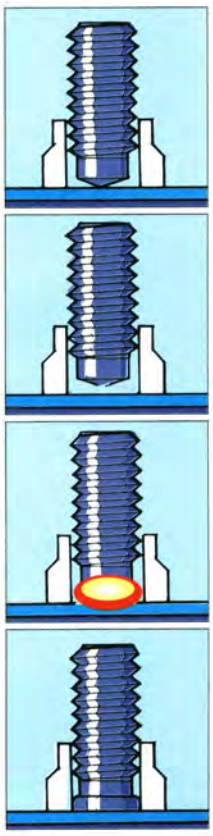
TAYLOR STUDWELDING SYSTEMS LIMITED

OPERATING GUIDE

FOR

TYPE SPi-10

SINGLE PHASE DRAWN ARC CONTROLLER



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USEFUL INFORMATION

MANUFACTURERS DETAILS

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You may wish to record the details of your controller below as this information will help with any technical assistance you may require:

CONTROLLER SERIAL No.	
DATE PURCHASED.	

PURPOSE AND CONTENT OF THIS GUIDE

This guide has been written for :

- The personnel of the end-user responsible for the installation and maintenance of the controller.
- The operator of the welding controller.

This guide contains information relating to :

- Installation and connection.
- Operation.
- Technical specifications and parameters.
- Spare parts.

USEFUL INFORMATION

FURTHER INFORMATION

Should you require additional technical information, please contact us directly (details on previous page) or our local agent / distributor (details of agents etc. can be obtained from us).

This guide contains important information which is a pre-requisite for safe Operation of the equipment. The operating personnel must be able to consult this guide when necessary. In the interests of safety, make this guide available to your personnel in good time.

If the equipment is sold / passed on, please hand over this manual to the new owner and if possible please inform us of the name and address of the new owner, in case we need to contact him regarding the safety of the machine.

PLEASE READ THIS GUIDE CAREFULLY BEFORE INSTALLING OR OPERATING THE CONTROLLER.

PLEASE OBSERVE CAREFULLY ALL SAFETY PROCEDURES/INSTRUCTIONS.

DUE TO THE POWER REQUIREMENTS AND ELECTROMAGNETIC EMISSIONS PRODUCED DURING NORMAL USE, THIS MACHINE MUST ONLY BE OPERATED IN AN INDUSTRIAL ENVIRONMENT.

THIS MACHINE OPERATES FROM A MAINS SUPPLY OF 400V AC @ 50Hz

NEVER REMOVE ANY PORTION OF THE UNIT HOUSING WITHOUT FIRST ISOLATING THE CONTROLLER FROM THE MAINS ELECTRICAL SUPPLY.

NEVER OBSTRUCT THE UNDERSIDE, FRONT OR REAR PANELS AS THIS MAY CAUSE THE UNIT TO OVERHEAT DURING OPERATION.

DO NOT USE THIS WELDING POWER SOURCE FOR PIPE THAWING OR IN CONDITIONS OF RAIN OR SNOWFALL.

THIS EQUIPMENT HAS BEEN EMC TESTED AND APPROVED IN ACCORDANCE WITH BS EN 60974-10 (CATEGORY 2).

IMPORTANT SAFETY INFORMATION !

PROTECT YOURSELF AND OTHERS !

Read and understand these safety notes.

1. ELECTRICAL

No portion of the outer cover of the welding controller should be removed by anyone other than suitably qualified personnel and never whilst mains power is connected.

ALWAYS DISCONNECT THE MAINS LEAD BEFORE ATTEMPTING ANY MAINTENANCE.

BEWARE - RISK OF ELECTRIC SHOCK !

Do not use any fluids to clean electrical components as these may penetrate into the electrical system.
Installation must be according to the setting up procedure detailed on page 11 of this guide and must be in line with national, regional and local safety codes.

2. FIRE

During welding small particles of very hot metal are expelled. Ensure that no combustible materials can be ignited by these.

3. PERSONNEL SAFETY

Arc rays can burn your eyes and skin and noise can damage your hearing. Operators and personnel working in close proximity must wear suitable eye, ear and body protection.
Fumes and gases can seriously harm your health. Use the equipment only in a suitably ventilated area. If ventilation is inadequate, then appropriate fume extraction equipment must be used.
Hot metal spatter can cause fire and burns. Appropriate clothing must be worn. Clothing made from, or soiled with, combustible materials must NOT be worn.
Have a fire extinguisher nearby and know how to use it.
Magnetic fields from high currents can affect heart pacemakers or other electronically controlled medical devices. It is imperative that all personnel likely to come into the vicinity of any welding plant are warned of the possible risks before entering the area.

4. MAINTENANCE

All cables must be inspected regularly to ensure that no danger exists from worn or damaged insulation or from unsound electrical connections. Special note should be made of the cables close to the pistol, where maximum wear occurs. As well as producing inconsistent welds, worn cables can overheat or spark, giving rise to the risk of fire.

IMPORTANT SAFETY INFORMATION !

5. TRAINING

Use of the equipment must be limited to authorised personnel only who must be suitably trained and must have read and understood this manual. This manual must be made available to all operators at all times. Further copies of this manual may be purchased from the manufacturer. Measures must be taken to prevent the use of this equipment by unauthorised personnel.

6. LIMITATIONS OF USE

The mass of the welding controller is under 22kg and is suitable for man lifting. It is fitted with an appropriate carrying handle to allow lifting by hand. The controller is suitable for use in an environment with increased risk of electric shock.

6. INSTALLATION

Ensure that the site chosen for the equipment is able to support the weight of the equipment and that it will not fall or cause a danger in the course of its normal operation. Do not hang connecting cables over sharp edges and do not install connecting cables near heat sources or via traffic routes where people may trip over them or they may be damaged by the passage of vehicles (forklifts etc).

7. INTERFERENCE

During welding operations, intense magnetic and electrical fields are unavoidably produced which may interfere with other sensitive Electronic equipment.
All Taylor Studwelding equipment is designed, manufactured and tested to conform the current appropriate European standards and directives regarding electromagnetic emissions and immunity and as such is safe to use in any normal environment.

8. DISPOSAL

The equipment either wholly or any of its component parts may be disposed of as part of general industrial waste or passed to a scrap merchant. None of the components used in the manufacture are toxic, carcinogenic or harmful to health in their “as supplied” condition.

INTRODUCTION TO STUDWELDING

The Taylor Studwelding SPi-10 Drawn Arc controller when matched with an appropriate pistol and earth cables is intended for precision stud welding up to 10 mm diameter reduced base studs. The controller is easily transportable and has been designed to operate with a minimum amount of maintenance.

The energy required to carry out the welding operation is derived from a fully micro-processor controlled power inverter inside the controller.

Taylor Studwelding Systems Ltd pistols are modern, ergonomically designed and offer maximum comfort in handling with minimum operator fatigue.

THE PROCESS

The process of drawn arc studwelding is long established and well proven. The basic steps are as follows :

- A measured amount of weld stud protrusion is set at the welding pistol.
- Once in position, the pistol lifts the stud away from the work-piece, simultaneously striking an arc between the two.
- Both the tip of the weld stud and the surface of the work-piece melt as the arc is sustained for a pre-determined interval.
- At the completion of the pre-determined interval, the pistol returns the weld stud to the molten pool on the work-piece, thus forming a weld.

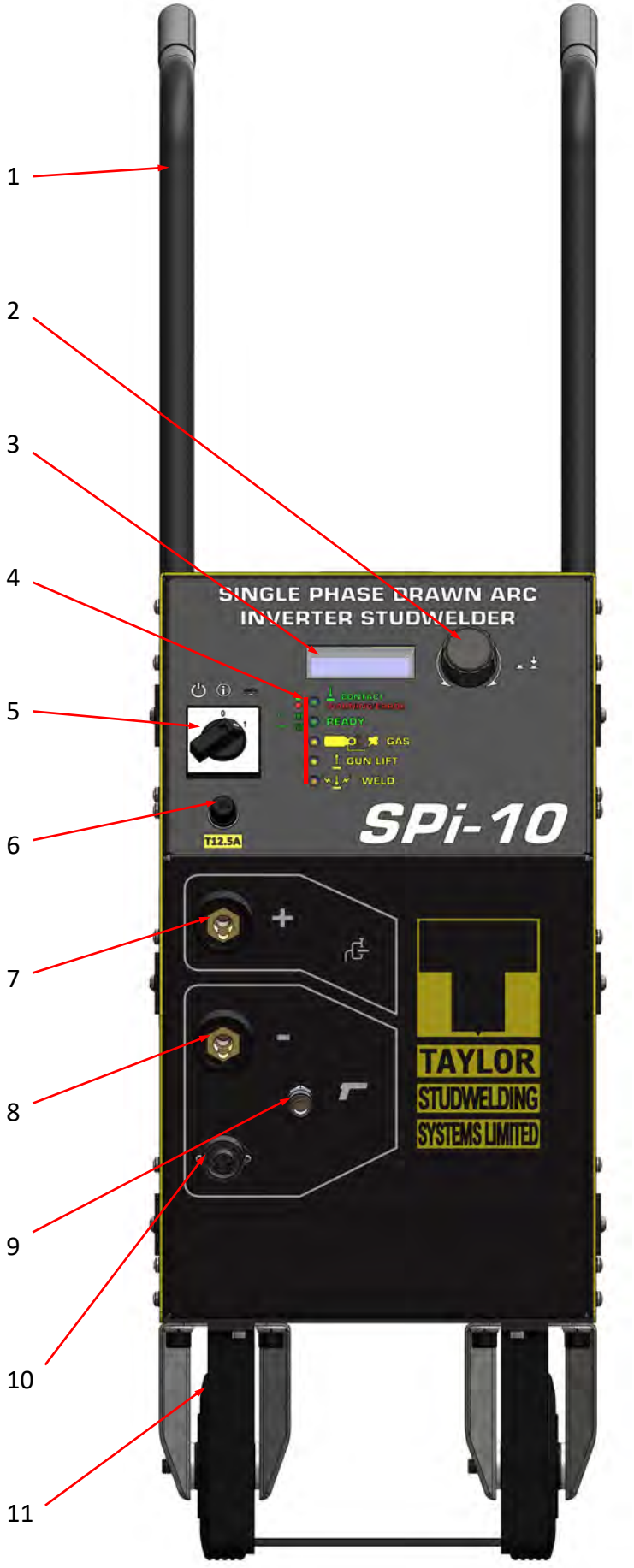
The most common and traditional drawn arc welds have a weld duration greater than 100ms and employ the use of a single use ceramic arc shield, commonly referred to as a ferrule. This ferrule helps to protect the arc during the weld and assists in formation of the final fillet. Post welding the ferrule is removed and disposed of.

It is possible to stud weld without a ferrule. This method is more commonly employed with welds having a duration of less than 100 ms and this type of weld is referred to as short cycle stud welding. Although no ferrule is employed, it is recommended practice in short cycle welding to employ a suitable shielding gas to reduce the amount of porosity in the completed weld and improve weld quality.

