Pro-Tech TOOLS

Professional 3-in-1 laser welding system: CUT, TIG, MMA



User Manual

Translation of the original user manual

Introduction to the device

This handheld fibre laser welding machine utilises a top-class domestic fibre laser generator
fibre lasers, a new generation of high-performance water-cooled machine, and independent research and development of a new generation of welding controller, welding head and digital intelligent wire feeder to fill the gaps in the laser welding industry. It offers simple operation, automatic welding, high welding speed and the advantage of requiring no consumables. When welding thin sheets of stainless steel,
iron sheets, galvanised sheets and other metallic materials, it can perfectly replace traditional argon arc welding, electric welding and other processes.

Dimensions of the equipment

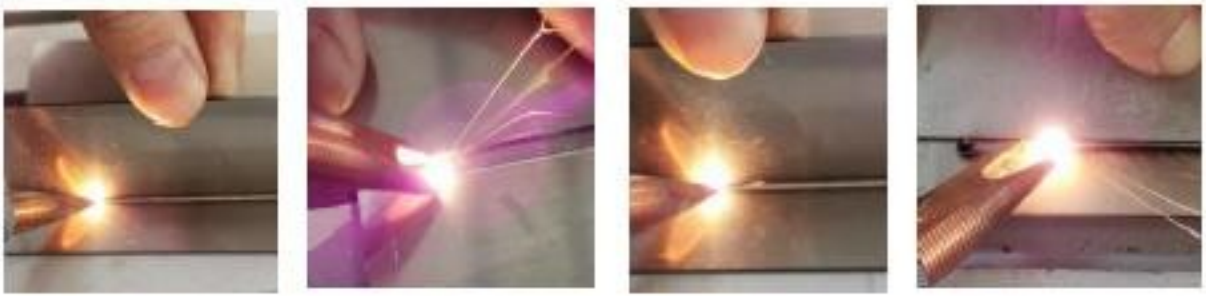


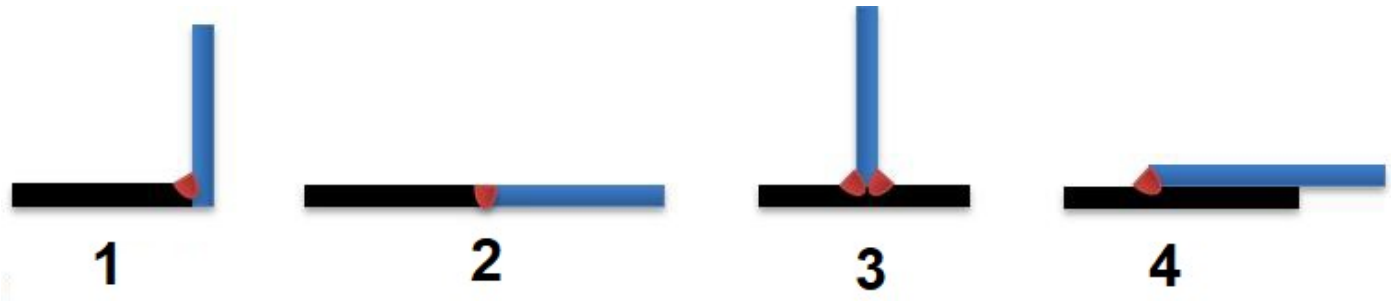
Specifications

MODEL	LBW-1500Lmini 3-in-1
POWER	1500W
NAME	Welding – cutting – cleaning 3-in-1 laser welder
TYPE	Fibre Laser
WAVELENGTH	1080 nm ± 3 nm
MAXIMUM WELDING DEPTH **NET WIDTH/CUT**	Stainless steel/iron <4 mm, aluminium <3 mm/ net 20–40 m
POSITIONING MODE	Red light positioning, copper nozzle
COOLING MODE	1500W water cooling
TOTAL POWER	＜7.5 kW
ELECTRICITY CONSUMPTION	230 V ±10% – 50/60 Hz
LENGTH OF MOVABLE OPTICAL FIBRE	10 m
DIMENSIONS	980 × 420 × 712 mm
OPERATING TEMPERATURE	10–40 ℃
OPERATING RELATIVE HUMIDITY	≤70%

Product advantages

Oscillating welding mode, adjustable spot width, high welding error tolerance, compensation for minor disadvantages of the laser welding spot, extended tolerance range
of machined parts and weld width, improved weld shape. Operation is simple and it is possible to perform welding modes for various joints.



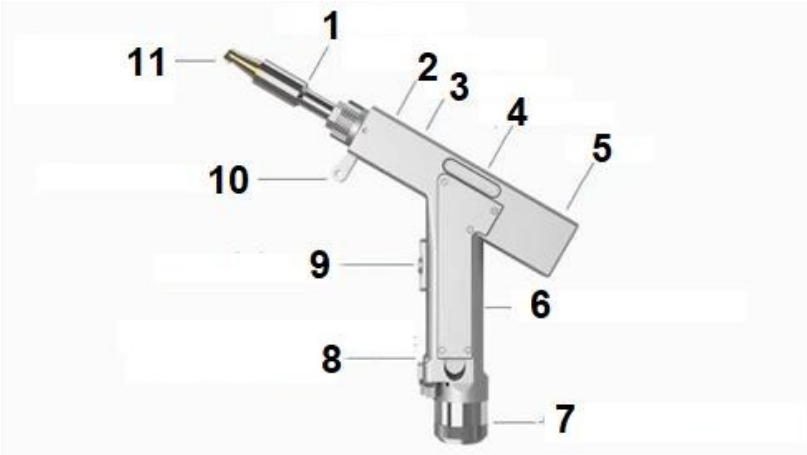


1. Fillet welding 2. Butt joint 3. T-joint 4. Sheet metal joint

3-in-1 handheld laser system

Hand-held torch

The 3-in-1 handheld system for welding, cleaning and cutting is our latest integrated system for laser welding, cleaning and cutting. It can switch between operating modes flexibly according to different application scenarios and provides diversified solutions for various user requirements. The product includes a welding/cleaning head, a proprietary control system, multiple safety alarms, and active safety shut-off and light-off settings.



1. Measuring tube
2. Protective glass
3. Focusing lens
4. Reflector
5. Motor
6. Collimating mirror
7. QBH protective cover
8. No. 1, No. 3 water circuit, No. 2 gas circuit
9. Switch
10. Wire feed support
11. Brass nozzle

Control panel operation

Welding mode interface

(1) This interface displays the current process parameters (the process cannot be adjusted on this page) and real-time alarm information.

(2) When the system is running, the default setting is ON. By default, the red light indicates the LINE status and the welding mode is continuous. When the function is switched off, no ON signal is sent to the laser; this can be used to test the gas output function. Switch off the red indicator and the motor will stop rotating. At this point, the red light serves as a reference point for setting the centre position. The welding mode is divided into continuous welding and spot welding. When selecting spot welding, the spot welding type must be set on the settings page.

(3) The safety lock is divided into grey and green. When pins 5 and 6 of signal interface 1 are short-circuited, the light turns green. At this point, the light can be activated by operating the signal pin
'optical switch for welding heads 1 and 2'.

(4) The orange button in the top right-hand corner is the toggle button. Clicking it takes you to the cleaning mode selection interface.

