS-EXT, QS-ON, SHT-ON and MODE must be on at the interface of software.

2.2 Detailed Explanation for Rear Interfaces
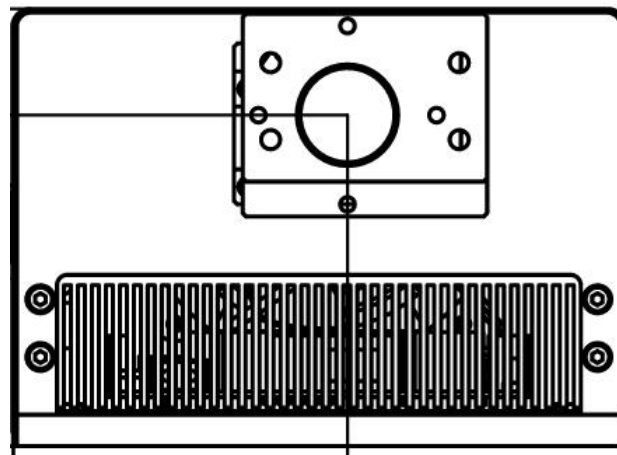
Picture of Front Panel
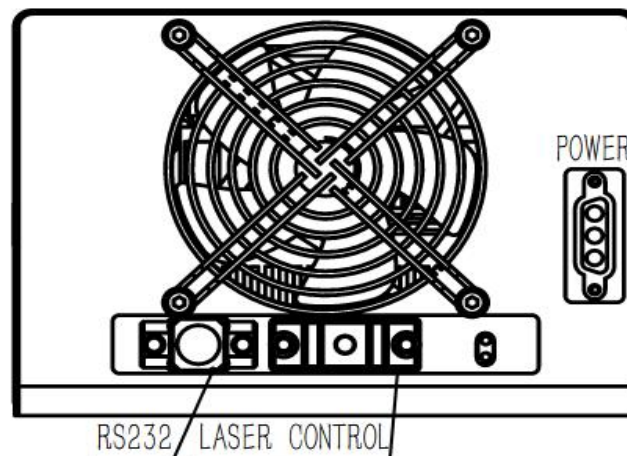
Picture of Rear Interfaces

Definition of Rear Interfaces:

POWER: 12VDC inputs ports(Our company delivers the power adapter of RSP320-12);

RS232(DB9):   Communication Interfaces of RS232 Serial Ports;

LASER CONTROL(DB15):   Function of Laser Control Interfaces

LASER CONTROL(DB15)   Pins Definition:

LASER CONTROL
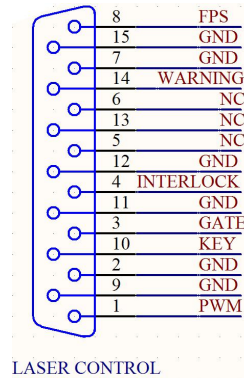
Pins	Signal	Pins Definition
1	PWM	PWM Input PIN
2	GND	Make Up Hardware Switch Function with PIN 10
3	GATE	GATE Input PIN
4	INTERLOCK	INTERLOCK Input PIN
5	NC	No Connection
6	NC	No Connection
7	GND	Make Up Warning Output Function with PIN 14
8	FPS	FPS Signal Input PIN
9	GND	Make Up PWM Signal with PWM Input
10	KEY	Input Port of Hardware Switch(Default internal parts are closed or opened.)
11	GND	Make Up GATE Signal with GATE Input
12	GND	Make Up INTERLOCK Signal with INTERLOCK Input(Default functions are closed)
13	NC	No Connection
14	WARNING	Warning Output Port(Warning Output 5V Signal)
15	GND	Make Up FPS Signal with FPS Input 信号