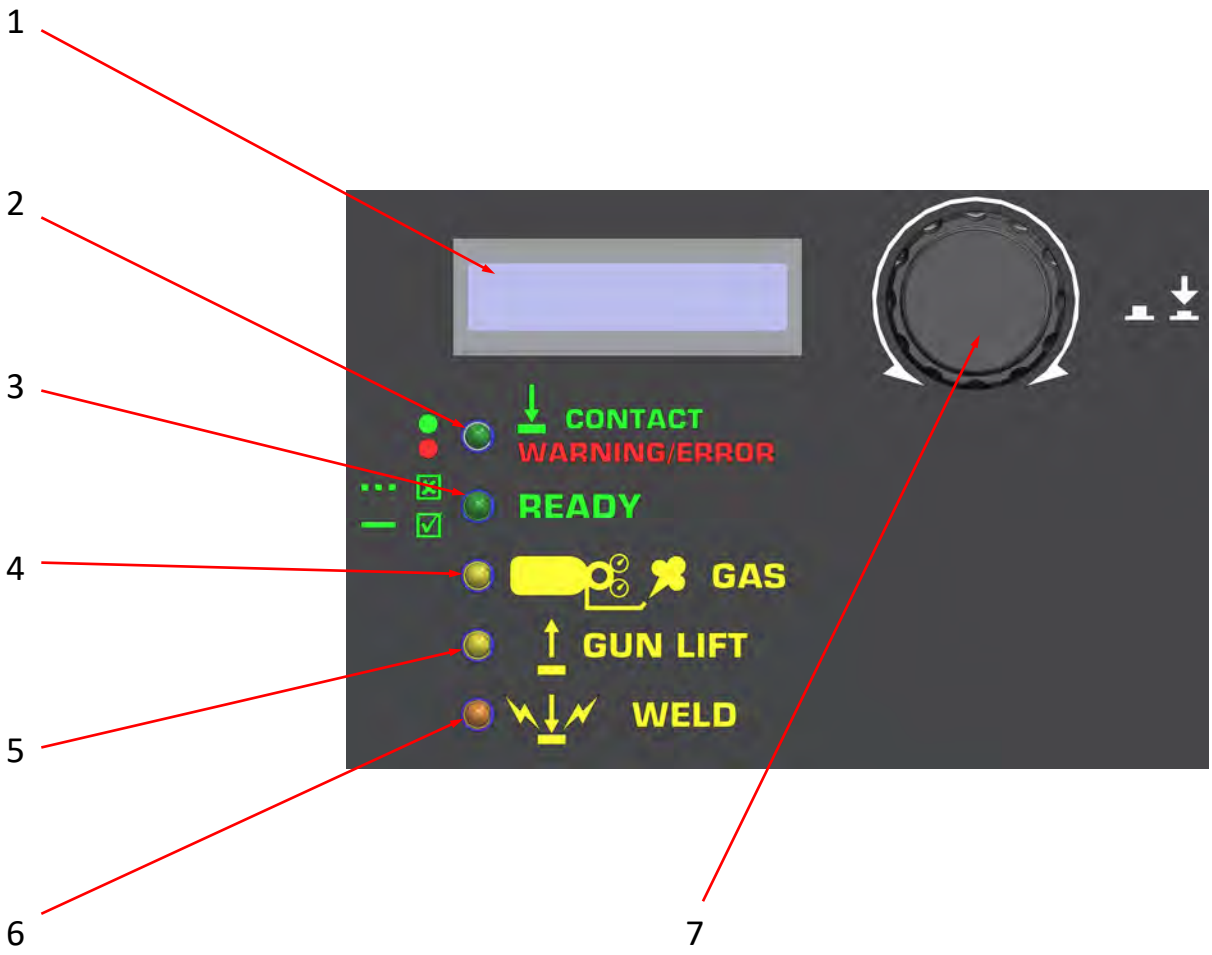
GUIDE TO EXTERNAL FEATURES

FRONT PANEL

1. HANDLE
2. CONTROL KNOB/PUSHBUTTON
3. MULTI-FUNCTION DISPLAY
4. INDICATOR LEDS (SEE PAGE 9)
5. ON/OFF SWITCH
6. MAINS FUSEHOLDER
7. WELDING EARTH (+) SOCKET
8. WELDING PISTOL (-) SOCKET
9. SHIELDING GAS INLET
10. PISTOL CONTROL SOCKET
11. WHEELS



GUIDE TO EXTERNAL FEATURES



CONTROL PANEL

1. MULTI-FUNCTION DISPLAY UNIT - USED TO SELECT OPERATIONAL PARAMETERS ETC. AND REPORT BACK INFORMATION

2. CONTACT LED - INDICATES STUD TO PLATE CONTACT WITHOUT WHICH A WELD CANNOT TAKE PLACE. NOTE! THIS IS A BI-COLOUR LED AS IT IS ALSO USED TO INDICATE FAULT/ERROR CONDITIONS ALONGSIDE ADDITIONAL INFORMATION DISPLAYED ON THE MULTI-FUNCTION DISPLAY.

3. READY LED - SOLID ON INDICATES READY TO WELD, FLASHING INDICATES NOT READY.

4. GAS LED - INDICATES THAT SHIELDING GAS FLOW IS ACTIVATED

5. GUN LIFT LED - INDICATES THAT THE GUN LIFT HAS BEEN ACTIVATED

6. WELD LED - INDICATES THAT THE WELD CURRENT HAS BEEN ACTIVATED

7. CONTROL KNOB - INCORPORATING PUSH BUTTON FUNCTION - USED FOR INTERACTION WITH MULTI-FUNCTION DISPLAY

GUIDE TO EXTERNAL FEATURES

BACK PANEL

1. SHIELDING GAS INLET

2. MAINS CABLE INLET GLAND

3. RATING/SERIAL PLATE

SETTING UP AND WELDING

Set up the control unit in a suitable location at the place of work, ensuring that the controller mains switch is in the **OFF** position.

Plug the controller into a single phase AC supply. NOTE! The controller is able to operate on 110V AC &240V AC supplies, when fitted with an appropriate mains plug or via an adaptor.

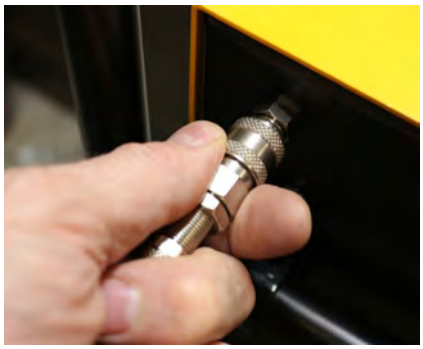
Plug the pistol control cable into the controller. Note that the cable end plug and panel-mounting socket are keyed to prevent incorrect fitting. Push the plug firmly home and twist the locking ring to secure the plug in position.

Plug the welding pistol cable into the controller. Note that the cable end weld plug has a peg which mates with the key slot in the panel mounted socket.

IMPORTANT! Secure the connectors with a clockwise turn until they lock. Failure to do this may result in damage to the connectors during welding.

SETTING UP AND WELDING

If an optional shielding gas is being used. Plug the pistol gas connector into the quick release socket on the front panel. Connect the bottle supply to the quick release bayonet on the back panel of the controller.

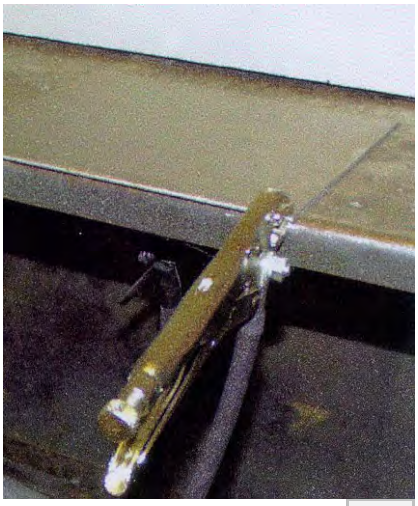


NOTE! Using shielding gas will not only improve the quality of welding but also lower the power requirement of the controller during operation.

Plug the welding earth cable into the controller. Note that the cable end weld plug has a peg which mates with the key slot in the panel mounted socket.

IMPORTANT! Secure the connectors with a clockwise turn until they lock. Failure to do this may result in damage to the connectors during welding.

Attach the welding earth clamp to the work piece. Prior to fitting the clamp, ensure that the contact area of the work piece is free from contamination e.g. rust, paint, grease etc., as this will result in a poor welding connection. If necessary, clean the surface at both the earth clamping point and the stud weld positions using an angle grinder.



Set up the welding pistol according to the instructions in the operating guide supplied with the pistol.

SETTING UP AND WELDING

If the mains supply is switched. Turn **ON** the mains supply.

Turn **ON** the controller and observe the start-up sequence.

During the start-up sequence. The display will cycle through several screens.

Start screen | Firmware screen | Current Parameter Set screen | Charge status screen

The controller examines the supply voltage and checks that it is within the operating ranges required.

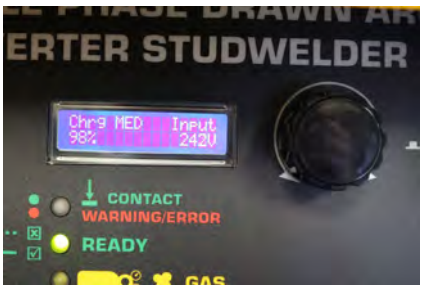
The controller will perform optimally if the supply voltage is in the following ranges:

90 - 130V AC (110VAC supply)
180 - 260V AC (240VAC supply)

NOTE! The controller will still work between 130 and 180V AC but the performance will be sup-optimal and the capacitors may not charge to 100%. The controller will also work a little below 90V AC but once the voltage is too low, will fault out.

At the end of the start-up sequence. The controller will charge the internal capacitor bank (this supplies the energy required to carry out welding operations). The screen will display the charge status screen (see above). The information displayed on this screen comprises:

1. The charging cycle (expressed as a percentage value).
2. The charging rate (MIN, LOW, MED or MAX).
3. The supply input voltage.



The READY LED will pulse during the cycle, turning solid once the charge reaches 100% (signifying the controller is ready) and sounding an audible tone.

NOTE! The charging rate affects how quickly the unit charges the internal storage capacitors. Increasing the charging rate will draw more current from the supply. The controller is supplied with the charging rate set at **MED** which is suitable for most mains supplies. This can be altered if necessary. For example. If a very poor/low current supply is all that is available, the rate could be set to **LOW** or **MIN** to prevent over-loading the supply/breaker. Information on how to change the charging rate is not contained in this operating guide but can be supplied upon request by emailing a support request to **sales@taylor-studwelding.com** or contacting us directly by phone.

SETTING UP AND WELDING

Upon completion of the start-up sequence. The controller is ready to weld. The controller parameters at this point will be the ones that were set at the last switch off (as displayed on Current Parameter Set screen, see previous page). If these are the parameters you wish to use. No change will be required and you can begin to work immediately.

If this is not the case and new parameter settings are required this can be achieved with the following steps.

The control knob on the front panel has dual functionality, in that it is also a pushbutton.

PRESS & RELEASE the control knob and the display will change to show 2 options:

-> Change
Load

With the indicator (**->**) aligned with the word Change.

From this menu. You can elect to either “Change” the current welding parameters by adjusting the individual welding parameters or “Load” a previously saved parameter set from the controller memory.
NOTE! The controller does not come with any pre-saved parameter sets. The controller memory is there for you to add your own parameter sets (up to 25 different sets) to speed up future operations.

ROTATE the control knob, select either:

-> Change or **Change**
Load **-> Load**

PRESS & RELEASE the control knob to confirm selection.

NOTE! If no selection is made within 3 seconds. The display will revert to the current parameter set screen.

For “**Change**” see next page.
For “**Load**” see page 17.

SETTING UP AND WELDING

Selecting **Change** will take you into the manual weld parameter setting screens:

The first of which is the “Current” screen. Which is used to set the welding output current. The value is shown in Amps (A) and is adjustable between 10A and 800A in 5A steps.
NOTE! The adjustment knob features an accelerator feature. Slowly turning the knob will advance/retard the display slowly and turning the knob quickly will accelerate the rate of change in the display.

If no change is desired to the output current. **PRESS & RELEASE** the knob to move on to the next parameter screen (skip to “Time” screen below).

Otherwise, **TURN** the knob to set the required welding current.

Once the desired number is reached it is possible to pick up the pistol at this point and begin welding at this new setting. However, as the setting is unsaved at this point, the display will stay on the current selection screen until a save is performed. Also, if the controller is turned off, then it would not be at this setting when switched back on, but at the last saved setting (prior to your adjustment).

If no other parameters require change at this point. **PRESS & HOLD** the knob until the “Save to” screen is displayed. Using the knob. Select a memory location (numbered 1 to 25) and **PRESS & RELEASE** the knob. The controller will save a complete parameter set with the changed parameters to the location selected, an audible tone will sound and the screen will return to the current parameter set screen.

However, if other parameters require adjustment, then **PRESS & RELEASE** the knob to move on to the next parameter screen.

The next screen is the “Time” screen which is used to set the welding time (duration). The value is shown in milliseconds (mS) and is adjustable between 1 and 1000mS.
NOTE! Between 1 & 20mS the value is adjustable in 1mS steps. Between 20 & 100mS the value is adjustable in 5mS steps and between 100 & 1000mS the value is adjustable in 10mS steps.

SETTING UP AND WELDING

TURN the knob to set the required welding time.

Once the desired number is reached the choices are as previously outlined. Either go to the “Save to” screen using **PRESS & HOLD** or move on to the next parameter screen using **PRESS & RELEASE**.

The next screen is the “Gas” screen which is used to set the time duration of the pre-weld shielding gas purge. The gas purge time sets a duration of gas purging which occurs before the weld commences to help purge normal atmosphere from the welding zone. If shielding gas is being used the gas purge will then continue throughout the weld time duration and turns off when the current flow through the weld turns off.

The gas purge is adjustable between 0.0S and 5.0S is 0.1S steps.

TURN the knob to set the required purging time.

NOTE! If shielding gas is not being used. Leave this value at 0.0S which disables the gas function.