Welding process interface

Feed rate range: 2–6000 mm/s;

Peak power range: 1 W ~ x W, where x is the laser power;

Duty cycle range: 0–100 per cent, default setting 100 per cent, usually unchanged Pulse frequency

range: 5–100,000 Hz, 5–5,000 Hz recommended

Note:

(1) The process interface contains process parameters for debugging. In this version, a total of 10 processes can be saved.

(2) You can edit the parameters on the process page by clicking on the input field. After editing, click OK and then save. To use them, click Import (Edit – Save – Import).

(3) Some lasers are unable to produce light at a power level of less than 10 per cent. If the peak laser power on the process page is less than 10 per cent of the maximum laser power on the settings page, all output signals will be normal, but there may be no light output.

(4) The duty cycle is set to 100% by default, which usually does not need to be changed. In this case, the pulse frequency has no effect. If necessary, adjust the value based on actual requirements. Example: Peak power 300 W, duty cycle 50 per cent, pulse frequency 1000 Hz. At this point, the photolysis duration is 1 mS; photolysis occurs at 300 W for 0.5 mS, and there is no photolysis for the remaining 0.5 mS, after which the cycle repeats. At this point, the air at the welding site crackles and an abnormal sound is emitted. Actual conditions depend on the laser parameters.

(5) Click the 'Help' button in the top right-hand corner of the screen for further explanations of the relevant parameters.

Welding settings interface

On the home page, click Settings and, on the password entry page, enter the password 123456.

(1) The laser power is the maximum power calibrated by the laser manufacturer. Enter it correctly.

(2) The default gas switching delay is 200 ms, within a range of 0 ms to 3000 ms.

(3) Example: Set the air delay to 1000 ms and the gas delay to 500 ms. The actual effect is that, when the trigger is pressed, the first gas is released 1000 ms before the laser is fired. When the trigger is released, the laser stops emitting light, continues to emit gas for 500 ms, and then stops emitting gas. A sensible setting for the gas switching delay can protect the molten bath from oxidation and prevent damage to the lens from slag.

(4) The process power is gradually increased from N1 per cent to 100 per cent; when the light is switched off, the process power is increased from 100 per cent to N2.

Generally, the preset optical switching power is 20 per cent and the progressive optical switching time is 200 ms. Wire feed delay compensation is relative to the wire offset time of the optical signal and can be used with the recoil function; the default value is not set.

(1) The maximum threshold value for the temperature alarm is 65 ℃. If this value is set to 0, the temperature alarm will not be triggered.

(2) Scan correction coefficient = target line width / measured line width, ranging from 0.01 to 4. It is generally set to 1.

(3) Laser centre offset: -3 to 3 mm; a value of -3 moves the centre to the left, whilst a value of 3 moves it to the right; this is used to adjust the centre of the red light beam.

(4) The alarm level for air pressure, water cooler and laser is set to low by default. When this alarm signal is used, the alarm level should be adjusted to match that of the external device.

(5) The spot welding duration is the illumination time in each cycle of spot welding mode, and the spot welding interval is the pause time in each cycle of spot welding mode.

(6) Click the ‘Language’ box in the bottom left-hand corner to change the interface language. The current version supports Chinese, English, Korean and Russian. Click the ‘Help’ button in the top right-hand corner for more information about the

parameters. **Switching**

between modes

Operation

Click the toggle button on the welding home page to access the transition page. Click the ‘Continue’ button, then switch off and restart the machine as instructed by the system to switch to cleaning mode.

You can switch back from cleaning mode to welding mode in the same way.

Cleaning mode interface

(1) This interface displays the current process parameters (which cannot be edited on this page) and real-time alarm information.

(2) When the system is running, the function is set to ON by default and the red light is in the LINE state by default. When the function is switched off, no power-on signal is sent to the laser, which can be used to test the gas output function. Switch off the red light and the motor will stop rotating. In this case, the red light serves as a reference point for setting the centre position.

(3) This mode no longer detects the safety lock signal, so there is no need to adjust the wiring after switching modes.

(4) The orange button in the top right-hand corner is the mode switch button. Click it to switch to the welding mode interface.

Cleaning process interface

Frequency scan range: 0–100 Hz;

Scan width range: 0–20 mm/50 mm/150 mm; the maximum width depends on the gun body and the type of focusing mirror. See the model selection page for details.

Peak power range: 1W–xW, where x is the laser power setting; Duty

cycle range: 0 to 100 per cent. The default value is 100 per cent. Pulse

frequency range: 5–100,000 Hz, recommended 5–5,000 Hz

Note:

(1) The process interface contains process parameters for tuning. This version can store a total of 3 processes.

(2) 2 × scan frequency × scan width = actual scan speed. Maintaining a consistent scan frequency can ensure a relatively uniform scan trajectory at different scan widths
scan widths.

(3) The process page parameters can be edited by clicking on the input field. After editing, click OK and then Save. To use, click Import (Edit – Save – Import).

(4) Some lasers are unable to produce light at a power level below 10 per cent. When the peak laser power on the process page is less than 10 per cent of the maximum laser power on the settings page, all output signals are normal, but there may be no light output.

(5) The duty cycle is set to 100% by default, which usually does not need to be changed. In this case, the pulse frequency has no effect. If necessary, adjust the value based on actual requirements. Example: Peak power 300 W, duty cycle 50 per cent, pulse frequency 1000 Hz. At this point, the photolysis duration is 1 mS; photolysis occurs at 300 W for 0.5 mS, and there is no photolysis for the remaining 0.5 mS, after which the cycle repeats. At this point, the air at the welding site crackles and an abnormal sound is produced. Actual conditions depend on the laser parameters.

(6) Click the ‘Help’ button in the top right-hand corner of the screen for further explanations of the relevant parameters.

Cleaning settings interface

On the home page, click Settings and, on the password entry page, enter the password 123456. Compared to welding mode, certain parameters that are not used for cleaning are removed from

the cleaning mode settings page, and two parameters specific to cleaning are added: ‘gun head model’ and ‘trigger setting’.

(1) The laser power is the maximum power calibrated by the laser manufacturer. Enter this correctly.

(2) The default gas switching delay is 200 ms, with a range of 0 ms to 3000 ms;

(3) The scan correction is set to 1 by default, with a range from 0.1 to 4. ‘Scan correction’ × ‘scan width’ on the process page = actual scan width at the focal point (±3 mm);

(4) The default laser centre offset is 0 mm, within a range of -75 mm to +75 mm. A decrease in the offset to the left and an increase in the offset to the right are applied to the centre of the red light on the adjustment axis.

(5) The default temperature alarm threshold is 65 ℃, and the alarm is disabled when set to 0 ℃.

(6) Trigger settings: When ‘double-click’ is selected, press the trigger twice in quick succession before the light comes on, to prevent accidental contact. Select ‘single-click’ to turn the light off when the trigger is pressed.

(7) The alarm level for air pressure, water cooler and laser is set to low by default. When using this
When setting the alarm signal, the alarm level should be set to match that of the external device.

(8) ‘Gun Head Model’ Click on the orange area to access the model selection page and select the appropriate scan width for the specific model. If the width does not match the model, the laser may strike the inside of the gun body and damage the product.