2.3　Wiring Method of Markingmate PMC2

P2 (LASER_CONNECTOR): Laser Control Interface

15-pin 母座脚位图	脚位	脚位说明
	1	Analog Out1
	2	Analog Out2
	3	GND2 [1]
	4	Laser1 (PWM) [2]
	5	Laser2 (FPK) or R05 [2]
	6	L0 (Laser On/Off)
	7	L1 (Leading Light On/Off)
	8	L2 (Shutter)
	9	L3 (CW select)
	10	L4 (Lamp On/Off)
	11	L5 (启动省电模式)
	12	/START 为输入干接点(与 Pin15 短路即可触动 START)
	13	/STOP 为输入干接点(与 Pin15 短路即可触动 STOP)
	14	+5V
	15	GND [1]

Input Types of Control Signal	Markingmate PMC2（DB15 Triple Rows）	GRACE X Laser Pins （DB15 Double Rows）
PWM	PIN 4(Laser1)	PIN 1(PWM)4
	PIN 3(GND)(connect to the shielding layer of coaxial cable)	PIN 9(GND)
GATE	PIN 6(L0_Laser On/Off)	PIN 3(GATE)
	PIN 3(GND)(connect to the shielding layer of coaxial cable)	PIN 11(GND)
FPS	PIN 5(Laser2)	PIN 8(FPS)
	PIN 15(GND)(connect to the shielding layer of coaxial cable)	PIN 15(GND)

Attention: Accessing FPS, GATE, PWM signals must use gold plating DB15 male (delivered) connector and radio frequency cables which has strong ability of anti-interference.

2.4 Wiring Method of EzCad(JCZ) (Strongly advise using the latest USB digital card)

Attention：As there are too many types of JCZ board card, please check if pins(see pictures below) are consistent before wiring. If not, please consult the supplier of board card or directly contact us.
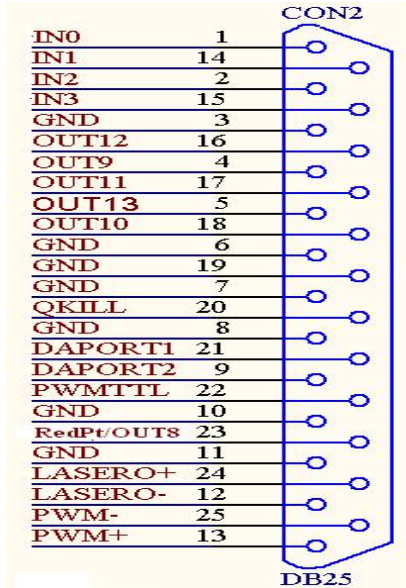
Pin	Name	Function
1, 2, 14, 15	IN0——3	General input 0-3. Form the loop with signal GND. To use these signals connect this pin and GND to a switch. This corresponds to the In0-3 in the software.
3, 6, 7, 8, 10, 11, 19	GND	The reference ground of the control board and 5V input power of control card. Use as a return pin(reference ground) of all the signals of CON2.
4, 5	OUT 9, OUT13	General output 9 and 13. TTL output.
16, 17, 18	OUT 12, 11, 10	General output 10-12. Open chain output.
20	QKILL	First pulse kill signal. TTL output. The reference ground is pin GND.
9	DAPORT2	Frequency control/ first pulse kill. This is a analog signal between 0-5V. The maxim drive current is 5mA. This signal can be set in the software. Form the loop with signal GND.
21	DAPORT1	Laser power control signal. This is a analog signal between 0 and 10V. The maxim drive current is 5mA. Form the loop with pin GND.
23	RedPt/OUT8	Red light indicator signal/general output signal 8, TTL output. The reference ground is pin GND.
12	LaserO-	Laser switch signal(Light shutter signal). TTL output. Form the loop with pin GND. Low electrical level is effective.
24	LaserO+	Laser switch signal(Light shutter signal). TTL output. Form the loop with pin GND. High electrical level is effective.
13, 25	PWM-/PWM+	PWM signal. Differential output.
22	PWMTTL	PWM signal. TTL output. For CO2 laser the reference ground is GND signal. This signal is used to set the laser power as well as signal Tickle output For YAG laser it's used as a repeat frequency signal of Q driver.