If you wish to go around the 3 parameter setting screens again **PRESS & RELEASE** the control knob to skip to the first/next screen (Current, Time, Gas) ad infinitum
or
if you wish to save the parameters you have set to one of the 25 locations in the controller memory. **PRESS & HOLD** the control knob until the “Save to” screen appears.

TURN the control knob to set the number on screen to a value between 1 & 25. Then **PRESS & RELEASE** the control knob. The controller will save your parameter set to that location. A single audible tone will sound and the display will return to the current operational parameters screen (now displaying the parameters you have set, which have become the current operational parameters).

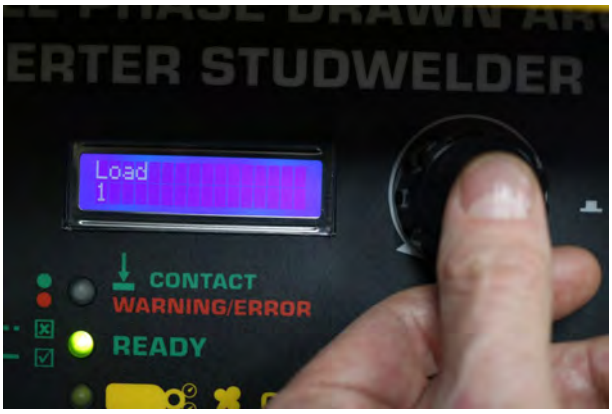
SETTING UP AND WELDING

From page 14.

Selecting **Load** will take you to the parameter load screen.

If you have previously saved a parameter set to one of the 25 memory locations in the controller memory. You can recall those parameters using this screen.

Simply **TURN** the control knob to select the appropriate memory location (numbered 1 to 25).



Then **PRESS & RELEASE** the control knob. This will load the saved parameter set into the current operating parameters and the display will return to the operating screen (now displaying the loaded parameters).

SETTING UP & WELDING - SUPPLEMENTAL SCREENS

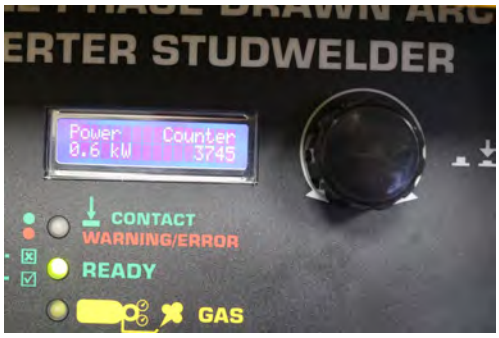
The display has 5 different display screens when in normal operating mode. These can be accessed by simply turning the adjuster knob in either direction.

The main display screens which have been previously described are:

Current Parameter Set

Charge Status Screen

There is also a Power - Counter screen:

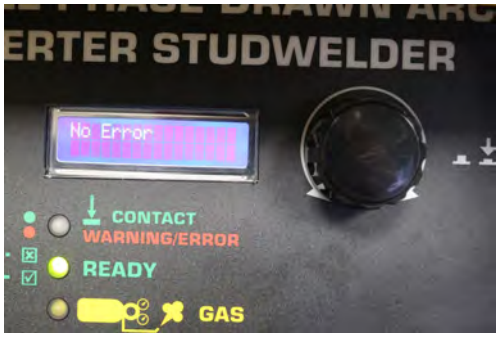


This screen displays the power used by the controller for the last executed weld in kW and also displays a user resettable weld counter. The counter can be reset to zero whilst the screen is displayed by executing a **PRESS & HOLD** until it shows 0.

In normal operating mode. The above screens will stay on display unless changed by user selection or by entering setting mode.

There are 2 further information screens (when selected, these screens will only display for approx. 3 seconds before reverting to the previous screen):

Error Reporting Screen

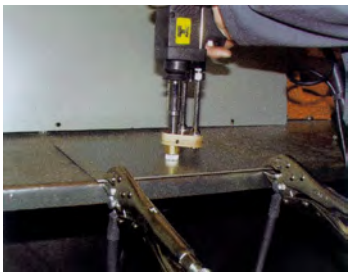


This screen reports system errors. Which is useful if a problem occurs.

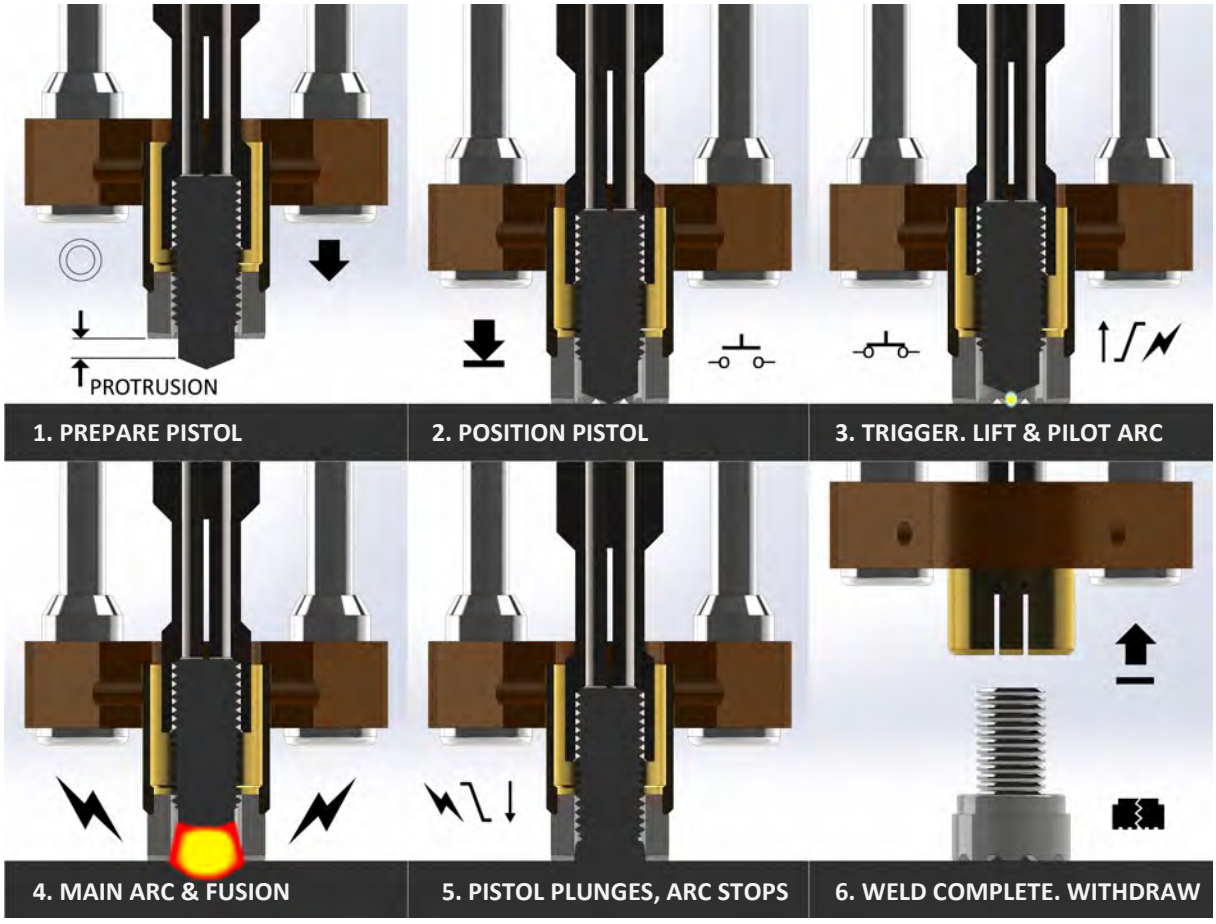
Prg - Gas Screen

This screen reports the current program memory location No. and the current gas purge setting.

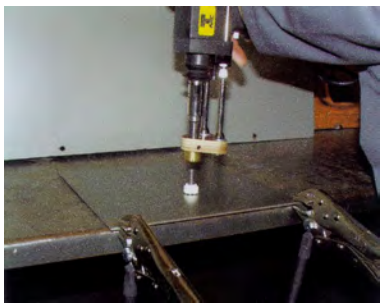
SETTING UP AND WELDING



Set up the welding pistol in-line with the operating guide supplied with the pistol. Ensuring that there is sufficient stud protrusion and that the stud is centred in the ferrule/foot assembly. Place the pistol perpendicular to the work piece with the stud touching down at the desired location to be welded. Press down on the pistol until the ceramic ferrule rests firmly on the work piece. Press the trigger to initiate the weld sequence (see graphic below). See the section on **STUDWELDING TECHNIQUES** for further advice.



Having welded the stud, draw the pistol vertically off the stud. Failure to do this may cause the split tines of the chuck to splay out. This will result in the chuck and stud arcing together during subsequent welds.



Finally, remove the ferrule by lightly tapping until it shatters and visually inspect the weld.

For a guide to the inspection of the welded stud see the sections on **VISUAL WELD INSPECTION** and **WELD TESTING**.

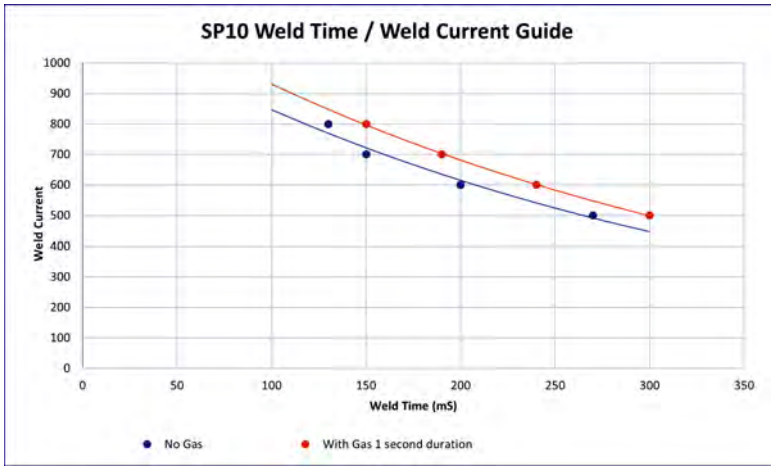
WELDING TIME AND CURRENT SETTINGS

This page is intended as a guide to setting your machine.

The SPi-10 Single Phase Inverter Drawn Arc Stud Welder uses inverter technology to charge a bank of high energy storage capacitors from a single phase mains supply. Because the energy used to perform welding operations is stored, it is therefore finite and users need to be aware of this.

The controller output of current and time have maximum range values of 800A and 1S respectively but it is important to note that the controller cannot deliver 800A for 1S.

The chart below is intended as a guide to help you balance the 2 welding parameter values to help get the best out of the controller. Especially when welding near the limit of its capabilities.



As can be seen from the chart. A good tip for getting maximum performance is to use a shielding gas when welding as it can give up to 30mS more arc time at any given current.

The table on the right gives a starting point for welding various stud sizes but, as always, they are only intended as a guide. You must carry out you own sample welds to establish what best suits your application.

STUD TYPE	ACTUAL DIAMETER (mm)	WELD CURRENT (A)	WELD TIME (ms)
5FB	5	400	100
6RB	4.7	376	94
6FB	6	480	120
8RB	6.2	496	124
8FB	8	640	160
10RB	7.9	632	158
10FB	10	750	175

NOTE! If when welding, the controller displays the message “Warning out-current” This is a warning that your weld did not have the available energy to complete the process at the settings you are using.
This does not necessarily mean that your weld is bad. As it may have been only a few amps short of the requirement and testing /inspection of the weld may prove it to be acceptable. However, if you receive this warning. We suggest you adjust your output parameters.

VISUAL WELD INSPECTION

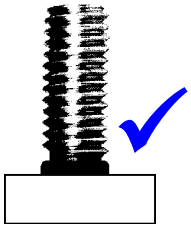
This page will help you to recognise a poor weld when you see one and give some of the possible explanations as to how it may have occurred. Your test welds should look like the first example diagram in the series and once you transfer to the actual job, periodic checks should be made to ensure that your welding is consistently good.

POINTS TO LOOK FOR IRRESPECTIVE OF PROCESS USED.

- L.A.W. (Length After Welding). This should be correct to within + 0 / - 1 mm.
- The base fillet of the welded stud is complete.
- The welded stud is perpendicular to the work-piece.

WHEN USING A CERAMIC FERRULE.

This diagram is an example of a good normal weld, fulfilling the criteria above i.e. The LAW is correct, the stud has a complete, well formed and even fillet and is also perpendicular to the work-piece.

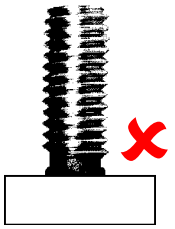


The following examples will help you to recognise the most common types of poor weld, explain the possible causes of these problems and how to remedy them.