Selecting the scan cleaning width

(1) ‘SUP20T – 150 mm focal length – 20 mm width’ corresponds to the manufacturer’s default configuration 20T welding torch from the manufacturer. After selecting this model, simply remove the calibration tube at the front end of the welding torch and the associated firmware before use, and the maximum cleaning width will be 20 mm.

(2) ‘SUP20T-400 mm focal length – 40 mm width’ corresponds to the extended configuration of the 20T welding torch. Once this model has been selected, the front calibration tube must be removed and the focusing mirror replaced with a D20-F400 lens. The maximum cleaning width is 40 mm.

Overview of cutting functions

This system does not have a dedicated professional cutting mode; however, based on the laser’s actual power output, the welding mode can be used for cutting thin sheets of metal. If you need to use the cutting function, fit the copper cutting tip and set the scan width to 0 mm. Unlike welding, the cutting spot has no width, so the scan width must be set to 0; that is, the red light is a point. The other parameters (peak
power: reference value) (duty cycle: reference value 100%) (pulse frequency: reference value 1000) are consistent with those for welding. Once you have set the parameters, imported the settings and returned to the home screen, you can view this process on the left-hand side of the home page. Negative focus is recommended (this directly affects the cutting effect).

Maintenance and replacement of protective lenses

Maintenance and replacement of protective lenses:

Before use, wash and dry your hands, then wipe them again with cotton wool and alcohol.

Remove the screw securing the protective lens cover in a relatively dust-free area, pull out the support, cover it thoroughly with paper and inspect the protective lens. If there is a visible burn mark on the surface of the protective lens, it should be replaced immediately.

Then check the white regenerative seal beneath the protective lens. If the battery seal
is scratched or deformed, it must be replaced immediately. Wipe the mouth of the housing and the inside of the housing cover with cotton wool soaked in alcohol, quickly insert the protective mirror holder into the protective mirror housing and tighten the screws.

Single-mode continuous-wave fibre laser

QBH connector

The specific appearance and individual dimensions of the QBH connector used in series fibre lasers are shown in the figure.



Diagram of the appearance and dimensions of the QBH connector (unit: mm)

The size of the QBH output head slot is a standard size suitable for commonly used machining heads.
During installation, ensure that the QBH is fitted correctly to ensure a reliable connection of the LOCK contact ring. Otherwise, the laser will not function properly.

Before installing the QBH output head into the machining head, the QBH output head mirror must be checked. If the QBH output head mirror is found to be dirty, it must be cleaned.

For single-module fibre lasers with a power output below 6000 W, QBH heads are fitted with protective window mirrors that shield the internal quartz crystals from external dust.

Operating environment

The basic operating environment for the laser is as follows:

Laser operating environment

LASER MODEL	FC1500S
VOLTAGE	220V ± 10%, 50/60Hz AC
ENVIRONMENTAL SETTINGS	Flat, upright (avoid upside-down or sideways positions), free from vibrations and shocks
TEMPERATURE	5–40°C
HUMIDITY	30%RH ~ 70%RH
ELECTROMAGNETIC ENVIRONMENT	Avoid strong electromagnetic interference, which may cause a false laser alarm
COOLING WATER QUALITY	The QBH water and the cooling water for the entire machine must be treated with deionised water to prevent limescale build-up. If deionised water is not available, deionised drinking water may be used. If the ambient temperature is below 0 °C, an antifreeze mixture (30% alcohol) should be added to the cooling water.

Warning



Note: Set the water temperature in the cooling system correctly according to the ambient temperature. If the water temperature is too high, the laser will not function properly. If the water temperature is too low, condensation will form inside the laser or in the QBH output head, causing irreversible damage to the laser.



Note: (1) Before assembling the QBH output head, the QBH lens and the cavity of the processing head must be clean and free of contaminants; (2) Keep the black protective cover of the QBH output head must be kept in good condition to prevent contamination; otherwise, the protective cover will cause indirect contamination of the QBH output head.



Note: The connection, inspection and adjustment of all laser control cables should carried out whilst the system is de-energised. Installing control cables whilst the system is live may cause damage to the laser.

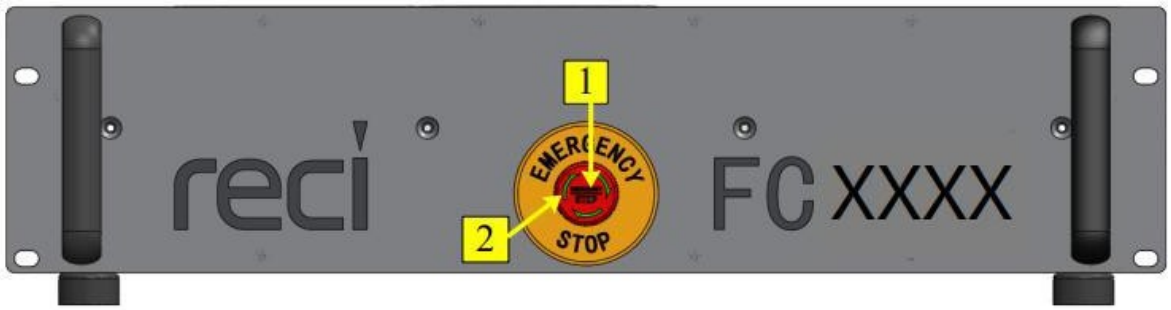


Note: (1) The laser output cable must be kept as straight as possible, and kinking of the output cable is prohibited; (2) An output cable with an excessively small diameter will cause damage to the laser.

Front panel

1. Front panel

2. The figure shows the front panel of the laser. All of our company's single-module fibre lasers have the same button layout on the front panel.



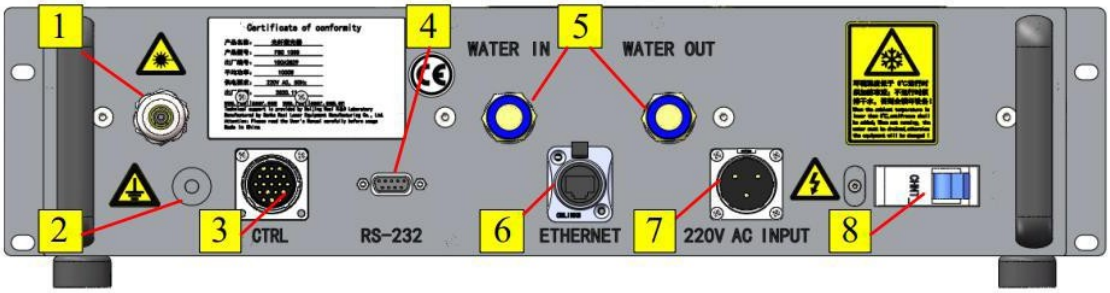
The laser's front panel. The buttons on the front panel have the following functions:

Functions of the front panel buttons

NAME	AREA	FUNCTION	FUNCTIONAL DESCRIPTIONS
EMERGENCY STOP	Button 1 area	Press	Power off immediately laser printer and lock it (emergency)
		Clockwise rotation	Release button, lifting of the state of emergency (requires to restart)
	Indicator area 2	Green light is on	Switched on remote remote REM_START Start, normal state
		Red light is on	Laser failure
		Yellow indicator light is on	Pressing the emergency button

Rear panel

The image shows the design of the laser's rear panel. Details are shown in the following image:



Rear panel of the laser

Functions of the buttons on the rear panel

No.	Button/interface name	Function description
1	Armoured seat and waterproof cable connector	This is the QBH ejection position, used to hold the QBH armour
2	Ground interface	Used to earth the casing to prevent electrical leakage, etc.
3	CTRL	19 Basic control signal interface, navigation interface
4	RS-232	RS-232 interface, option to install a Bluetooth module or an optional 232 cable via connection to the top computer control unit
5	WATER IN & OUT	WATER IN is the water inlet, WATER OUT is the water outlet (Φ12 quick-connect fitting)
6	ETHERNET	Network cable interface: communicates with a computer via the network and is used for remote data processing data
7	220V AC INPUT	220 V AC input

8	Air switch	Control for switching the AC power supply on and off

How can I prevent condensation on the laser?