Input Types of Control Signal	Ezcad USB Digital Card（DB25）	GRACE X Laser Pins （DB15 Double Rows）
PWM	PIN 13(PWM+)	PIN 1(PWM)
	PIN 10(GND)(connect to the shielding layer of coaxial cable)	PIN 9(GND)
GATE	PIN 12(LASERO-)	PIN 3(GATE)
	PIN 11(GND)(connect to the shielding layer of coaxial cable)	PIN 11(GND)
FPS	PIN 20(QKILL)	PIN 8(FPS)
	PIN 7(GND)(connect to the shielding layer of coaxial cable)	PIN 15(GND)

Attention: Accessing FPS, GATE, PWM signals must use gold plating DB15 male (delivered) connector and radio frequency cables which has strong ability of anti-interference.

2.5 Wiring Method of SAMLight (See as Picture Below)

2.3.2 Interface Definition of DB37			
Item	Pin	Function	Signal Instruction
LP1~LP7	16~18, 34~37	8 bit output. Used to control the laser power of YLP. LP7 is the highest.	TTL output. The maximum is 30mA.
LPO	19	Laser power locked and stored pulse output	
OPTO_IN0	1	Externally start triggling. Valid for high electrical level.	Optocoupler input. The threshold value is +2V.
OPTO_IN1	20	Externally stop triggling. Valid for high electrical level.	
OPTO_IN2	2	Laser State Bit 1 (Software Configuration Bit)	
OPTO_IN3	21	Laser State Bit 2 (Software Configuration Bit)	
OPTO_IN4	8	Software Configuration Bit	
OPTO_IN5	9	Software Configuration Bit	
OPTO_OUT0	3	Marking state output. Valid for high electrical level.	Optocoupler output. Need to supply power externally via pin 5(+) and pin 6(-). When it is 5V, the output current is 1mA. It can be 10 mA if connecting externally a 470Ω resistor between pin 5 and output terminal.
OPTO_OUT1	22	Malfunction State Bit	
OPTO_OUT2	4	Guide red laser control output. High electrical level=marking.	
OPTO_OUT3	23	Software Configuration Bit	
OPTO_OUT4	27	Software Configuration Bit	
OPTO_OUT5	28	Software Configuration Bit	
OPTO_V+	5	Supply power by photocoupler output circuit. Only +5V can be used when connecting YLP laser.	+5~24VDC
OPTO_GND	6	Connect ground when supplying power by photocoupler output circuit.	
LASER_GATE	31	Laser switch control output.	Optocoupler TTL output. The maximum is 5mA. Power can be supplied externally via pin 11(+) and pin 30(-). +5VDC
LASER_A	13	Pulse repetition frequency and Q switch output.	
LASER_B	12	First Pulse Suppression Output	
LASER_OPTO_VCC	11	Laser signal when supplying power by optocoupler output circuit.	5V DC
LASER_OPTO_GND	30	Laser signal when connecting ground and supplying power by photocoupler output circuit.	
DAC_A	10	Internally 8 bit D/A conversion output 1. Can choose the range of voltage via wire jumper: 2.5V, 5V or 10V.	Analogue output. The maximum is 10mA.
DAC_B	29	Internally 8 bit D/A conversion output 2. Can choose the range of voltage via wire jumper: 2.5V, 5V or 10V.	
RXD	32	Interface of RS232. Range of baud rate: 2400~57600. RXD	RS232 Serial Communication
TXD	33	Should connect to RXD and TXD of control devicein the same way.	
VCC_+5V	24	Externally+5V and power supply input. Supply power to internal basic circuit.	5V DC
GND	25, 14,	Public Ground	
MOF_CH0	7	Encipheror Input 1	5VDC. The maximum is 7V. The threshold value is 3.4V.
MOF_CH1	26	Encipheror Input 2	

Input Types of Control Signal	SAMLight Card（DB37）	GRACE X Laser Pins （DB15 Double Rows）
PWM	PIN 13(LASER_A)	PIN 1(PWM)
	PIN 14(GND)(connect to the shielding layer of coaxial cable)	PIN 9(GND)
GATE	PIN 31(LASER_GATE)	PIN 3(GATE)
	PIN 15(GND)(connect to the shielding layer of coaxial cable)	PIN 11(GND)
FPS	PIN 12(Laser_B)	PIN 8(FPS)
	PIN 30(GND)(connect to the shielding layer of coaxial cable)	PIN 15(GND)

Attention: Accessing FPS, GATE, PWM signals must use gold plating DB15 male (delivered) connector and radio frequency cables which has strong ability of anti-interference.