EXAMPLE 1

PROBLEM : Insufficient heat, causing the L.A.W. to be too long and the fillet to be underdeveloped and/or incomplete.

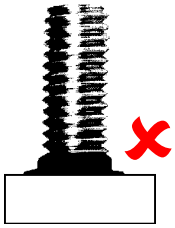
REMEDY : Increase the welding time (see page 13).



EXAMPLE 2

PROBLEM : Excessive heat, causing the L.A.W. to be too short and the fillet to be too large and messy, spreading out under the ferrule and/or splashing up the threads.

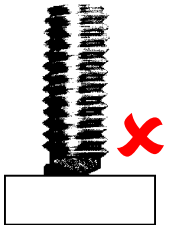
REMEDY : Reduce the welding time (see page 13).



EXAMPLE 3

PROBLEM : The ferrule is not being held firmly against the work-piece and/or the stud is binding against the ferrule.

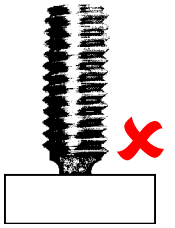
REMEDY : Hold the pistol firmly down to the work-piece (see page 14) and reset the alignment of the stud and ferrule (refer to your pistol setup guide).



EXAMPLE 4

PROBLEM : Insufficient stud protrusion set on the pistol and/or the stud is binding against the ferrule.

REMEDY : Adjust stud protrusion to correct setting (refer to your pistol setup guide).

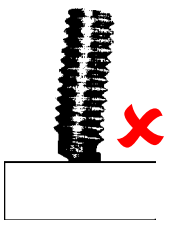


EXAMPLE 5

PROBLEM : Poor alignment i.e. stud is not perpendicular to the work- piece.

REMEDY : Hold the pistol perpendicular to the work-piece (see page 14).

NOTE : If the misalignment is only slight and in all other aspects the weld is good, then the weld may be salvaged by tapping straight with a soft mallet.



WELD TESTING

There are two factors which should receive special attention in establishing visually whether or not a stud weld is sound. These are :

- The length after weld (L.A.W.) of the stud should be correct. That is to say that a stud which is intended to be 50 mm long after welding, should be correct within +0/-1 mm. A word of explanation is perhaps needed on this point. All studs produced include a "weld allowance". This allowance is so arranged for the different diameters of stud, that it will be completely melted during the welding process, provided of course that the correct conditions have been established and the correct values of current and time are used.
- The fillet of metal formed around the base of the stud should be well formed, reasonably evenly distributed, completely free from blow holes and of a silver blue colour.

These two factors combined form the basis of all visual stud weld examination. It should be the aim of every operator to produce these results.

Under normal conditions a stud welded to clean mild steel plate of adequate thickness having the correct L.A.W. and fillet formation. as described above, will be a satisfactory weld.
It should be remembered, however, that different applications or conditions will produce slightly different visual results, particularly in the appearance of the fillet, i.e.. Slightly rusty, dirty or oily plate will produce blow holes in the fillet, in proportion to the degree of plate contamination. Welding close to some magnetic obstruction may produce uneven fillet distribution. Too much power will produce a fillet that flows too easily and is lost either up in the threads of the stud or out through the ferrule vents, while too little power may not melt sufficient material to form a complete fillet.
It is important, therefore, to judge the degree to which these possible variations will affect the weld strength, but in general, provided that the L.A.W. is correct and the fillet formation is not unsightly, a visual examination is all that is required.
Further testing may be carried out on a "percentage of production" basis, and the methods used fall into the classes outlined below.

1. DESTRUCTIVE TESTING.

Should only be used on studs welded to samples and test pieces.

- Hammering a stud over may look spectacular, but it is not a satisfactory test, as the direction and force behind the blows is uncontrolled, as also is the point at which the impact takes place. The length, diameter and type of stud also have an effect on the results obtained.
- Bending the stud over by using a tube of approximately the same bore as the stud diameter. This method is preferred to hammering, but again no conclusive evidence as to the strength of the weld is obtained.
- Loading the stud by the use of washers / spacer and a nut until the stud breaks. This method is much more conclusive and should show that the weld is in fact stronger than the stud. Use of a suitably calibrated torque wrench for this test will give an indication of the U.T.S. developed by the stud material under test.

WELD TESTING

2. NON DESTRUCTIVE TESTING.

Generally the most practical way of testing threaded stud welds, without destroying the stud, is with the use of proof tests. A torque wrench is particularly useful for this purpose.

Below and overleaf are some tables which you may find useful. However, it must be noted that :

- Formulas & data shown are intended for guidance only.
- In applications where control of preload is important, the torque - tension relationship should be determined experimentally on the actual parts involved including any lubricants.
- The coefficient of friction (k) varies with material, surface finish and lubricity of threads and bearing areas of fastened parts.
- For standard steel screws it is 0.19 to 0.25 and 0.13 to 0.17 for plated screws. Anti-seize materials and lubricants can lower k to 0.05. For some stainless steel threads and parts not coated or lubricated k may be as high as 0.33
- All the figures are approximate and do not form part of any specification.
- Designers and specifiers must satisfy themselves that the studs and materials chosen are suitable for their particular application.

Material properties:	(N/mm^2)	(N/mm^2)	(N/mm^2)
	UTS	Yield	Safe
Mild Steel (4.8)	420	340	272
Stainless Steel (1.4301)	540	350	280
Note: safe loads are 80% of the yield			

All torque figures are calculated by the formula : $T = kDP$

Where : T = Torque (Nm)
D = Effective Stud Diameter (m)
k = Coefficient of Friction (0.2 used for calculations)

WELD TESTING

Stud loads - Full Base Drawn Arc Studs (kN)

	Mild Steel	Mild Steel	Mild Steel	Stainless Steel	Stainless Steel	Stainless Steel
Thread	UTS	Yield	Safe	UTS	Yield	Safe
M5 x 0.8	5.8	4.7	3.7	7.4	4.8	3.8
M6 x 1.0	8.2	6.6	5.3	10.6	6.8	5.4
M8 x 1.25	15.2	12.3	9.8	19.6	12.7	10.1
M10 x 1.5	23.8	19.2	15.4	30.6	19.8	15.8
M12 x 1.75	34.6	28.0	22.4	44.5	28.8	23.1

Torque required to reach the loads above (Nm)

	Mild Steel	Mild Steel	Mild Steel	Stainless Steel	Stainless Steel	Stainless Steel
Thread	UTS	Yield	Safe	UTS	Yield	Safe
M5 x 0.8	4.9	4.0	3.2	6.3	4.1	3.3
M6 x 1.0	8.2	6.7	5.3	10.6	6.9	5.5
M8 x 1.25	20.7	16.8	13.4	26.7	17.3	13.8
M10 x 1.5	40.5	32.8	26.2	52.1	33.8	27.0
M12 x 1.75	71.0	57.5	46.0	91.3	59.2	47.4

Stud loads - Reduced Base drawn Arc Studs (kN)

	Mild Steel	Mild Steel	Mild Steel	Stainless Steel	Stainless Steel	Stainless Steel
Thread	UTS	Yield	Safe	UTS	Yield	Safe
M6 x 1.0	7.2	5.8	4.7	9.3	6.0	4.8
M8 x 1.25	12.6	10.2	8.2	16.3	10.5	8.4
M10 x 1.5	20.5	16.6	13.3	26.4	17.1	13.7
M12 x 1.75	29.7	24.0	19.2	38.2	24.8	19.8

Torque required to reach the loads above (Nm)

	Mild Steel	Mild Steel	Mild Steel	Stainless Steel	Stainless Steel	Stainless Steel
Thread	UTS	Yield	Safe	UTS	Yield	Safe
M6 x 1.0	6.8	5.5	4.4	8.8	5.7	4.6
M8 x 1.25	15.7	12.7	10.2	20.2	13.1	10.5
M10 x 1.5	32.5	26.3	21.1	41.8	27.1	21.7
M12 x 1.75	56.6	45.8	36.6	72.7	47.1	37.7

STUDWELDING TECHNIQUES

The operating instructions given previously in this guide apply to the majority of general applications where it is possible to use the pistol in the down hand position and with standard cable lengths. For many applications these conditions do not apply and the following notes will give some guidance as to the methods used to obtain satisfactory results for a variety of applications.

1. WELDING TO A PLATE IN THE HORIZONTAL POSITION.

In this position there is a tendency for the weld metal to run to the underside of the stud during welding, due to the action of gravity, resulting in an uneven fillet. The effect is more noticeable as stud diameter increases and generally speaking it is not recommended that studs of 12 mm diameter and over be welded to vertical plates for this reason. The essential requirement to obtain satisfactory fillet formation is to use the shortest weld time possible with increased welding current. Welding to a vertical surface reduces the maximum size of the stud a given power source will weld. It must be remembered, that greater care is required to ensure that the stud is perpendicular to the work piece. A special tripod foot attachment can be supplied if required. Take particular care to keep the ferrule grip, foot adapter and chuck clean.

2. WELDING TO A PLATE IN THE OVERHEAD POSITION.

IMPORTANT ! You must protect your face and shoulders with a helmet and cape before carrying out overhead welding operations. Weld spatter can do a lot of damage !
Firstly, obtain satisfactory weld settings in the down hand position before making attempts in the overhead position. Since the weld metal is transferred from stud to plate in small particles in the down hand position, it follows that, when welding overhead, the transfer takes place against gravity. As with vertical welding the best results will be achieved using the shortest possible weld time with increased welding current.
It is important that the ferrule grip, foot adapter and chuck are kept free from spatter build up as this can cause stud return problems or possibly short out/bridge out the weld.

3. PISTOL ADJUSTMENTS WHEN WELDING IN THE VERTICAL OR OVERHEAD POSITIONS.

Problems may be encountered when welding in the vertical or overhead positions with a damped pistol. To prevent problems occurring, where it is possible to do so, the damping effect should be removed or turned off.
Welding can then continue as outlined in sections 1. and 2.

4. USING LONG CABLE LENGTHS.

Frequently the pistol must be used some distance from the nearest available mains supply, for instance on board ship, in power stations and building construction, in workshops building large pre -fabricated structures etc. In these cases long lengths of welding cable are used and it must be realised at the outset that, the longer the cables the smaller the maximum diameter of stud which can be welded with a given power source.
To help get over this problem, if larger diameter studs are to be welded with long lengths of cable, increase the welding cable conductor size.
Try to avoid running the pistol cables and the earth cables alongside each other as this can cause a choking effect, reducing power. Also avoid coiling any excess cable as this will have the same effect.

STUDWELDING TECHNIQUES

5. WELDING STUDS LESS THAN 25 mm LONG USING FERRULES.

As we have seen previously, the stud is held in a recess in the chuck and must be long enough to allow us to set the correct protrusion. A standard chuck has a recess 12 mm deep and ferrules vary in length up to 13.5 mm high. Thus if a stud is much less than 25 mm LAW we shall not be able to obtain the correct protrusion, i.e.. The chuck may hit the ferrule on the return stroke and prevent the stud returning to the plate correctly.

This problem may be overcome by using "shallow recess" chucks (the recess depth is only 6 mm) or if the studs are required to be very short, by using a special type of stud known as a "break-off" type. These studs have an overall LAW of 30 mm and are welded using a standard chuck and ferrule. The stud is "grooved" at the required length from the welding end. After welding, the surplus portion of the stud is broken off with a pair of pliers. By these means, very short studs can easily be welded.

6. USING TEMPLATES TO ENSURE POSITIONAL ACCURACY.

When welding studs around the periphery of a flange, i.e. for cover plates, inspection doors etc., positioning of the studs in relation to each other becomes most important. A simple template made from 2 mm sheet, shaped to suit the component and provided with clamps is usually the answer to this problem. The position of the studs is accurately marked and holes drilled in these positions to accept either the ferrule of the stud to be welded or, if using short cycle, the pistol gas shroud. The size of the holes should be the outside diameter of the ferrule / shroud +0.4 mm. It is also advisable to provide 2 mm thick pads underneath the template so that there is a space between the component and template, this space will allow the gases developed during welding to vent properly from the ferrule / shroud. For any further advice or help in the design of jigging or templates contact your local field sales engineer.

7. MINIMUM PLATE THICKNESSES WHEN STUD WELDING.

When using standard Drawn Arc with ceramic ferrules, the minimum ratio of stud diameter to plate thickness is 4 : 1 for plate thickness greater than 3 mm and 3 : 1 for plate thickness between 1.5 mm and 3 mm. When using the short cycle system with or without gas purging it is possible to weld equivalent size studs onto slightly thinner sections, due to the short weld duration. These ratios ensure that the strength of the plate is sufficient to support a stud of a given size when it is loaded, without there being a tendency for the plate to distort.