During laser operation, avoid environments where condensation forms. The specific control standards are as follows:

Maximálna relatívna vlhkosť (%)	20	30	40	50	60	70	80	90	95
Teplota prostredia °C	Rosný bod Td (℃)								
10	-11.9	-7	-0.3	0	2.5	4.8	6.7	8.4	9.2
15	-7.9	-2.3	1.5	4.6	7.3	9.6	11.6	13.4	14.2
20	-3.5	2	6	9	12	14.5	16.5	18	19
25	0.5	6	10.5	14	16.5	19	21	23	24
30	4.6	10.5	15	18.5	21.5	24	26	28	29
35	8.5	15	19.5	23	26	28.5	31	33	34
40	13	20	24	27.5	31	33.5	36	38	39
			Rozsah prevádzkových teplôt lasera						

Note: The figure above is a table showing the dew point of the environment. The temperature at the intersection of the temperature and humidity parameters is the ‘dew point temperature’ for that environment. For example, at the intersection shown in the figure above, when the laser’s operating temperature is 35 °C and the relative humidity is 60 per cent, the temperature of the laser’s water cooler is less than or equal to 26 °C, and condensation occurs inside the laser’s water cooler.

(1) The ambient temperature in the laser’s independent enclosure is below 35 ℃;

(2) The humidity in the separate room where the laser is located is less than 60 per cent;

(3) It is recommended to maintain a constant temperature and humidity within the equipment room, thereby effectively preventing condensation on the laser;

(4) If conditions permit, a separate air-conditioned room should be constructed for the high-power laser to effectively prevent condensation in this environment;

(5) When the ambient temperature and humidity are too high, the dehumidification process will take approximately 30 minutes after the laser is started up, which is normal. Once the condensation alarm has been cleared, the laser can be restarted.

(6) The cooling water temperature at the laser’s QBH interface is relatively flexible. A dual-temperature, dual-control chiller can appropriately raise the set water temperature so that it is above the dew point, but the set water temperature should not exceed 30 ℃.

(7) When the equipment is out of operation, switch off the laser and the water chiller simultaneously.

Cooling system

Requirements for the cooling medium

(1) The cooling fluid must be softened water, such as purified water, distilled water, high-purity water, etc., with the option of adding glycol in a volume ratio of 30 per cent or less, or ethanol in a volume ratio of 20 per cent or less, with the option of adding preservatives and bactericides approved by the manufacturer.

(2) It is strictly forbidden to use antifreeze with a volume ratio of > 30 per cent; it is strictly forbidden to use oil or oil-based fluids; it is strictly forbidden to use flammable or explosive fluids; it is strictly forbidden to use fluids containing solid particles; in particular, it is strictly forbidden to use fluids that are corrosive to aluminium and stainless steel.

(3) To prevent pipe blockages caused by mould growth in the water cooler, it is recommended to add ethanol when filling with clean water. The volume ratio of ethanol is 10 per cent.

(4) If the ambient temperature of the equipment is between -10 °C and 0 °C, an ethanol solution with a volume ratio of 30 per cent must be used and replaced every two months.

Note: If frost damage is caused by the customer, the product will not be repaired free of charge.

(5) If the ambient temperature of the equipment is below -10 ℃, a dual water-cooling system (with a simultaneous heating function) must be used to ensure continuous operation of the cooling system.

(6) If the laser is not used for an extended period, the cooling water inside the cooling system and the laser should be drained; otherwise, this will cause irreversible damage to the laser.

Filling and draining water

Adding water

Add softened water via the water inlet to the unit up to the standard level (green area). After the unit’s pump has been running for a short while, continue topping up the water tank to the standard level. As shown in the figure.



High water level Normal water

level

Low water level

Drain

After adding water for the first time and replacing it with fresh water, bleed the air from the pump so that you can start using it; otherwise, the equipment may be damaged. When using the bleeding method, slowly loosen the pump's bleed plug
(do not unscrew it) until air begins to escape, then tighten the drain plug. Note: In winter, when it is necessary to drain the liquid from the unit, a label with instructions is visible on the outside of the pump.

Introduction to the control panel

Front panel



Nixie tube	FUNCTION
Display window	Display of measured temperature (L.X.X for low-temperature water/H.X.X for normal-temperature water), display of set temperature (S.X.X for low-temperature water/D.X.X for normal-temperature water), alarm code (Exx) and parameter code (Fxx).
Indicator light	**FUNCTION**
Start	On: the unit is operating; Off: unit stops

Alarm	Flashing: System fault. Off: No fault detected
Buttons	**FUNCTION**
▲ ( )	Setting parameters and resetting faults
▼ ( )	Switching between display modes

Default value

By default, the home screen displays the temperature measured at low temperature (l.xx.x). When the temperature is displayed, press the <▼> button to switch between the measured normal water temperature (H.X.X), the set low-temperature water temperature (S.X.X) and the set normal water temperature difference (D.X.X).

If it does not switch after 30 seconds, the device will automatically return to the low-temperature water interface.

Note: L./H./S./d. denotes the temperature code and xx.x denotes the temperature value.

Controller parameter settings

In normal operating mode, press the <▲> and <▼> buttons simultaneously to enter the low-temperature water setting interface. The set temperature xx.x flashes on the display. At this point, you can adjust it by pressing the <▲> or <▼> button to set the temperature. If you do not press any button within 5 seconds of making the setting, the system will automatically save the set value and exit the setting mode. The set low-temperature water temperature
normal temperature = [set low-temperature water temperature] + [F01 normal-temperature water temperature difference]; the manufacturer's parameter [F01 normal-temperature water temperature difference] must be adjusted.

In the temperature display interface, press the <▲>+<▼> buttons simultaneously to enter the manufacturer's parameters after 5 seconds. Parameters set by the manufacturer are not usually adjusted; if you need to adjust them, seek the manufacturer's approval. Whilst selecting manufacturer parameters, press <▼> to select a parameter, press <▲> to enter the parameter setting; after 15 seconds without pressing any button, you will exit the manufacturer parameter settings (the parameters will be shown on the display).