Chapter Three   Operation Instruction of GRACE X Series Laser on Staring up and Shutting Down

3.1   Operation Instruction on Hardware Startup & Shutdown

Remarks: Strongly advise not close the general power switch. It will make laser working in sleeping an standby state and keep the temperature of harmonic generation crystals, which is beneficial to the storage of crystals and extension of operation time.

The factory default automatic starting-up mode of GRACE X series laser is 2. Controlling laser by PWM signal is advised to customers.

Starting-up Procedures of Hardware:

1. Plug in the cable of power adapter. Turn on the general power switch;

2. Wait laser automatic starting up for 2 minutes;

3. Check if there is guide laser at where the laser is emitted after 2 minutes;

4. Guide laser and flashed green light of hardware state light indicates that automatic starting up of hardware is completed.

Shutting-down Procedure(See as Picture Below):

1. Connect serial port cables on industrial computer. Start laser software and read laser parameters;

2. Click "TURN OFF" once. Wait status bar of Message on the right of software until seeing "Shutting down is completed" and then get 220V power off.
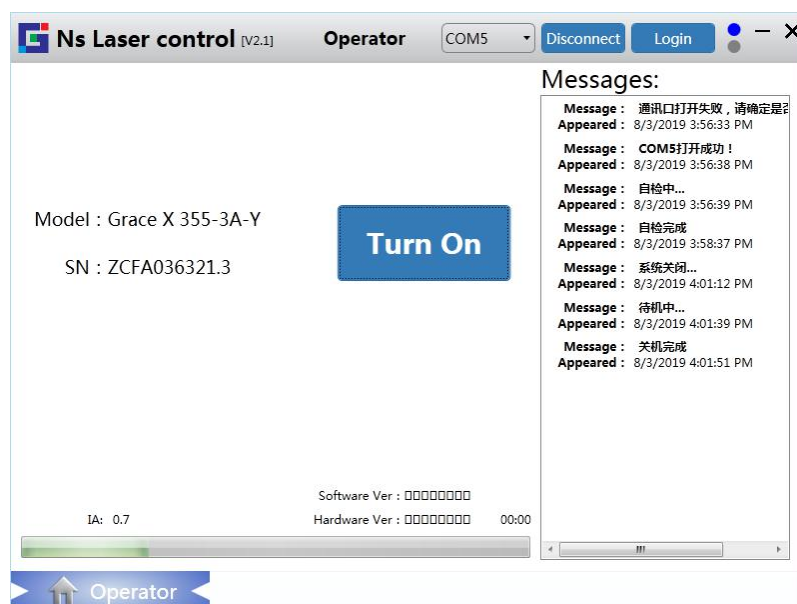
3.2 Operation Instruction on Software Startup & Shutdown

Starting-up Procedure of Hardware:

1. Plug USB transferring to RS232 cable onto the PC main board. Install USB transferring to RS232 driver(in laser software catalogue) and "dotnetfx45_full_4.5.51209" documents supporting laser software being used in Win 7(in laser software catalogue);

2. Plug in the cable of power adapter and ensure the laser is power on;

3. Start laser software, choose correct ports and click "CONNECT". The state light at the top right corner of software will be blue and green or "COMX is successfully opened" will occur under Messages, indicating serial ports are successfully connected;

4. Click "TURN ON" key in the middle of software and wait 2 minutes. "Running..." occurring under Message on the right indicates laser starting up is completed.

