Alfa Engineering

M A N U A L

X –Ray Tube Power Supply

X2A-400E

V4.1

10/2006
Rev. 1

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Safety Instructions

GENERAL

On receipt the unit should be carefully unpacked and inspected to ensure that no transit damage has occurred. Provided that this inspection is satisfactory and reveals no evidence of damage then installation can proceed.
It is essential that the person undertaking the installation and set-up of this power supply has received appropriate technical training to be aware of the hazards to which that person may be exposed in performing the tests, and of measures to minimize the risks to themselves, and other personnel. Metallic or conductive tools should not be used to adjust any of the potentiometers. The unit has no user serviceable parts and should not be dismantled.

DO NOT HANDLE OR TOUCH THESE UNITS WHEN THE SUPPLY IS CONNECTED. AFTER DISCONNECTION FROM THE SUPPLY, ALLOW 30 SECONDS BEFORE HANDLING SO THAT ALL THE CAPACITORS CAN DISCHARGE.

To ensure that the output is fully discharged short to ground before touching any high voltage circuit.

Care should be taken not to operate the unit outside the specified limits given above, failure to do so may damage the unit.

COMPLIANCE WITH SAFETY STANDARDS

The unit is designed to meet Normalized European Safety Standards for installation in equipment conforming to EN61010 and hence installation of the power supply unit into the equipment should comply with the following requirements:

a. A PROTECTIVE EARTH must be provided for safety in accordance with EN61010 Part 1: Clause 6.5.1. The case of the units should be bonded to this protective earth.
b. The output is classed as hazardous and must therefore not be accessible to operators. The output must be isolated from accessible circuits by Double Insulation or a protective screen as defined in EN61010-1.
c. The unit is intended to be installed in an electrical enclosure and should not be accessible to the operator. Access should be restricted to authorized service personnel only, with use of a tool. Care should be taken to prevent access to the interior of the unit and protect against items (e.g. tools or wires) inadvertently entering the interior of the unit.
d. The unit is not fitted with a fuse and so should be operated from a limited supply of <8 amp.
e. The primary safety interlock must remove the 24Vdc supply, thereby removing the source of energy, NOT relying on the Inhibit input.

INSTALLATION

The outputs of these units are considered hazardous and should be installed such that they cannot become accessible. The output should be connected such that the shortest creepage and clearance path is to a protective earth connection. ENSURE that a LOW IMPEDANCE connection is made to the unit chassis from the system PROTECTIVE EARTH. The safety earth conductor must not contain any switches or fuses.
Under worst case conditions the unit draws a current of 7A and any input supply cable must be of a suitable type and rating. The unit is not fitted with a fuse and so should be operated from a limited supply. Fuses may be fitted externally to the unit to protect unit and interconnecting wiring etc. but these should be rated to prevent nuisance failures. Care should be taken in the

design of the interconnecting wiring within the system to ensure that connectors with hazardous voltages cannot be connected to accessible circuits. Ensure that the filaments outputs are connected to the load prior to operation of the unit and that a good low impedance high voltage joint is made. Sharp points on either the high voltage or return joint should be avoided as this will cause corona which will make the output appear noisy. In general a tracking distance (creepage distance) of 25mm (1 inch), per 10kV to earth is advised as a minimum to ensure no breakdown or corona occurs, a much greater distance will be required under adverse conditions. Care must be taken not to damage the cable inner when forming the connections.

During arcing currents exceeding 1000 Amps will flow. It is important that these currents return to the high voltage power supply by the shortest possible route using the screen (shield) of the output cable. Failure to observe this will result in the control terminals of the unit seeing large voltage spikes during arcing and radiation of electromagnetic interference.

Adequate ventilation should be provided to keep the unit cool and the ventilation inlets should not be covered in any way.

The ambient air temperature around the inlet must not exceed 45 °C. The unit is fitted with a thermal cut-out to protect itself should the ambient temperature exceed this level. To restart the unit it must be allowed to cool. De-asserting and reasserting the INH input will then clear the trip. The unit will operate in any orientation, however it is not recommended to operate with the silk-screened face as the lowest face.

OPERATING NOTES

1. HIGH VOLTAGES ARE DANGEROUS. ENSURE THE OUTPUT IS FULLY DISCHARGED BY SHORTING TO GROUND BEFORE TOUCHING ANY HIGH VOLTAGE CIRCUIT.
2. The unit is short circuit proof but care should be taken that the high voltage cannot be shorted into one of the control pin connections.
3. TO ENABLE THE UNIT PIN 8 MUST BE TAKEN TO LESS THAN 1.5V WITH RESPECT TO PIN 9.

1. Power Requirements

Power to X2A-400E is supplied through power plug P1 on the main card. For proper operation of the x-ray tube power supply it is necessary to supply regulated 24VDC/8.5 A (+/-10%). There is red LED to indicate DC power is applied.