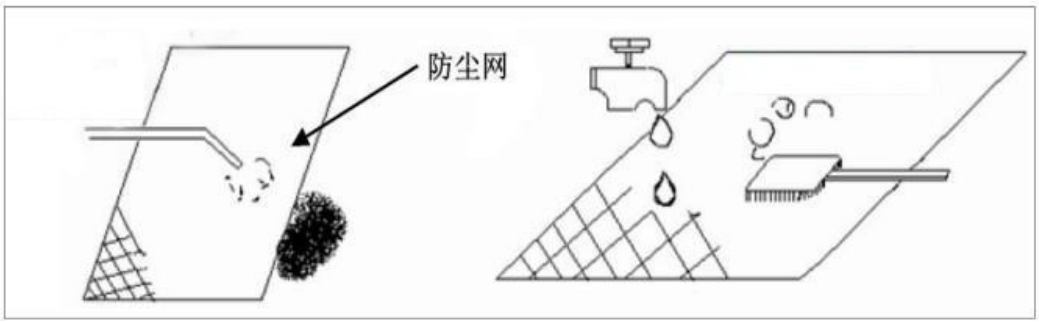
Whilst setting the parameters, you can adjust the parameter values using <▲> or <▼>. After 5 seconds without pressing any buttons, or by pressing <▲>+<▼>, you will return to the parameter selection screen and save the changes (the display window flashes and shows the parameter values).

Maintenance

Simple maintenance

The unit must first be switched off, the power supply disconnected, and work may only be carried out after 3 minutes; otherwise, there is a risk of electric shock. If the ambient temperature is below 2 ℃ and the unit has

switched off for an extended period, the water inside must be completely drained. In summer, clean the condenser and the machine's dust guard approximately every 15 days, as shown in the illustration.



Winter antifreeze

If the unit is being transported or is not in use for an extended period, the water in the water tank should be drained via the drain valve, and the drain plug beneath the water pump should be loosened to drain any remaining water from the water pump. If the ambient temperature at night is below 2 ℃, it is recommended that customers do not switch off the unit or add antifreeze. The volume ratio of ethylene glycol should be selected according to Table 1, and the freezing point should be set to the ambient temperature of the unit minus approximately 5 ℃. If the average daily temperature is higher than 5 ℃, replace the water containing antifreeze with softened water.

Relationship between different volume ratios of ethylene glycol and the freezing point

volume/%	freezing freezing point/℃	volume/%	freezing of freezing/℃	volume/%	freezing of freezing/℃
1.8	-0.6	26.0	-13.0	51.9	-41.0
3.6	-1.3	28.0	-15.0	53.9	-44.0
5.4	-2.0	29.9	-17.0	56.0	-48.0
7.2	-2.7	31.9	-18.0	78.9	-47.0
9.1	-3.5	33.8	-20.0	81.0	-43.0
10.9	-4.4	35.8	-22.0	83.1	-40.0
12.8	-5.3	37.8	-24.0	85.2	-36.0
14.6	-6.3	39.8	-26.0	87.3	-33.0
16.5	-7.3	41.8	-28.0	89.4	-29.0
18.4	-8.0	43.8	-31.0	91.5	-26.0
20.3	-9.0	45.8	-33.0	93.6	-23.0
22.2	-11.0	47.8	-36.0	95.8	-19.0
24.1	-12.0	49.8	-38.0	100	-13.0

Daily maintenance

The operating environment of a fibre laser cooler is very demanding. To ensure the unit performs well and to extend its service life, it is necessary to carry out maintenance on the unit once a week. Maintenance includes, amongst other things, the following:

(1) Check the condenser to ensure there are no foreign objects blocking the air ducts and that the air inlets and outlets around the unit are unobstructed;

(2) Clean the condenser and the dust filter;

(3) Check the cooling medium to ensure it contains no foreign objects and that no microorganisms are multiplying in it. The cooling medium should be replaced within 15–20 days and must consist of clean water, distilled water or ultra-pure water;

(4) Check that the water connection is secure and that the water pump is watertight;

(5) Check the water tank and remove any dirt that has accumulated inside it;

(6) Clean the filters in the unit's water circuits regularly, usually every 7–10 days.

Fault analysis and troubleshooting

When the appliance detects a fault, the display alternates between showing the temperature and the error code 'Exx'. If multiple faults occur, you can press the <Up> or <Down> button to cycle through and view the different faults. When you press the <Up> or <Down> button, the error code is locked in and displayed. After 5 seconds, the temperature and error code will alternate again. The error codes and descriptions are listed in the table below:

Fault codes	Fault name	Fault analysis	Action	Solution troubleshooting
E01	Low-temperature water probe fault	1. Short circuit / disconnection of the low-temperature water sensor 2. Damaged low-temperature water sensor	Leave the water pump switched on; stop all other outputs	1. Check that the sensor lead is not loose 2. Replace the probe
E02	Low and high water temperature warning	1. Insufficient water flow 2. Poor ventilation 3. Too many layers of limescale	Stop only the water heating and low-temperature electricity	1. Check the water supply pipe 2. Clear away any debris 3. Clean the layer of ash on condenser
E03	Compressor pressure fault	1. Poor ventilation 2. Refrigerant leak 3. Condensate fan not running 4. There are too many grey layers on the filter screen 5. Damaged pressure switch	Stop compression and let the water pump run	1. Remove any surrounding debris 2. Check for leaks 3. Check the fan 4. Clean off the layer of ash 5. Check that the pressure switch and wiring
E04	Phase sequence alarm	1. Power supply phase failure/loss 2. Phase sequence fault 3. Three-phase imbalance	Stop the entire machine	1. Check the power supply 2. Swap any two phase lines 3. Replace the circuit

		4. Faulty phase sequence protector		of the power supply 4. Replace the phase sequence protection
E05	Phase sequence alarm	1. Low-temperature water pipe blockage 2. Reversed connection of inlet and outlet 3. Leak in the suction pipe 4. Damaged flow switch	Leave the water pump switched on, with all other outlets switched off	1. Clean the pipework 2. Check the inlet and outlet pipes 3. Check the suction pipe and tighten it 4. Check the the flow switch and replace it
E06	Water level switch alarm	Insufficient water level in the tank	Water heating stops when the water temperature is low and normal water temperature and electricity	Top up the water (to the standard liquid level range)
E07	Compressor overload	1. The condenser is dirty and blocked 2. Fluorine leak 3. Inlet and outlet are blocked 4. Ambient temperature is too high	Compressi on shutdown	1. Clear the layer of ash 2. Check for leaks 3. Remove debris from around the unit 4. Benefits of good ventilation when installing the unit
E08	Low water temperature alarm	The unit's outlet temperature is too low	Stop compression and let the water pump running	Check that the relay is not sticking
E09	Water sensor for normal water temperature not working	1. Short circuit/disconnectio n of the room temperature 2. Damage to the room temperature water sensor	Leave the water pump switched on, all other outputs switched off	1. Check the terminals and wiring of the sensor 2. Replace the sensor

E10	High water temperature alarm at normal temperature	1. Blockage in the pipe with normal water temperature 2. Reversed connection of inlet and outlet 3. Leak in suction pipe	Stops only normal water and electricity temperatures during heating	1. Check whether there is a backflow of room-temperature water in the pipe and that the drain is not blocked 2. Clear away any surrounding debris
		4. Faulty flow switch		
E11	Low water temperature alarm at normal temperature	1. The temperature of the unit is too low	Stop compression and let the water pump run	1. Check that the relay is not sticking
E12	Water flow alarm at normal temperature	1. Blockage in the pipe with normal water temperature 2. Reversed connection of inlet and outlet 3. Leak from the normal-temperature water pipe 4. Faulty flow switch	Shutdown of water heating and electricity	1. Check that there is no return water in the cutting head 2. Check the inlet and outlet pipes 3. Check the water pipe connection and tighten it 4. Replace the flow switch

[Note]: For faults requiring a manual reset, once the fault has been rectified on the integrated controller, the fault can be reset by pressing the <Set> button. For a split controller, press the <▲> button for 3 seconds to reset the fault. Once the fault has been rectified, the system will restart automatically.