Ps: Only support Windows 7 or higher systom. Not support XP system.

Shutting-down Procedure:

1. Connect serial port cables on industrial computer. Start laser software and read laser parameters.

2. Click "TURN OFF" once. Wait status bar of Message on the right of software until it shows "Shutting down is completed" and then get 220V power off.

⚠ **Attention! The temperature of laser diode can not be arbitrarily changed without the guidance of technical persons from Inngu Laser.**

Chapter Four   Brief Introduction of Signal Control of GRACE X Series Laser

4.1 Control by Gate Signal

GATE:
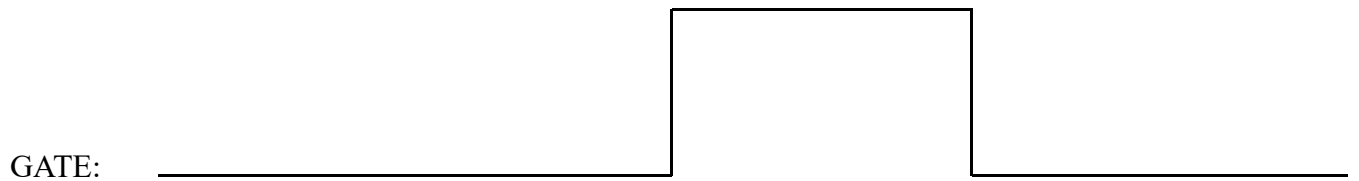
Internal   PWM   Adjustment   100%-10%
（500ns-10us）(1064nm laser is 10us-1us)

Internal Frequency:

>20us

FPS:

Laser pulse:
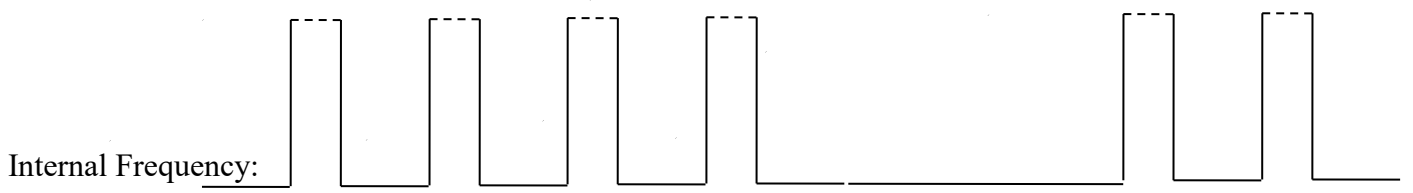
4.2 Control by External PWM Signal(Advise using)

>500ns(1064nm laser is >1us)

External Frequency：

GATE:

>20us

FPS:

Laser pulse:
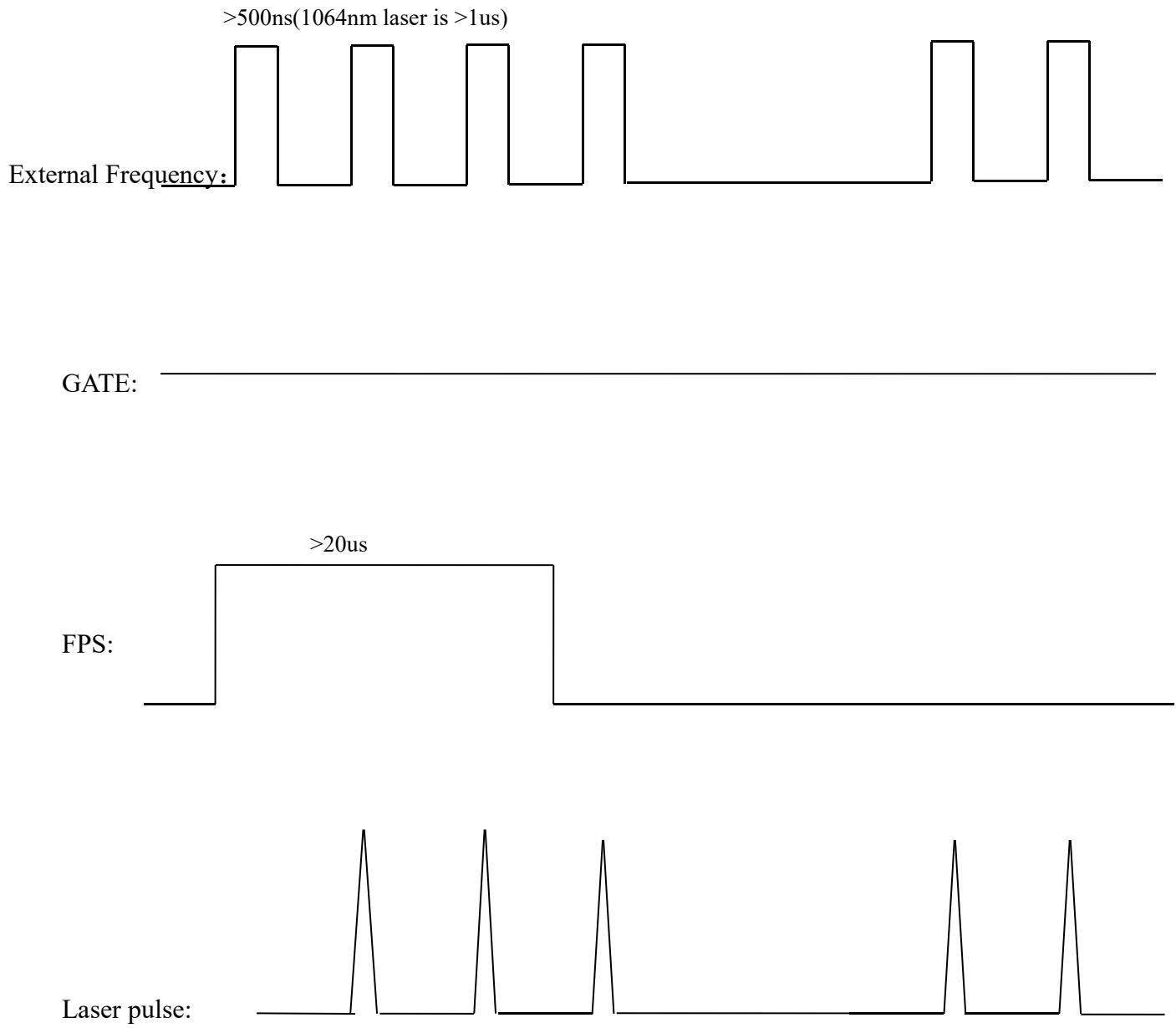
Chapter Five　　Detailed Explanation for RS232 Communication of GRACE X Series Laser