Occasionally, however, it may be necessary to weld a stud outside of these ratios. This can sometimes be accomplished without distortion by "heat sinking" the component, by using a flat copper or water cooled backing piece behind the weld area, to support the plate and assist in dissipating heat quickly.

8. WELDING STAINLESS STEEL.

Austenitic stainless steel studs of the 18/8 g/N : weld decay proof type can be supplied for welding to similar parent material or mild steel. The technique does not differ from that used for mild steel stud welding. There is a tendency with larger diameters of stainless steel studs for metal transfer across the arc to take the form of large particles. If short circuits occur then the arc can be heard to splutter. This may occur with any diameter of stainless steel stud if the lift of the hand tool is not correct. Due to this tendency to transfer in large particles increased lift may be required and time settings should be kept as low as possible.

STUDWELDING TECHNIQUES

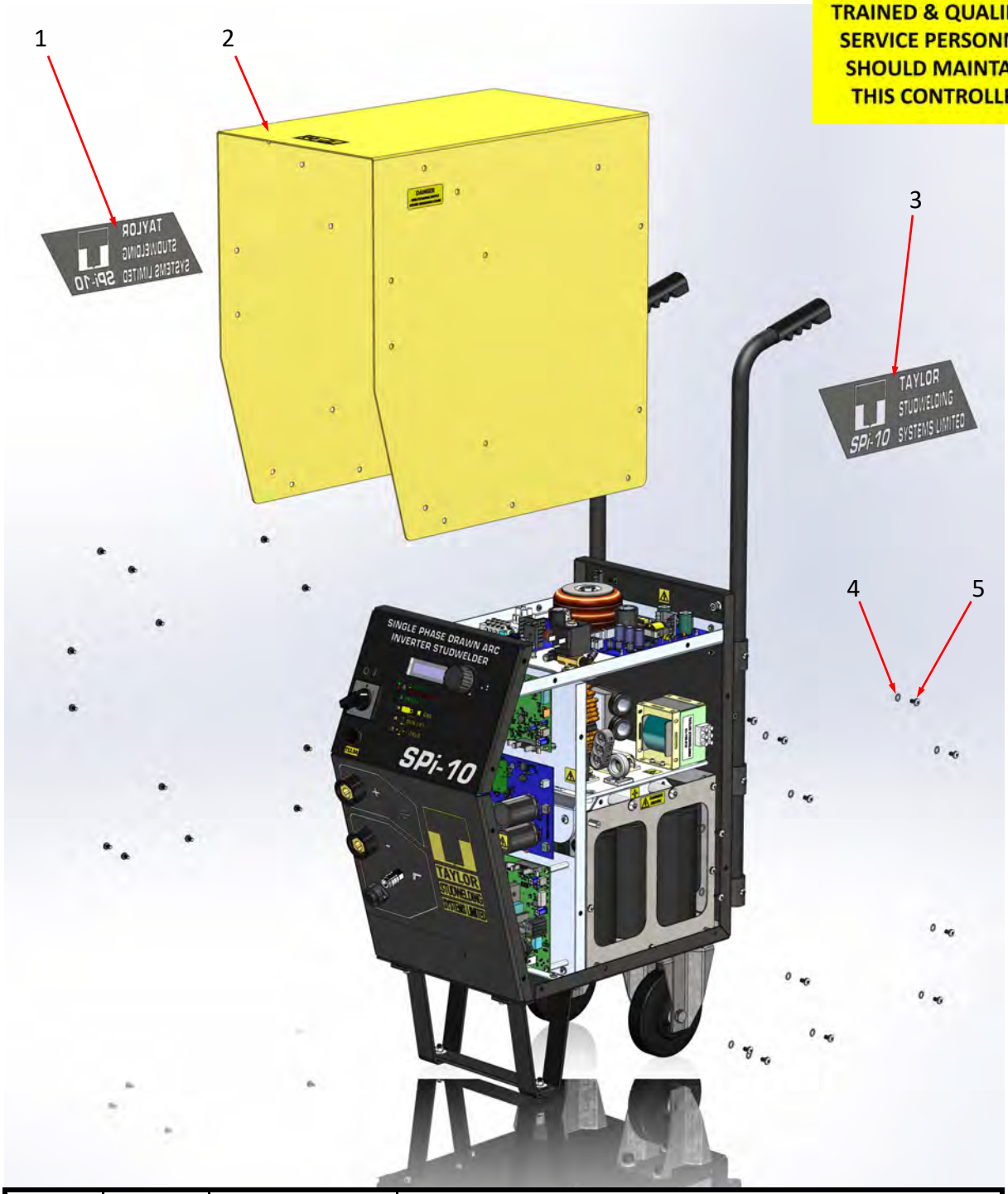
9. WELDING CLOSE TO CORNERS, FLANGES AND OTHER OBSTACLES.

When welding close to the edge of a plate, in / on a corner, on long strips of narrow plate etc. An effect known as "arc-blow" occasionally will produce an uneven fillet, in such a fillet, most of the material is blown to one side of the stud. "Arc-blow" is caused by the magnetic forces surrounding the arc being intensified in one direction, due to the presence of an air gap or the proximity of a large mass of magnetic material. It is dependant on a number of factors, size of stud, shape of component, position of earth connection, current density etc. No hard and fast rules can be applied to correct it. The following methods are generally helpful, but if satisfactory results cannot be obtained, our field staff will be pleased to advise you. Check that no other fault is present by welding a few studs on to a test piece and inspecting the fillet formation, before deciding that "arc-blow" is causing the uneven fillet.

"Arc-blow" can sometimes be corrected by placing a block of steel near the position of the weld area, on the opposite side to that at which the fillet has blown. When welding near the edge of a plate, the fillet will be blown towards the general mass of material, i.e.. away from the edge. The block in this case should therefore be placed at the edge the plate, touching it, thus providing a more evenly distributed magnetic field. The earth connection can be located immediately below the position of the stud weld, this latter is not always practicable, since it requires the earth connections to be moved frequently. The use of two earth connections, spaced evenly across the welding area, is also advisable.

DANGER!
600VDC
ONLY SUITABLY TRAINED & QUALIFIED SERVICE PERSONNEL SHOULD MAINTAIN THIS CONTROLLER

PARTS LIST & EXPLODED DIAGRAM



ITEM	No. OFF	PART No.	DESCRIPTION
1	1	81-300-156	SIDE STICKER
2	1	81-300-152	HOUSING COVER
3	1	81-300-157	SIDE STICKER
4	26	Z620-05-000	WASHER
5	26	Z200-05-008	SCREW

PARTS LIST & EXPLODED DIAGRAM

DANGER! 600VDC

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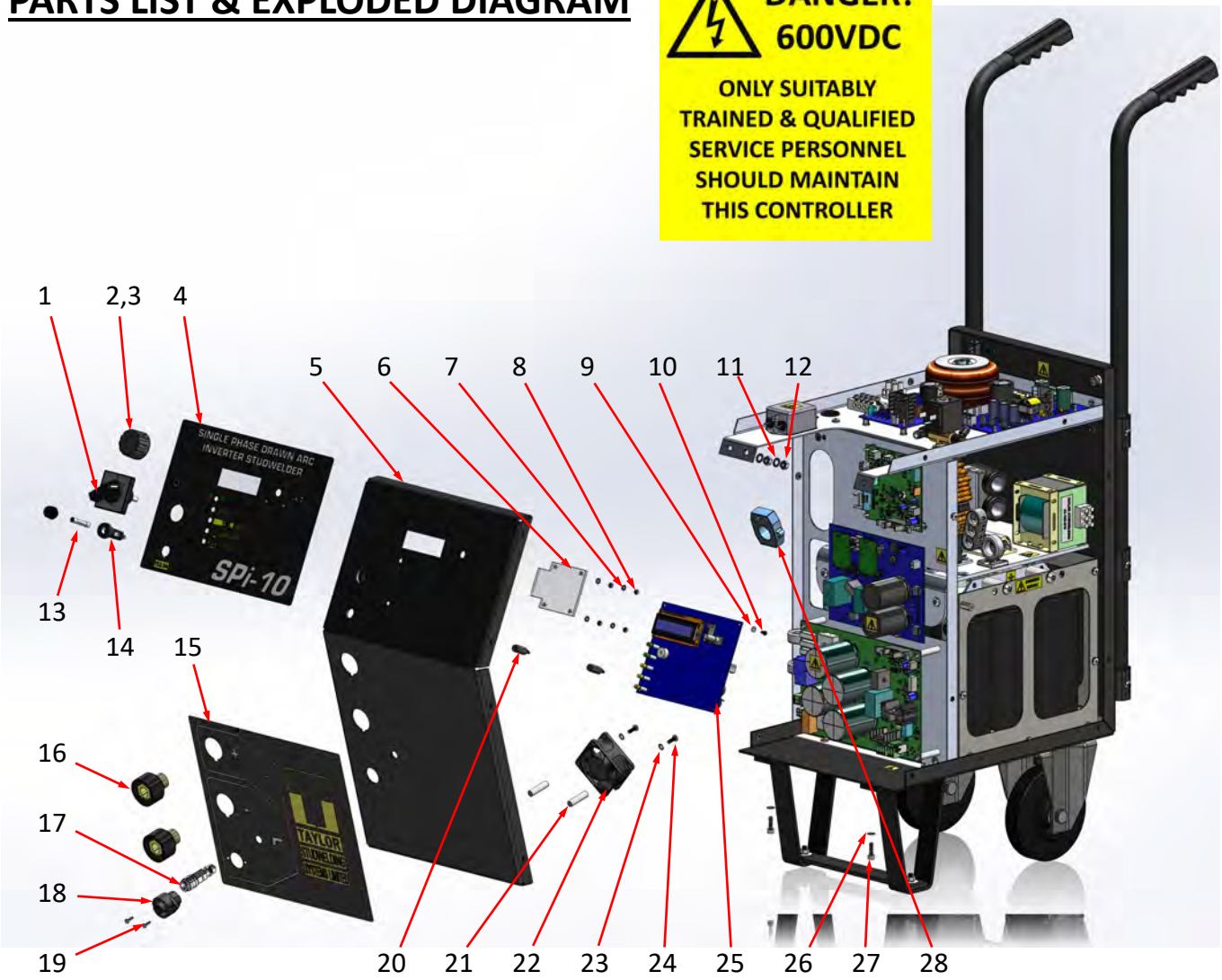

ITEM	No. OFF	PART No.	DESCRIPTION	ITEM	No. OFF	PART No.	DESCRIPTION
1	1	81-108-067	ON/OFF SWITCH	15	1	81-300-155	LOWER PANEL OVERLAY
2	1	81-104-030	KNOB	16	2	81-106-031	WELDING SOCKET
3	1	81-104-032	KNOB CAP	17	1	PFX-CSS-B06-BUL	GAS OUTLET
4	1	81-300-154	UPPER PANEL OVERLAY	18	1	70-102-025	CONTROL SOCKET
5	1	81-300-151	FRONT PANEL	19	2	Z200-03-010	SCREW
6	1	81-300-025	WINDOW	20	2	81-300-093	PCB MOUNT
7	4	Z600-03-000	WASHER	21	2	Z860-04-030	PILLAR
8	4	Z505-03-000	NUT	22	1	70-105-053	FAN
9	2	Z610-04-000	WASHER	23	2	Z620-04-000	WASHER
10	2	Z200-04-008	SCREW	24	2	Z200-04-010	SCREW
11	3	Z620-06-000	WASHER	25	1	81-300-087	PCB
12	3	Z505-06-000	NUT	26	2	Z620-05-000	WASHER
13	1	70-105-236	FUSE	27	2	Z200-05-016	SCREW
14	1	70-102-085	FUSEHOLDER	28	1	81-300-014	TRANSDUCER