Wire feed system

Installing the welding wire spool

(1) The welding wire is standard welding wire, which can be installed in spools weighing between 5 kg and 30 kg; however, do not use welding wire with flux.

(2) Adjust the roller tension using the internal hexagon so that the wire is neither too tight nor too loose and does not jam during feeding (usually no adjustment is necessary).

(3) Once adjusted, replace the cover.



Installing the wire feed wheel

(1) There are two wire feed wheels available in total, with different models on either side to suit different core diameters. Ensure you install them correctly. If you are installing 1.2 welding wire, the side marked 1.2 on the wire feed wheel should face outwards.

(2) Before starting to weld, do not forget to clamp the welding wire into the groove.

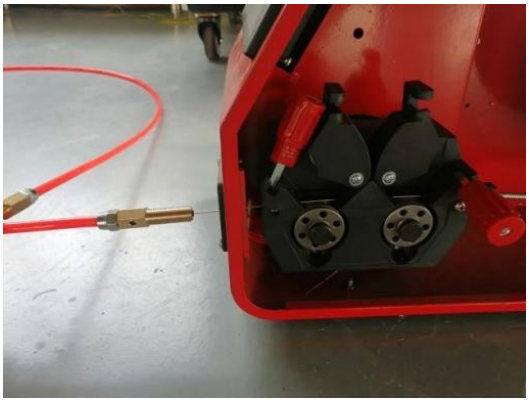


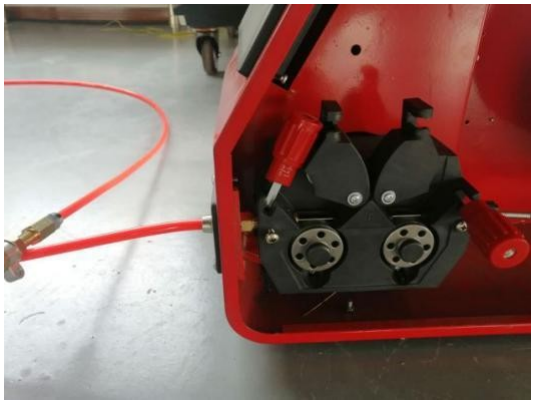


Fitting the wire feed tube

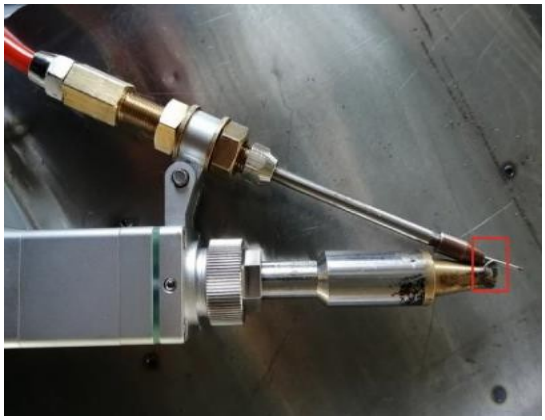
(1) After inserting the wire into the wire feed tube, position it correctly. If it is too short, it may cause the wire to jam. Then tighten the screw.

(2) When installing the wire feed tube, first remove the copper nozzle at the end that protrudes outwards and match it to the corresponding copper nozzle.









Control panel

1. The digital display on the home screen shows the wire feed speed, which can be adjusted by pressing the up and down buttons. Keep it switched on whilst in use.

2. Manual wire feed: When you press and hold the button, the wire feeder will start feeding wire. The speed of manual wire feed depends on the background setting.

3. Manual retraction: When you press and hold, the wire feeder will start retracting the wire; the speed of manual retraction depends on the background settings.

4. Once you have completed all the settings on the settings page, you must click the Save button.

5. Set the wire feed speed on this page to the default wire feed speed; this means that after changing it, the machine will remain switched on and off without any change.

6. Start delay: not set by default.

7. Retract length and repair wire length: set according to actual usage.

- When wire feed stops, the system first retracts the wire by a certain distance and then feeds the wire by a certain distance. This function is mainly used in the event of a wire break.
- If the wire is still protruding at the start of each weld, set the retraction length to be greater than the length of the repair wire.

Reference process

Reference welding procedure

When welding, observe the following principles:

1. The thicker the sheet metal, the thicker the welding wire, the higher the power and the lower the wire feed speed.

2. The lower the power, the whiter the weld surface and the higher the output. The weld seam changes from coloured to black, and at this point one side is formed.

3. The thickness of the welding wire should not exceed the thickness of the sheet metal and should be adjusted to match the thickness of the sheet metal. The welding wire affects the fullness of the weld seam.

4. The thinner the welding wire, the narrower the weld width.

The following processes are based solely on reference sample testing, and appropriate adjustments are required during use. Carbon steel/galvanised sheet metal.

Carbon steel

Material	Thickness (mm)	Scan speed	Scan width mm	Power W	Wire model	Welding angle	Form
carbon steel	1	400	2.5	380	ER1.0	Flat welding	90% penetration
carbon steel	1	400	2.5	380	ER1.0	Internal angle	yellowish
carbon steel	1	400	2.5	380	ER1.0	External angle	70% penetration
carbon steel	0.5	400	2.5	220	ERO.8	Flat welding	penetration
carbon steel	0.5	400	2.5	220	ERO.8	Internal angle	yellowish
carbon steel	0.5	400	2.5	220	ERO.8	External angle	Penetration

carbon steel	2	400	3	700	ER1.2	Flat welding	Transmission
carbon steel	2	400	3	700	ER1.2	Internal angle	White
carbon steel	2	400	3	700	ER1.2	External angle	Transmission
carbon steel	3	400	3	1200	ER1.2	Flat welding	Transmission
carbon steel	3	400	3	1200	ER1.2	Internal angle	White
carbon steel	3	400	3	1200	ER1.2	External angle	80%
carbon steel	4	400	3.5	1500	ER1.6	Flat welding	Transmission
carbon steel	4	400	3.5	1500	ER1.6	Internal angle	Transmission
carbon steel	4	400	3.5	1500	ER1.6	External angle	80%
carbon steel	5	400	3.5	1700	ER1.6	Flat welding	Transmission
carbon steel	5	400	3.5	1700	ER1.6	Internal angle	Transmission
carbon steel	5	400	3.5	1700	ER1.6	External angle	80%
carbon steel	6	400	4	2000	ER1.6	Flat welding	Transmission
carbon steel	6	400	4	2000	ER1.6	Internal angle	Transmission
carbon steel	6	400	4	2000	ER1.6	External angle	80%