5.1 Pins Instruction of RS232 Interfaces

　　Remarks: Advise operating by using the serial ports data provided by our company as our company offers USB transferring to RS232 cable; if the customers insist using the serial port cables which RS232 is direct connected, they must buy finished serial port cables to ensure the norma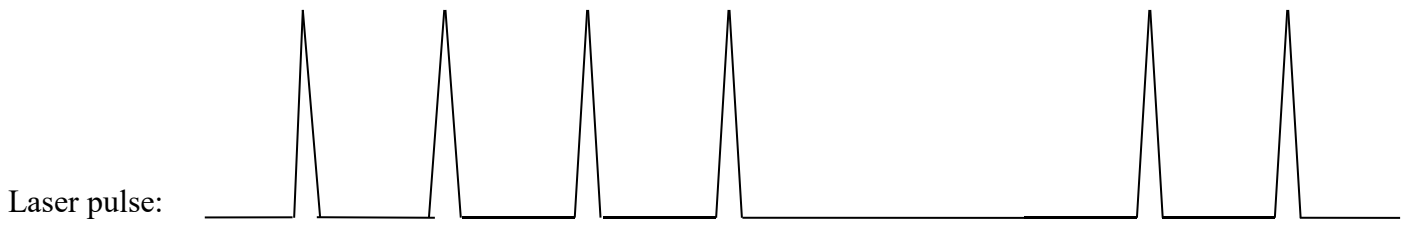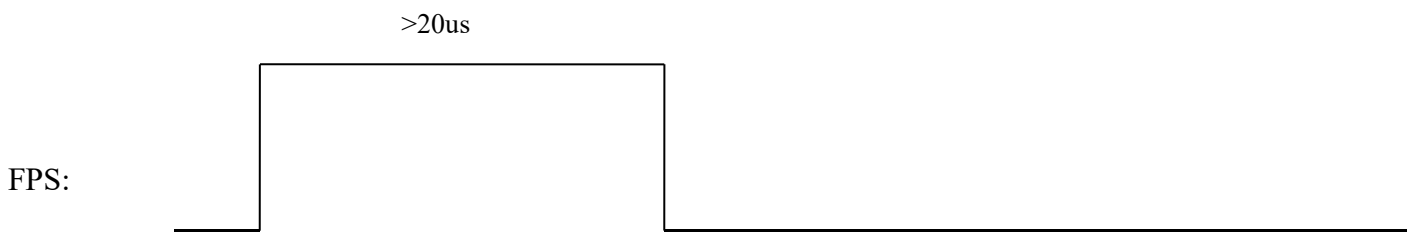l communication of serial ports. Home-made twisted pair cables without shielding layer must not be used.
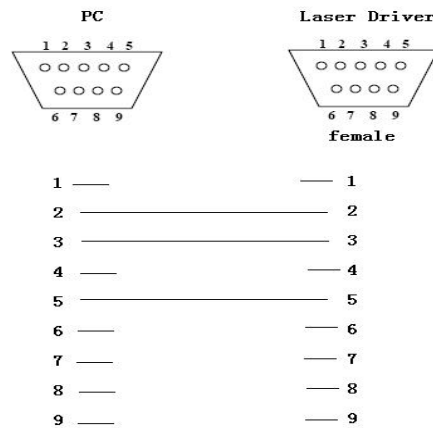
Pins(PC)	Instruction	Pins(Laser Driver)	Instruction
1	Vacant	1	Vacant
2	Receive Data	2	Send Data
3	Send Data	3	Receive Data
4	Vacant	4	Vacant
5	Earth Wire	5	Earth Wire
6	Vacant	6	Vacant
7	Vacant	7	Vacant
8	Vacant	8	Vacant
9	Vacant	9	Vacant

5.2 Software Control Instruction of RS232 Communication

5.2.1   RS232 Ports Setting

Generally, a computer may have four serial ports for RS232 communication. The laser uses COM1 port.(Search that by opening the device manager of PC)

Baud Rate	9600
Odd-even Calibration	Even
Data Bit	8
Halt Bit	one

5.2.2 Communication Protocol

Remarks: Please use the agreement with the software above InnguLcV2.1 version which is provided by our company;

Open MODBUS－RTU communication stipulations are adopted by GRACE X series laser. Please refer to related documents for detailed stipulations.

Example of MODBUS－RTU Communication Stipulations:

Function Code 03H(0x03)：Read   Save Register

Instruction: Read the data of 16 bits. High bits in front and low bits behind.

Eg.: Command: 01   03   00 31   00 01   CRC   (8 bits)

        Address   Function   Initial Address   Register Quantity CRC Calibration

Response: 01   03   02   00 00   CRC   (7 bits)

        Address   Function   Byte Count   Register Data   CRC Calibration

Take the example of assistant setting of JCBus serial ports adjustment:

写入:01 03 00 31 00 01 D5 C5   回传:01 03 02 【 00 00 】 B8 44

Function Code 06H(0x06): Set data of single register

Quantity of register: Set 1 register at one time

Eg.: Master Sending: 01　　　06　　　00 31　　　00 01　　　CRC　(8 bits)