PARTS LIST & EXPLODED DIAGRAM

DANGER! 600VDC

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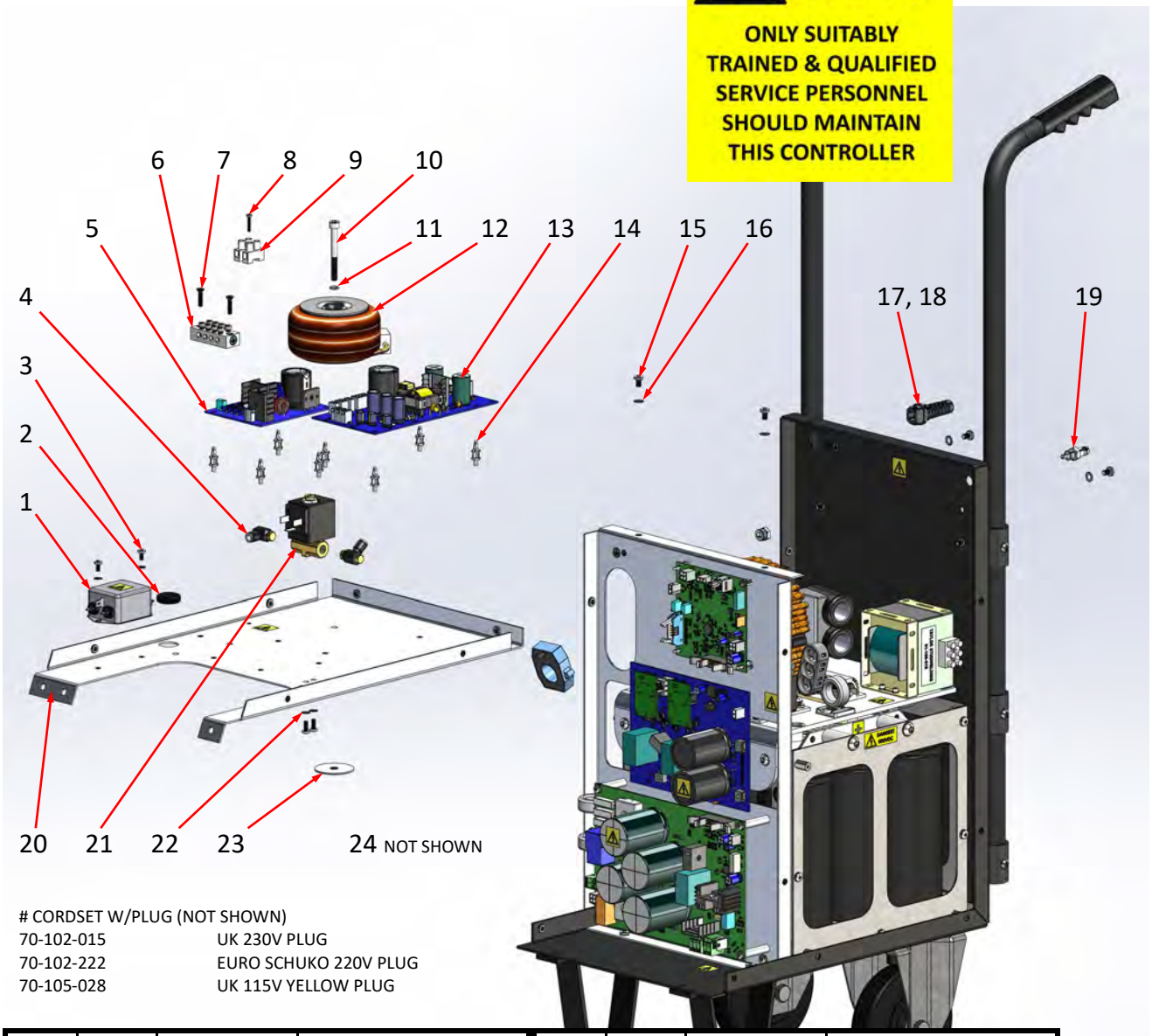
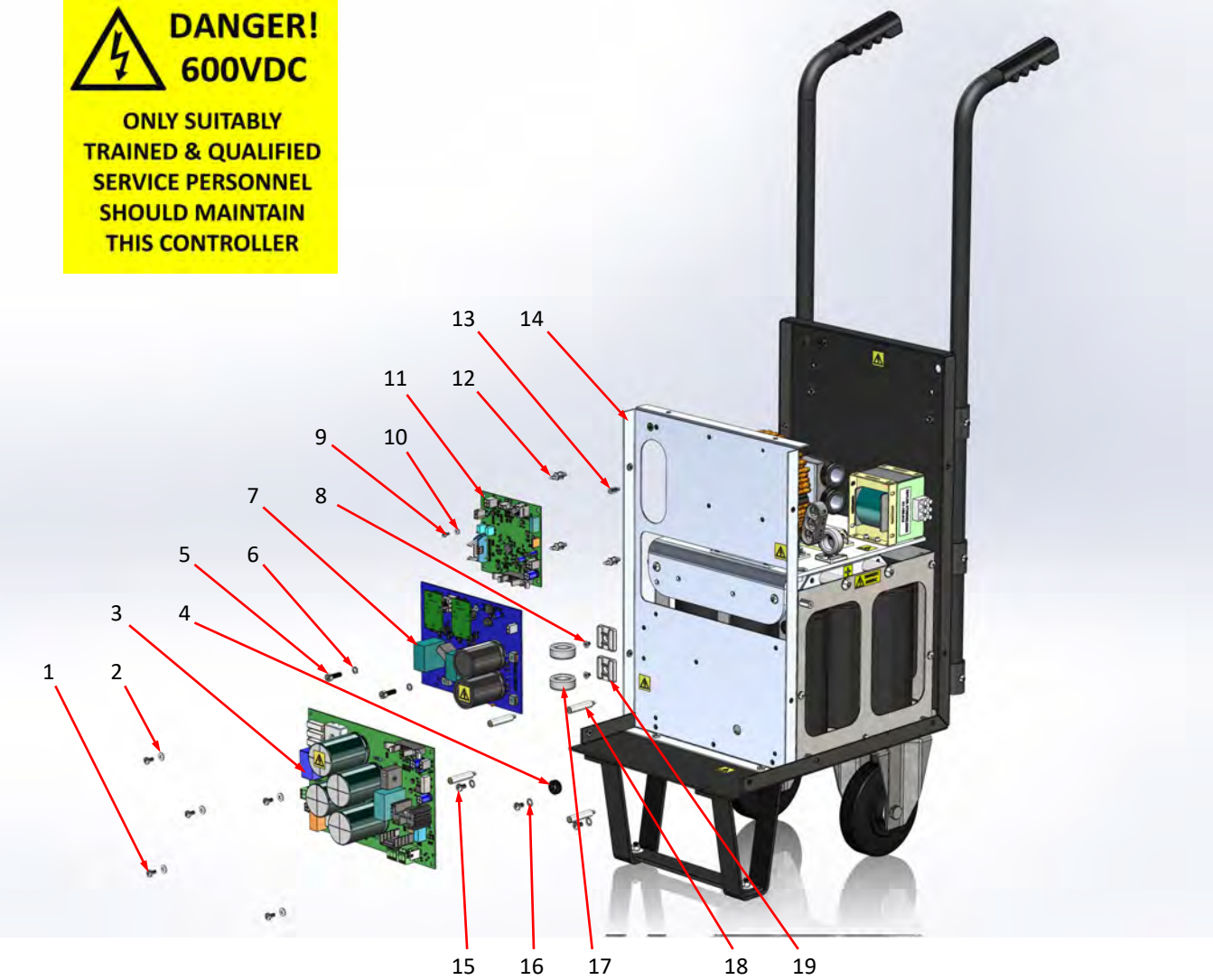


CORDSET W/PLUG (NOT SHOWN)

70-102-015	UK 230V PLUG
70-102-222	EURO SCHUKO 220V PLUG
70-105-028	UK 115V YELLOW PLUG

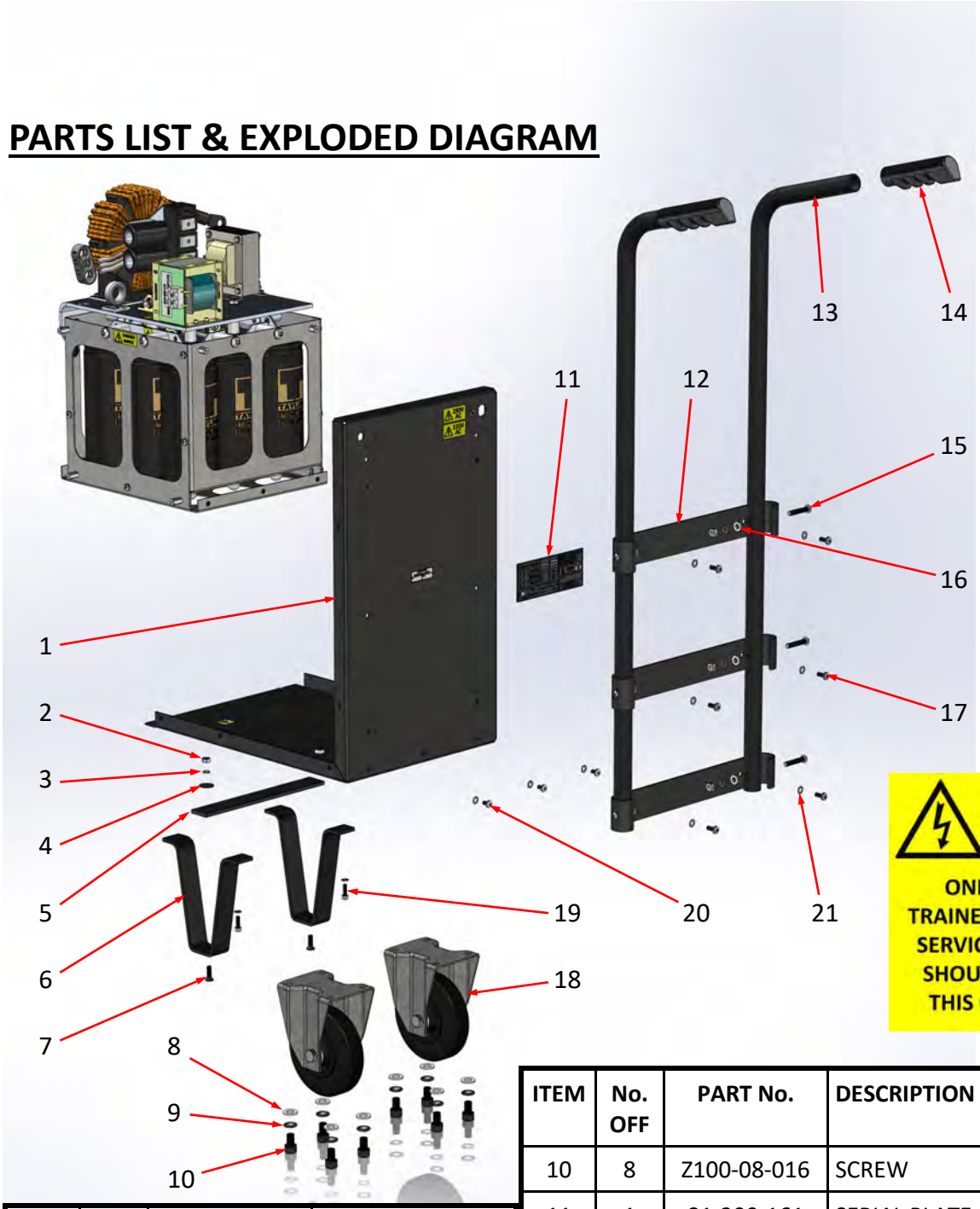
ITEM	No. OFF	PART No.	DESCRIPTION	ITEM	No. OFF	PART No.	DESCRIPTION
1	1	81-300-132	FILTER	13	1	81-300-088	PCB
2	1	81-300-136	GROMMET	14	8	81-300-092	PCB MOUNT
3	4	Z200-04-010	SCREW	15	4	Z200-05-008	SCREW
4	2	PFE-P06-U1M	ELBOW	16	4	Z620-05-000	WASHER
5	1	81-300-108	PCB	17	1	70-102-075	CABLE GLAND
6	1	70-105-190	EARTH BLOCK	18	1	SEE #	CORDSET (NOT SHOWN)
7	2	Z120-04-018	SCREW	19	1	71-200-067	GAS INLET
8	1	Z200-03-016	SCREW	20	1	81-300-149	TOP DECK
9	1	70-105-115	TERMINAL BLOCK	21	1	81-108-071	GAS VALVE
10	1	Z105-06-055	SCREW	22	4	Z620-04-000	WASHER
11	1	Z615-06-000	WASHER	23	1	81-300-141	SPREAD NUT
12	1	81-300-162	AUX TRANSFORMER	24	1	81-300-167	WIRING HARNESS