Stainless steel

Material	Thickness (mm)	Scanning Fast scan	Scanning width (mm)	Power (W)	Wire model	Welding angle	Form
S.S.	1	400	2.5	200	ER304.1.0		white
S.S.	1	400	2.5	320	ER304.1.0		colour
S.S.	1	400	2.5	350	ER304.1.0		colour
S.S.	2	400	2.5	600	ER304.1.0	straight	intersection
S.S.	2	400	2.5	450	ER304.1.0	straight	blue white
S.S.	2	400	2.5	260	ER304.1.0	internal angle	gold
S.S.	2	400	2.5	200	ER304.1.0	straight	yellowish
S.S.	3	400	3	550	ER304.1.2	straight	painted sculpture
S.S.	3	400	3	700	ER304.1.2	internal angle	70% overlap
S.S.	3	400	3	800	ER304.1.2	straight	straight prototyping
S.S.	4	400	3	1000	ER304.1.2	straight	colour
S.S.	4	400	3	1200	ER304.1.2	internal angle	70% overlap
S.S.	4	400	3	1500	ER304.1.2	flat welding	single-sided strips
S.S.	5	400	3	1500	ER304.1.6	internal angle	colour
S.S.	5	400	3	1500	ER304.1.6	flat welding	penetration 50%

S.S.	5	400	3	1700	ER304.1.6	external angle	intersection 80%
S.S.	6	400	3	1500	ER304.1.6	right angle	intersection 50%
S.S.	6	400	4	1700	ER304.1.6	external angle	intersection
S.S.	6	400	5	1900	ER304.1.6	internal angle	90% penetration

Parameter settings for cleaning the welding head

Cleaning process

Scanning frequency: Motor rotation speed within the range of 10–100 Hz; it is recommended to set this to 50 Hz.

Scanning width: Scanning width of the optical plate within the range of 0 to 150 mm; it is recommended to set this

to
150 mm.

Duty cycle: 100% by default

Pulse frequency: default 2000

Once you have set the parameters, import them and return to view this process on the left-hand side of the home page.

Focus confirmation

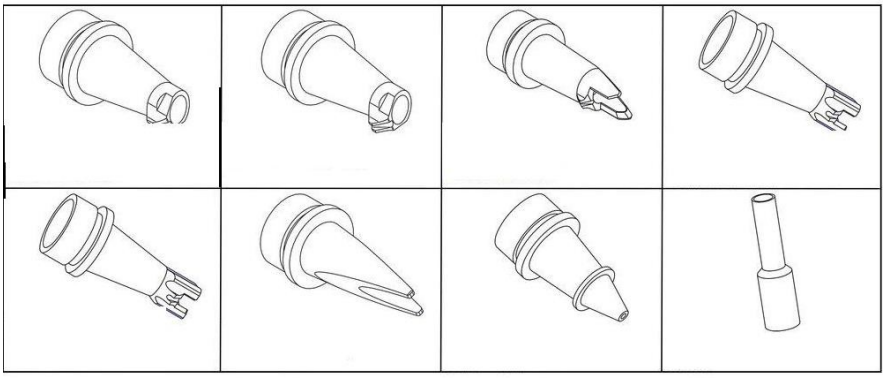
By scanning from close to far, we focus on the point of maximum sound and spark, and cleaning should be carried out at this distance, where the energy is strongest.

(Generally, the distance from the torch head to the workpiece is approximately 30 centimetres at the highest energy setting.)

Gas selection for copper-nozzle welding wire and focus confirmation

Use of a copper nozzle

Accessory box for copper nozzles for a manual laser welding head.



Copper nozzles are classified primarily according to whether the wire is to be fed, the size of the welding wire and the welding angle, as shown in the figure above. For example, AS-12 copper nozzles are used for welding with an internal wire feed angle of 1.0.

Selection of welding wire

Depending on the different welding plates, we must use different welding wires (solid-core welding wires in a protective gas atmosphere).

Stainless steel = stainless steel welding wire, for example ER304 Carbon steel/galvanised

sheet metal = iron wire

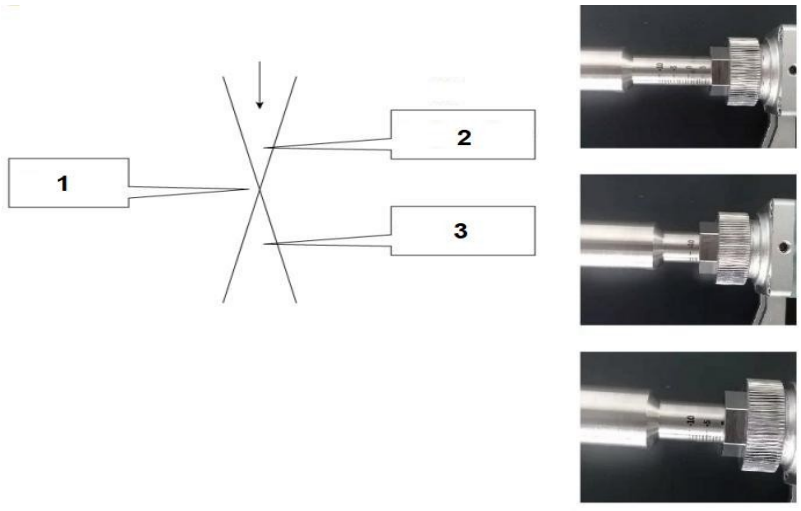
Aluminium = aluminium wire (we recommend using a Series 5 aluminium alloy or higher for aluminium welding wire, which has high hardness and is not prone to jamming).

Gas selection

(1) There are two common types: nitrogen or argon. When welding stainless steel, we recommend using nitrogen for a better welding result. Do not use mixed gas or nitrogen dioxide.

(2) Air pressure requirements: The flow rate should not be less than 15 and the pressure reading should not be less than 3.

Focus
Coke 0 is normally used for welding.



1. Focus
2. Negative defocus
3. Positive defocus

Focus position:

The spot with the smallest spot diameter and the highest and strongest energy can be used for spot welding, or when the energy is low and a minimal spot is required.

Negative defocus

The diameter of the light spot is slightly larger, and the further it is from the focal point, the larger the light spot becomes. It is suitable for continuous welding and spot welding with deep penetration.

Positive defocus

The spot diameter is slightly larger, and the further it is from the focal point, the larger the spot becomes. It is suitable for continuous welding of surface seals, or for applications with low penetration requirements.

Porosity formation and prevention

Suppressing porosity in welds through pre-weld surface treatment

Pre-weld surface treatment is an effective method for controlling metallurgical porosity in laser-welded seams of aluminium alloys. Surface treatment methods typically include physical-mechanical cleaning and chemical cleaning. Upon comparison, the best procedure for surface preparation of the test panel is the use of chemical methods (cleaning with metallic cleaning agents – rinsing with water – alkaline washing – rinsing with water – acid washing – rinsing with water – drying). A 25% aqueous solution of NaOH (sodium hydroxide) is used for alkaline cleaning to remove the surface layer of the material, and a 20% aqueous solution of HNO_3 (nitric acid) + 2% aqueous solution of HF (hydrofluoric acid) is used for acid cleaning to neutralise the residual alkaline solution. Once the test panel has been surface-treated, welding must be carried out within 24 hours. If the test panel is left for a longer period after treatment, the assembly must be wiped with anhydrous alcohol before welding.