　　　　　　　　　Address　Function Code　Initial Address　WRSR Data　CRC Calibration

Slave Response: Completely the same as the data sent by host machine　　(8 bits)

Take the example of assistant setting of JCBus serial ports adjustment:

写入:01 06 00 31 00 01 19 C5　　　　　　回传:01 06 00 31 00 01 19 C5

5.3 Register Definition

Function Code of Starting-up Command: 03H/06H

0030H	REG_DEVICEMODE	0: Automatic starting up（Staring system command must be written after the power on under this mode） 1: Automatic shutting down (No action is needed after power on under this mode. The system will complete the GATE starting-up process automatically.) 2: Automatic starting up （No action is needed after power on under this mode. The system will complete external PWM starting-up process automatically.）	Set Starting-up Mode 0-1Mode
0031H	REG_ON_OFF	0: System is closed. 1: System is started.	System Starting Command
0032H	REG_SYS_STE	0: Start 1: Starting is finished 2: Working （Laser can work normally.） 3: Warning 4: Standby （power off or start system）	Search System State
001AH	REG_SAVE_DIODECUR		Set the working current of automatic starting-up(adjust based on the current range from test report)

Waring Type ROM, Function Code 03H Warning Type

Register Address	Variate	Remarks	Description
0000H	REG_TDI	Return laser diode temperature in degrees Centigrade.	Search LD Temperature
0001H	REG_TK1	Return the number of TEMP1 value	Search Temperature OF Crystal 2
0002H	REG_TK2	Return the number of TEMP2 value	Search Temperature OF Crystal 2
0003H	REG_ENVACT	Return the number of environment temperature value	Environment Temperature
0004H	REG_LASACT	Return the number of laser temperature value	Laser Temperature
0005H	REG_SERVICE_TIME		Search Using Time
0006H	REG_ALARM		Warning Register
	BIT11~ BIT16	Reserved	
	BIT10		INTERLOCK OPEN ERROR
	BIT9	XL1ER_TEMP_L	Alarm for too low temperature of second harmonic generation
	BIT8	XL1ER_TEMP_H	Alarm for too high temperature of second harmonic generation
	BIT7	XL2ER_TEMP_L	Alarm for too low temperature of third harmonic generation
	BIT6	XL2ER_TEMP_H	Alarm for too high temperature of third harmonic generation
	BIT5	LH_TEMP_L	Alarm for too low cavity temperature
	BIT4	LH_TEMP_H	Alarm for too high cavity temperature
	BIT3	ENML_TEMP_L	Alarm for too low environment temperature
	BIT2	ENML_TEMP_H	Alarm for too high environment temperature
	BIT1	LD_TEMP_L	Alarm for too low LD temperature
	BIT0	LD_TEMP_H	Alarm for too high LD temperature

Definition of Read-write Register, Function Code of Key Setting 03H/06H

Register Address	Variate	Remarks	Description
0007H	REG_DIO	Turn the diode current on or off n = 1 is diode current on. n = 0 is diode current off	Switch DIODE
0008H	REG_IDI	Set the diode current to nn.n which ranges from 0 to 15 Amps	Set Current Value 0-15A
0009H	REG_PRF	Set the number of pulses Allowed range is 10~100000	Set PRFValue 1k-150k
000AH	REG_SHT	Turn the shutter on or off n = 1 turns shutter on n = 0 turns shutter off	SHT Switch
000BH	REG_QSW	Turn the Q-Switch on or off n = 1 turns Q-Switch on n = 0 turns Q-Switch off	QS-ON Switch
000CH	REG_EXT	Turn the QS-Trigger on or off n = 1 turns QS-Trigger on n = 0 turns QS-Trigger off	QS-EXT Switch
0010H	REG_PWM	Set the number of PWM value Allowed range is 20~380 20---100%　Max 380---10%　Min	Set PWM Value 10-100%
001FH	MODE Working Mode	0：MODE function is closed 1：MODE function is open	Adjustment of MODE Working Mode

Chapter Six   Installation Drawing

6.1 Diameter Drawing for Installation