PARTS LIST & EXPLODED DIAGRAM



ITEM	No. OFF	PART No.	DESCRIPTION	ITEM	No. OFF	PART No.	DESCRIPTION
1	5	Z200-04-008	SCREW	11	1	81-300-097	PCB
2	5	Z610-04-000	WASHER	12	3	81-300-092	PCB MOUNT
3	1	81-300-098	PCB	13	1	70-105-228	PILLAR
4	1	81-113-146	GROMMET	14	1	81-300-147	BULKHEAD
5	2	Z105-05-016	SCREW	15	3	Z200-05-008	SCREW
6	2	Z615-05-000	WASHER	16	3	Z620-05-000	WASHER
7	1	81-300-091	PCB	17	2	81-300-081	FERRITE
8	2	Z205-04-008	SCREW	18	5	Z855-04-035	PILLAR
9	1	Z200-03-006	SCREW	19	2	81-300-022	TIE BASE
10	1	Z600-03-000	WASHER				

PARTS LIST & EXPLODED DIAGRAM



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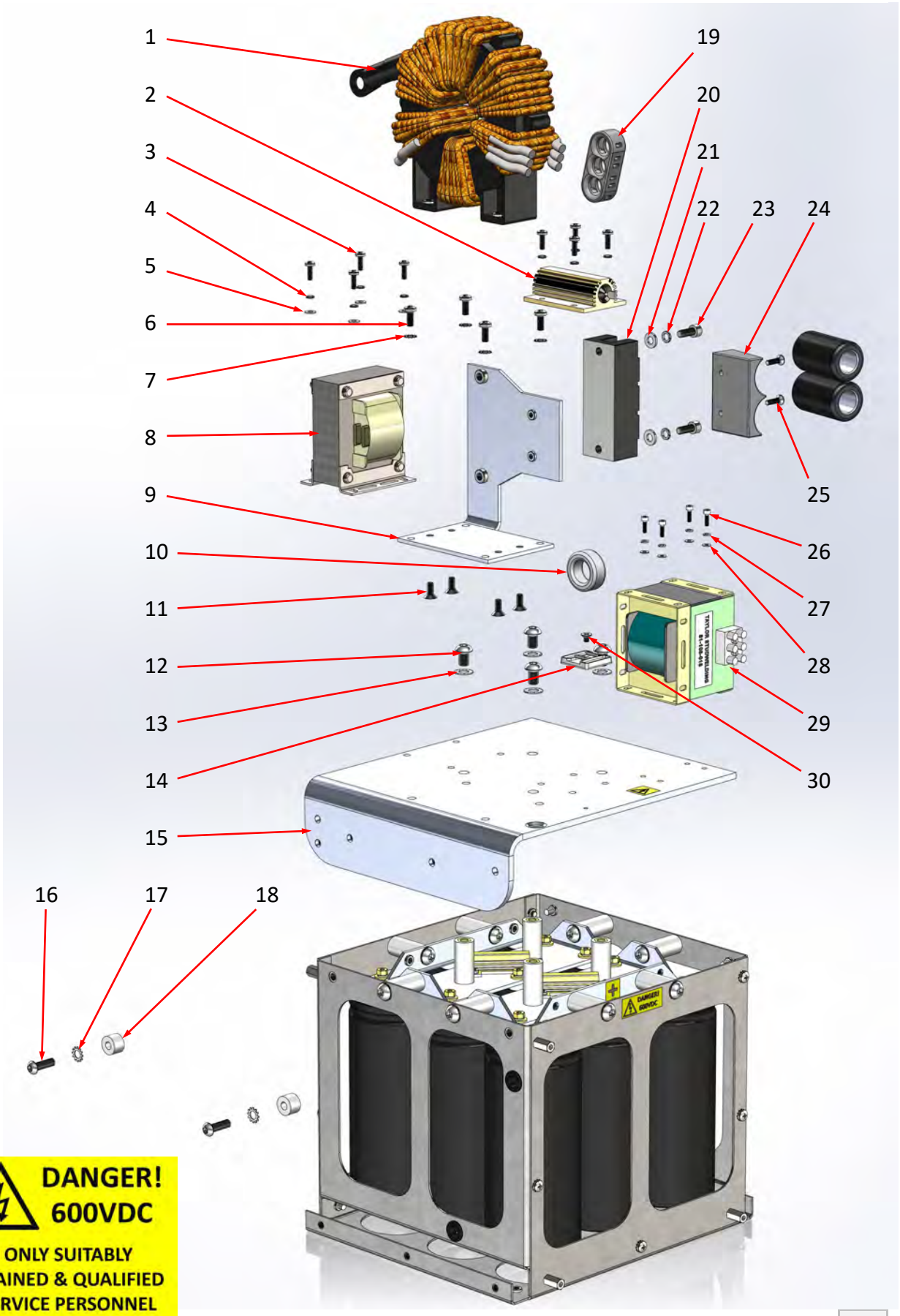
ITEM	No. OFF	PART No.	DESCRIPTION
1	1	81-300-148	BASEPLATE
2	8	Z505-06-000	NUT
3	8	Z615-06-000	WASHER
4	2	Z600-06-020	WASHER
5	1	81-300-166	LINK BAR
6	2	81-300-165	SUPPORT LEG
7	2	Z120-06-020	SCREW
8	8	Z600-08-000	WASHER
9	8	Z615-08-000	WASHER

ITEM	No. OFF	PART No.	DESCRIPTION
10	8	Z100-08-016	SCREW
11	1	81-300-161	SERIAL PLATE
12	3	81-300-164	HANDLE CLAMP
13	2	81-300-163	HANDLE TUBE
14	2	81-300-138	HAND GRIP
15	6	Z115-06-035	SCREW
16	6	Z600-06-000	WASHER
17	6	Z200-05-012	SCREW
18	2	81-106-011	FIXED CASTOR
19	2	Z105-05-016	SCREW
20	3	Z200-05-008	SCREW
21	11	Z620-05-000	WASHER

V-21C

PARTS LIST & EXPLODED DIAGRAM



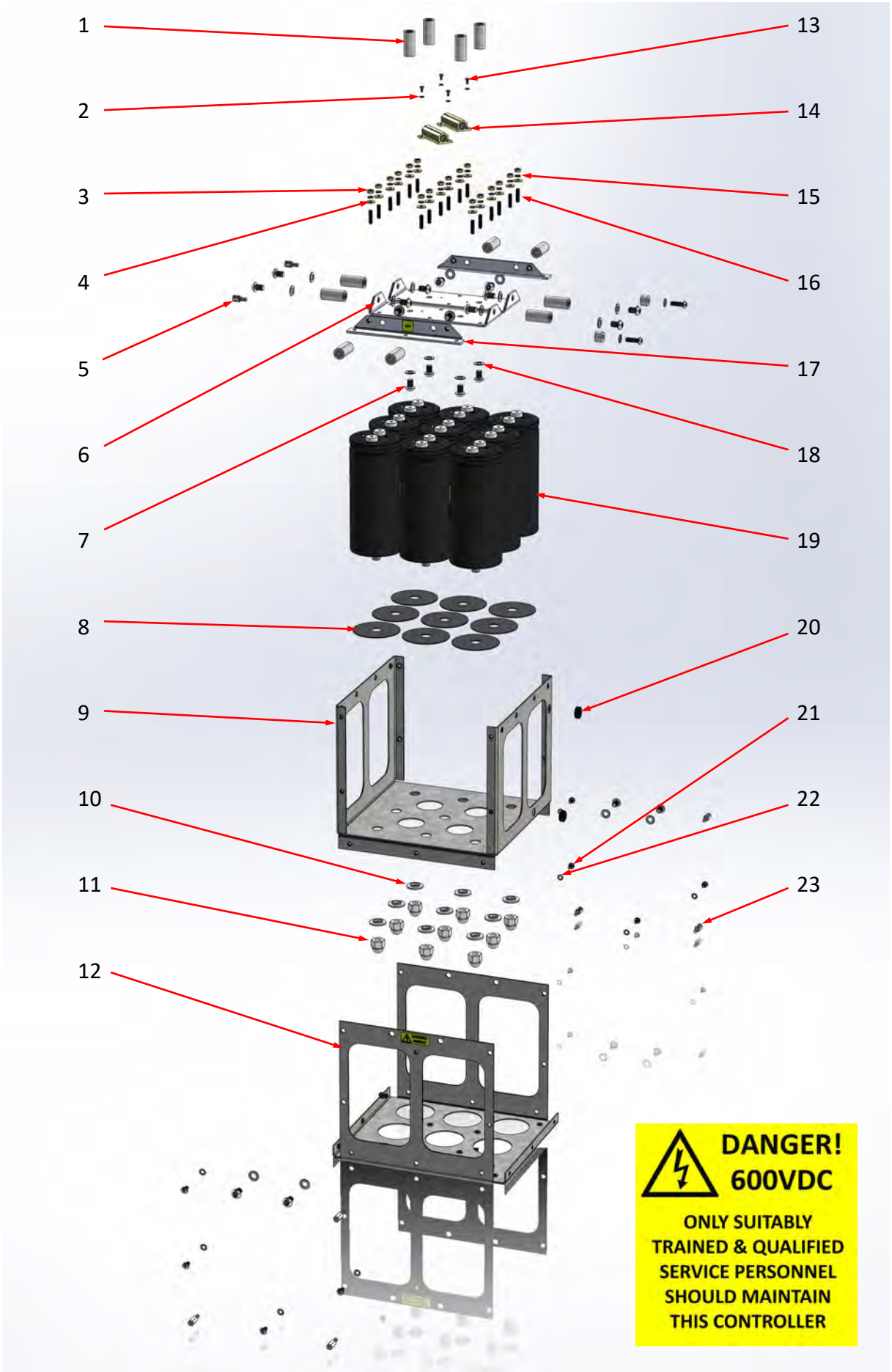
DANGER!
600VDC

ONLY SUITABLY TRAINED & QUALIFIED SERVICE PERSONNEL SHOULD MAINTAIN THIS CONTROLLER

PARTS LIST & EXPLODED DIAGRAM

ITEM	QTY.	PART No.	DESCRIPTION
1	1	81-300-158	TRANSFORMER
2	1	81-300-133	CHARGE RESISTOR
3	8	Z200-04-012	SCREW
4	8	Z615-04-000	WASHER
5	4	Z600-04-000	WASHER
6	4	Z200-05-012	SCREW
7	4	Z620-05-000	WASHER
8	1	81-300-019	INDUCTOR
9	1	81-300-150	Tx BRACKET
10	9	81-300-081	FERRITE
11	4	Z120-05-012	SCREW
12	4	Z115-08-012	SCREW
13	4	Z620-08-000	WASHER
14	1	81-300-022	CABLE TIE BASE
15	1	81-300-146	SINK PLATE
16	2	Z115-06-020	SCREW
17	2	Z620-06-000	WASHER
18	2	81-300-055	SPACER
19	1	81-300-140	ROUTING CLIP
20	1	81-300-010	OUTPUT DIODE
21	2	Z600-06-000	WASHER
22	2	Z615-06-000	WASHER
23	2	Z105-06-016	SCREW
24	1	81-300-139	F-PACK MOUNT
25	2	Z205-04-016	SCREW
26	4	Z105-03-010	SCREW
27	4	Z615-03-000	WASHER
28	4	Z600-03-000	WASHER
29	1	81-108-018	INDUCTOR
30	1	Z205-04-008	SCREW