Reducing weld porosity through welding process parameters

The formation of weld porosity is not only related to the quality of the weld surface finish, but also to the welding process parameters. The influence of welding parameters on weld porosity is particularly evident in weld over-welding, i.e. in the effect of the weld back width ratio on porosity.

Minimise weld porosity by selecting the correct shielding gas and flow rate

Ar (argon) and He (helium) are used to protect the surface of the weld seam. During the laser welding of aluminium alloys, Ar and He exhibit different degrees of ionisation in response to the laser, leading to different weld seam shapes. The results show that the overall porosity of the weld obtained using Ar as the shielding gas is lower than that of the weld obtained using He as the shielding gas. At the same time, it should be noted that a large amount of the plasma generated during welding cannot be blown away due to the low gas flow rate (<10 l/min), which causes instability in the weld pool and increases the likelihood of porosity formation. The gas flow rate is moderate (approximately 15 l/min) and the plasma is effectively controlled. The shielding gas has a good anti-oxidising effect on the molten pool, with minimal gas porosity. Excessive gas flow accompanied by excessive gas pressure causes part of the shielding gas to mix with the interior of the molten pool, leading to increased porosity. Given the influence of material properties, the phenomenon of absence of pores during welding cannot be completely avoided; it can only be reduced.

Daily maintenance of equipment

Equipment safety operating procedures

When laser equipment is in operation, a malfunction is extremely dangerous. Operators must strictly adhere to the safety operating procedures for the laser equipment; this is necessary not only to ensure the safety of personnel and the equipment, but also to ensure that the laser equipment can function normally, achieve its technical performance and fully utilise its processing advantages. It is therefore essential to strictly adhere to its safety operating procedures during use and operation.

(1) Operators must adhere to the equipment's safety operating procedures;

(2) Operators must undergo preliminary training, familiarise themselves with the structure and performance of the equipment, become acquainted with the operating procedures and obtain a licence before they are permitted to work independently;

(3) Wear personal protective equipment in accordance with regulations and wear safety goggles when in the vicinity of the laser beam. It is strictly forbidden to direct the laser beam at unprocessed products or human bodies;

(4) Whilst the equipment is in operation, the operator must not leave their post or entrust the care of the equipment to anyone else without authorisation. If it is necessary to leave the machine, it should be switched off.

(5) Keep a fire extinguisher within reach, switch off the laser and do not place paper, fabrics or other flammable materials near unprotected laser beams.

(6) Keep the area around the equipment clean, tidy and free of oil stains, and store workpieces, tools and waste materials in accordance with regulations.

(7) When using protective gas cylinders, it is important to ensure that wires, cables or gas pipes are not crushed, in order to prevent accidents caused by leaks. The use and transport of gas cylinders should comply with the regulations governing the supervision of gas cylinders. It is prohibited to expose gas cylinders to direct sunlight or placing them near heat sources. When opening the cylinder valve, the operator must stand on the side of the cylinder nozzle.

(8) During operation of the equipment, if any abnormalities are detected, the equipment must be brought to a halt as soon as possible to stop laser emission and movement, in order to minimise abnormal damage.

(9) The operator must remain focused whilst the equipment is in operation and must not engage in any non-work-related activities, such as chatting, playing games or listening to music.

(10) If the equipment is not in use for more than thirty minutes, switch off the power supply to the entire laser system as required.

(11) During the installation, repair and maintenance of manual welding equipment, it is essential to switch off the main power supply, as working on live equipment can have fatal consequences. Accidental exposure to high-voltage electric shock can lead to cardiac arrest, burns or other serious injuries.

(12) The emergency stop takes precedence over any other control operation, as it disconnects the laser's power supply, stops all system controls and any potentially hazardous functional components. If the laser is emitting light, light is leaking, or it is not functioning correctly, immediately release the light trigger on the hand-held welding torch and press the emergency stop button to check and identify the cause.

(13) During welding, no unauthorised personnel other than the usual operators should be present in the welding area. Prevent inexperienced welders or errors that could cause minor injury to others.

(14) Untrained personnel must not operate any peripheral equipment of the unmanned manual welding machine or laser technicians on site. The manufacturer accepts no liability for any consequences arising from unauthorised operation or failure to comply with operating procedures.

(15) Before starting the machine for the first time, check that there is sufficient water in the water tank, that the water temperature and pressure are normal; if the water level is insufficient, a sufficient quantity of water should be added before starting the machine to prevent damage to the equipment. The procedure for adding water applies to the operation of the cooling system.

(16) If the laser alarm indicator light does not come on after start-up, check that there is no fault. All laser parameters have been set upon delivery to the customer. Do not dismantle the laser or the water tank without consulting the manufacturer. None of the buttons, apart from the water-filling switch, should be dismantled.

Daily inspection tasks to be carried out

(1) Clean the machine tool of dust and foreign objects to maintain its clean appearance.

(2) Check that the dust cover is intact and remove any dust or dirt from it.

(3) Check that the protective mirror on the laser head is clean.

(4) Check that the temperature and pressure of the cooling water in the tank are normal.

(5) Check that the compressed gas is clean, free from water and oil, and that the gas pressure meets the required level.

Cleaning and maintenance

Safety precautions for mirror maintenance

During the installation and cleaning of the lenses, if the operator is not sufficiently careful, any adhesive, fingerprints or oil droplets may affect the transparency of the lenses, thereby shortening their service life and affecting the quality of laser processing. Therefore, the following precautions must be taken:

(1) Do not handle the lenses with bare fingers; wear powder-free finger cots or rubber/latex gloves;

(2) Do not use a suction device to avoid scratching the surface of the lens;

(3) When removing the lens, do not touch the coating or the mirror surface. Hold the lens by the edge and always place it on a cloth;

(4) Avoid talking over the lens and try as far as possible to keep all contaminants out of the working area;

(5) Acetic acid dissolves only dirt and does not damage the lenses.

(6) When cleaning the lenses, try to work in a dust-free environment as much as possible.

(7) Main maintenance tools: cleaning bottles, medical spirit, cotton buds.

Cleaning

(1) Cleaning the welding head: When using the welding head, a layer of black ash forms on the copper nozzle; this is sparks spattering from the metal after it has been heated and subsequently comes into contact with the nozzle. There is also dust in the air. After use, gently wipe the soot from the nozzle with a clean cloth and then clean all dust from the welding head. In a relatively clean environment, unplug the unit and check that the protective lens is clean. When the welding head is not in use, seal the copper nozzle with tape or a rubber cover to prevent dust from entering the lens. If the optical connector is disconnected, immediately seal the opening of the input optical connector (QBH) with a dust cover to prevent dust from entering the optical connector.

(2) Cleaning the lens: A protective lens is located at the front end of the welding head to protect the focusing lens. If dirt or foreign objects stick to the protective lens, this may cause damage. Regular maintenance of the lens is therefore necessary. It is recommended that you check it once before each use.

Regular cleaning is important

(1) Maintenance of the cooling system

- The distilled water in the water tank must be replaced every month.
- Clean the water tank’s dust filter regularly to prevent it from affecting heat dissipation.
- Check regularly for leaks at all joints between the water tank and the water supply pipes.

(2) Removing dust from the appliance: Clean away dust regularly to ensure ventilation and heat dissipation from the cabinet.