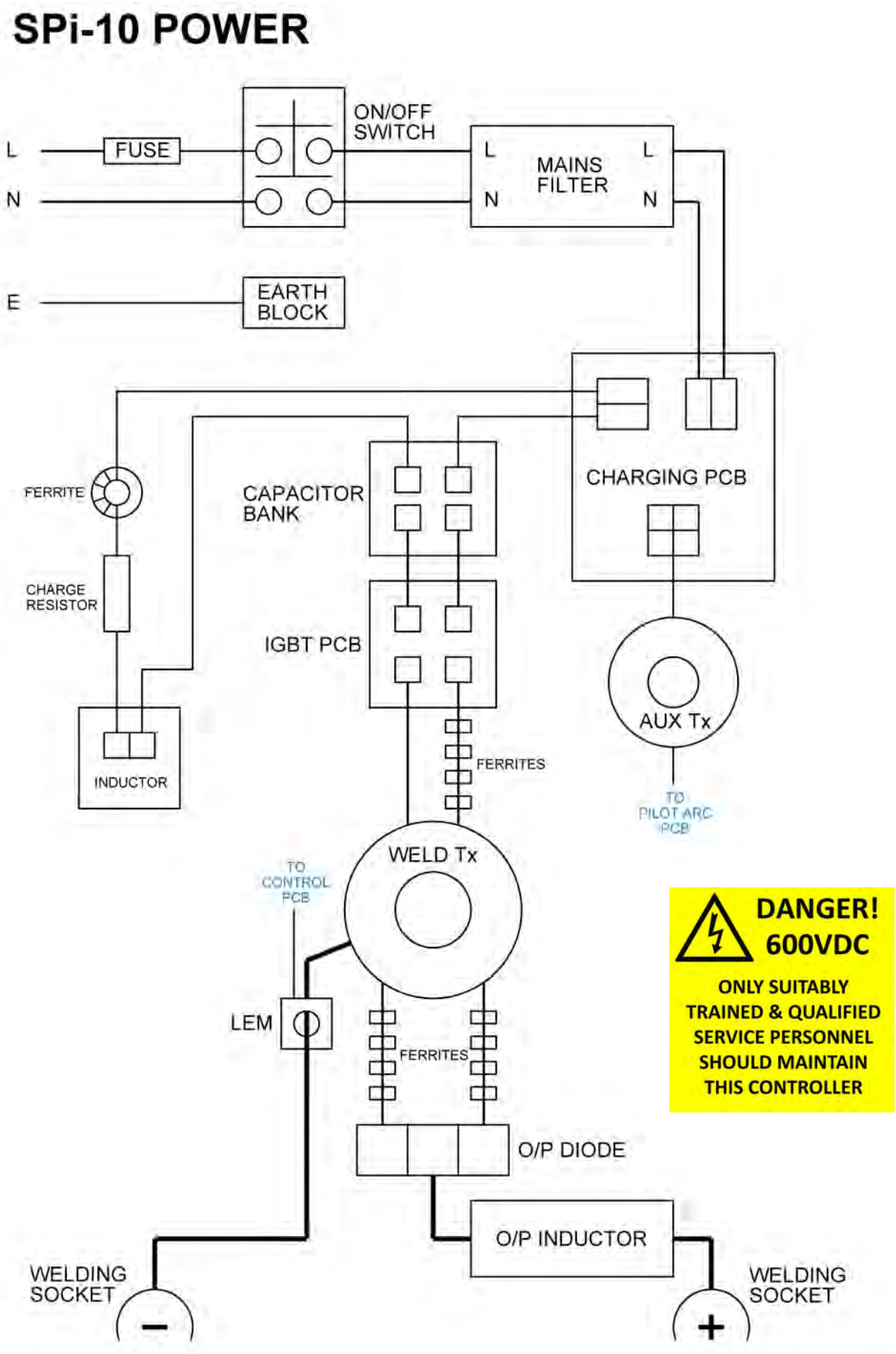
PARTS LIST & EXPLODED DIAGRAM



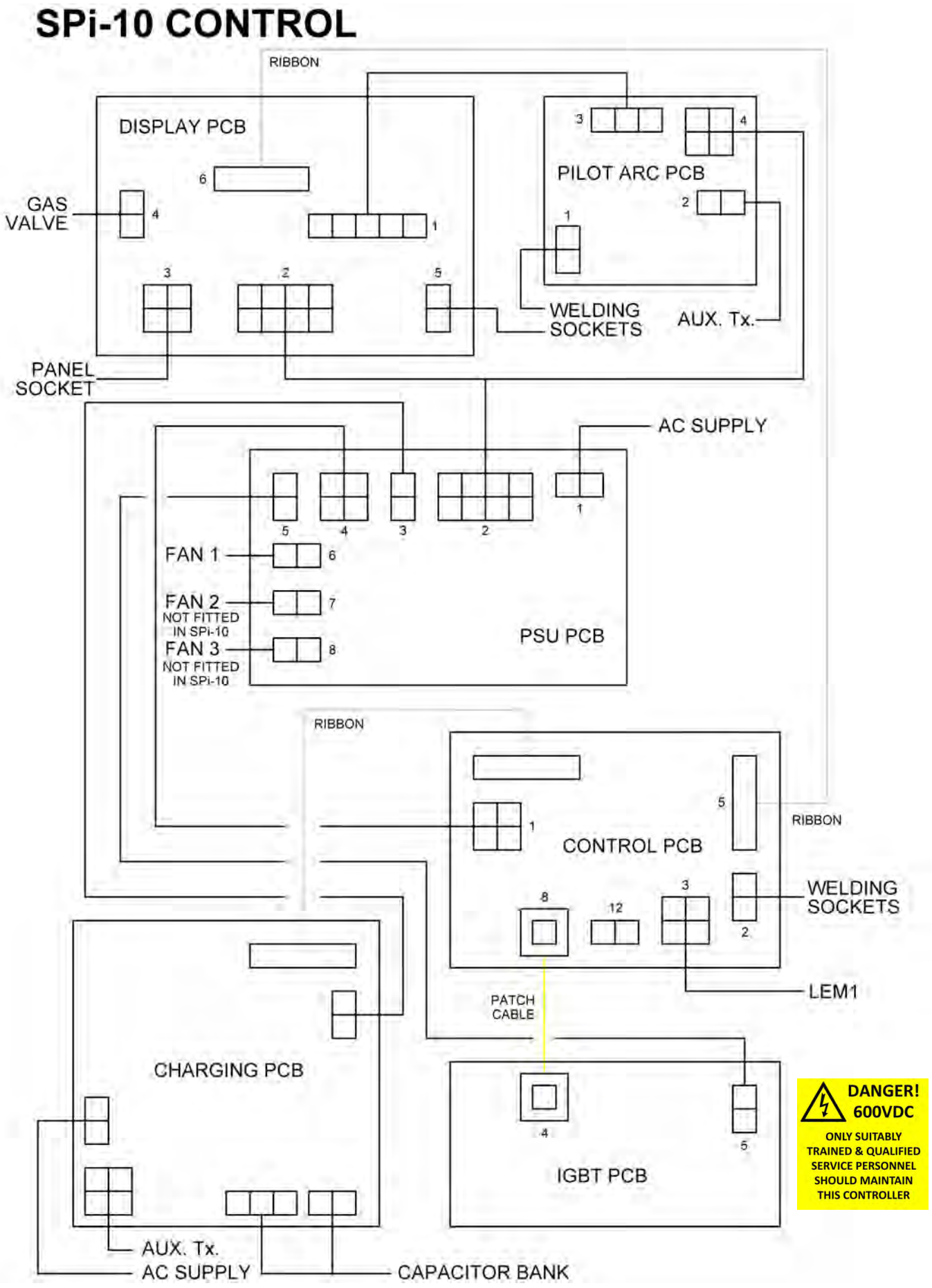
PARTS LIST & EXPLODED DIAGRAM

ITEM	QTY.	PART No.	DESCRIPTION
1	12	Z860-08-035	PILLAR
2	4	Z615-03-000	WASHER
3	18	Z515-05-000	NUT
4	18	Z605-05-999	WASHER
5	2	Z865-05-010	PILLAR
6	2	81-300-143	LINK BUSBAR
7	24	Z115-08-012	SCREW
8	9	70-105-258	INSULATOR
9	1	81-300-144	CAPACITOR CARRIER
10	9	70-105-259	INSULATOR
11	9	Z650-12-000	NUT
12	1	81-300-145	CARRIER MOUNT
13	4	Z200-03-006	SCREW
14	2	81-300-168	RESISTOR
15	18	Z615-05-000	WASHER
16	18	Z406-05-022	SCREW
17	2	81-300-142	CONNECTION BUSBAR
18	24	Z620-08-000	WASHER
19	9	70-105-040	CAPACITOR
20	2	81-113-146	GROMMET
21	8	Z200-05-008	SCREW
22	8	Z620-05-000	WASHER
23	6	Z865-05-015	PILLAR

CIRCUIT SCHEMATIC



CIRCUIT SCHEMATIC



TROUBLESHOOTING - WARNINGS & ERRORS

The internal software of the controller, amongst other things, is constantly monitoring various aspects of the system.

Occasionally, should conditions warrant it, the multi-function display may report a Warning condition. This will usually be accompanied by an audible tone from the controller. A warning does not always prevent the controller from continuing to operate as it may be advising an impending or remediable problem.

Similarly, the multi-function display may also report an error condition. Again, accompanied by an audible tone. Error conditions will also illuminate the CONTACT LED in RED. Error conditions will always prevent the controller from operation until cleared.

Some warning/error conditions are able to be cleared by remediating the problem that is causing the problem.

For example. If a pistol is not connected to the controller. The controller will detect this and display error code F510 on the display. If a pistol is subsequently connected to the controller. It will detect the pistol and self clear the error condition.

Other warning/error conditions can not be cleared without a re-start of the controller. However, simply turning the controller off and then on again will not necessarily clear these conditions either. If this is the case, further intervention may be required. Below and on the next page is a table which is intended to help with diagnosis/remediation:

CODE	DESCRIPTION	ACTION
C000	DATA ERROR FAULT	CONTACT SUPPLIER
C100-C105	POWER SUPPLY FAULTS	CONTACT SUPPLIER
C200-C203	WELDING POWER FAULTS	CONTACT SUPPLIER
C300-C303	TRANSDUCER FAULTS	CONTACT SUPPLIER
C400-C406	OVER TEMPERATURE	Stop welding, stay powered on to allow the fans to continue to operate and allow the unit to cool down. If the problem persists. Contact your supplier.
C407-C413	TEMP. SENSOR FAULTS	CONTACT SUPPLIER
F500	DATA ERROR FAULT	CONTACT SUPPLIER
F501	CONTACT LINE ON	The pistol has remained in contact with the stud after welding. Ensure the pistol has been cleared of the welded stud/workpiece.

TROUBLESHOOTING - WARNINGS & ERRORS

CODE	DESCRIPTION	ACTION
F502	POWER LIMIT REACHED	Avoid high duty cycle welding at high current outputs or with long welding extension cables.
F503-F509	DISPLAY CONTROL FAULT	CONTACT SUPPLIER
F510	PISTOL NOT DETECTED	CHECK PISTOL IS FITTED/FUNCTIONAL
F511-F512	GAS VALVE FAULT	CONTACT SUPPLIER
F513	DUTY CYCLE LIMIT	The unit is being worked above its designed duty rate. Reduce the work throughput rate.
F514	PISTOL SHORT CIRCUIT	The unit has detected a short circuit on the 4 way pistol lead. Investigate for cable damage or a faulty or incorrectly wired pistol extension.
WARNING	OUT CURRENT	The unit is unable to deliver sufficient weld current. The measured output current is considerably less than the set current. The mains voltage may be low or there may be a mains supply fault. Avoid welding at high currents and/or through long welding cables. If the problem persists. CONTACT SUPPLIER
WARNING	POWER LIMIT	This warning is given as a pre-cursor to fault F502 (see above). The unit will allow continued operation but if the workload is not lessened, fault F502 will stop working in the near future.
WARNING	DUTY CYCLE	This warning is given as a pre-cursor to fault F513 (see above). The unit will allow continued operation but if the workload is not lessened, fault F513 will stop working in the near future.

IMPORTANT NOTE!

THE CONTROL UNIT IS AN INVERTER BASED POWER SUPPLY AND HAS INTERNAL VOLTAGES OF 600VDC.

WE DO NOT RECOMMEND INTERNAL MAINTENANCE OF THE CONTROL UNIT BY ANYONE OTHER THAN SUITABLY QUALIFIED TECHNICIANS WITH APPROPRIATE TRAINING AND SAFETY EQUIPMENT.

ACCESSORIES

An earth cable must be connected to the controller in this user guide.

STANDARD EARTH CABLE ASSEMBLY FOR SYSTEM SPi-10	**99-101-095**

Spare parts for the maintenance of earth cables are listed below:

WELD PLUG	81-101-051
CABLE/m	71-300-005
EARTH CLAMP	81-101-135
CRIMP TERMINAL	Z700-08-060

EU DECLARATION OF CONFORMITY

Responsible Party Name	:	**Taylor Studwelding Systems Ltd**
Address	:	**Commercial Road** **Dewsbury** **West Yorkshire** **WF13 2BD** **UK**
Designation of Product :		**Inverter Studwelding Equipment. Model SPi-10** **Studwelding gun series DA2-A to DA20**

The above mentioned equipment complies with the requirements of the following directives :

93/68/EEC	**The CE Marking Directive**
2014/35/EU	**The Low Voltage Directive**
2014/30/EU	**The Electromagnetic Compatibility Directive**

The above mentioned products conform to the following European standards :

EN 60974-1:2012	**ARC WELDING EQUIPMENT - PART 1 : WELDING POWER SOURCES**
EN60974-10:2014	**ARC WELDING EQUIPMENT - PART 10 : ELECTROMAGNETIC COMPATIBILITY (EMC) REQUIREMENTS**

I hereby declare that the above mentioned equipment has been designed to comply with the relevant sections of the above referenced standards. The equipment complies with all applicable essential requirements of the above mentioned directives.

Signed.

David Taylor
Managing Director

Authorised European Representative : **J D PEARMAN**
GLENN MILLERWEG 36
1311 RT ALMERE
NETHERLANDS