2. Digital Displays

Digital displays with 2VDC differential input should be used for proper readings of kV, mA, filament current and temperature. However, the single ended input digital displays are supported when it is requested by the customer. The control card of X2A-400E takes care of all necessary signals and power requirements of such displays. They can be ordered separately from Alfa Engineering P/N: X2A-400D.

2.1. Display Mode

The "Display Mode" input controls display data selection. Digital displays will show kV and mA when input "Display Mode ", JB3 pin 29/60, is high - default state. If this pin is pulled low displays will show temperature and filament current on the respective displays. The display mode can be controlled by push button, JB3 pin 29/30, or by an I/O from control computer, JB3 pin 14/60.
Please, note that for proper control of the “Display Mode” function by the remote host computer it is necessary that pin 29/60 is high (default state - kV, mA reading) or it is not connected at all.

2.1.1. Timer

There are two possible ways of display mode operation:

1. Timed Reading
2. Momentary Reading

Jumper JP2 on control card selects desired mode. If JP2 is closed then timer is enabled and when "Display Mode", JB3 pin 29/60 or 14/60, is momentarily pulled low display will switch to filament current and temperature reading for 10 seconds and then revert to kV and mA reading. Different duration could be specified upon order of your X2A-400E. When momentary reading is selected (JP2 open on control card), then displays will show filament current and temperature values as long as any of "Display Mode" inputs is pulled low.

2.2. Display Mode LED Indicators

There are two outputs from control card of X2A-400E available to indicate the readings of the displays. Each output is ready to drive one to three LED's directly. When displays are showing mA and kV then LED on JB3 pin 41/60 is ON, and when filament current and temperature is shown then LED on JB3 pin 40/60 is ON.

3. Local / Remote

The selection between local and remote control of kV and mA settings of the X-ray power supply is done by input "Local/Remote", JB3 pin 28/60 for SPST switch or by pin 13/60 on JB3 for I/O from control host computer. If any (or both) of these pins are pulled low then the power supply will switch to remote operation and set kV and mA values according to remote control settings.

If these pins are released to high (default state) then the power supply will set kV and mA according to readings from potentiometers on the front panel. Please, note that for proper control of the “Local/Remote” function by the remote host computer it is necessary that pin 28/60 on JB3 is high (default state – Local settings) or it is not connected at all.
For detailed wiring refer to Appendix A.

3.1. Remote Power Control

Remote control of the tube power is done using MAX532 - dual digital to analog converter that is controlled serially via I/O port JB5. For detailed timing and serial protocol configuration please refer to data sheet for MAX532.
Standard 4-wire SPI protocol is used and signal description is in following pin out for JB5. “Output A” from MAX532 is designated for mA control and “output B” is designated for kV control. Jumpers J13 on the Remote Control and Interlock board can switch outputs.

3.2. Local / Remote LED Indicators

Two outputs - LED drivers, JB3 pin 35/60 (Local) and JB3 34/60 (Remote), are available to indicate in which mode of operation is the power supply.

4. Preset

Preset values (remotely or locally) can be read on the displays if input "Preset", JB3 pin 27/60, is pulled low by momentary push button or if pin 12/60 on JB3 is pulled low by I/O from control computer.
Please, note that for proper control of the “Preset” function by the remote host computer it is necessary that JB3 pin 27/60 is high (default state – Actual reading) or it is not connected at all.

5. Internal Interlocks

There are internal interlocks that monitor operation of the system, any activation of internal interlocks will not let you to turn ON the HV power.

5.1 X-ray Tube Filament Current Interlock

Filament current interlock monitors if the filament current is in it's limits. If filament current exceeds 4A for any reason (ex. filament short, high voltage cable short etc.) the internal interlock will be open and it will not be possible to turn ON HV power, and the "Filament Short" LED will be ON, JB3 pin 43/60.

Also, if the filament is broken or the x-ray tube is not plugged in it will not be possible to turn ON the HV power, and the "Filament Open" LED will be ON, JB3 pin 42/60.

5.2 Arc Interlock

If there is an arc in the system, the "Arc" internal interlock will be activated. It will shut down high voltage, and the "Arc" LED will be ON, JB3 pin 38/60.
Some minor arcs will be tolerated by X2A-400E but it is highly recommended to avoid any arc if possible.

5.3 Internal Temperature Interlock

X2A-400E has an ability to monitor internal or an external temperature that is interlocked, and if it exceeds 60°C (could be set to any value between 0°-100°C), the temperature interlock will be activated and it will shut down HV power, also the O/T LED will be ON, JB3 pin 39/60.

To display temperature at any time press “Display Mode” pushbutton and observe the KV/T display.

5.3.1. External Temperature Interlock

External temperature (x-ray tube, enclosure, ambient etc.) could be monitored and interlocked via input on JB4 connector pin 7/16. The selection of internal OR external temperature has been done via jumper JP1 on control card. If jumper is open then external temperature is chosen, or if it is shorted then internal temperature is chosen. For the correct reading of the external temperature use LM45 sensor. This temperature will be shown on display when the “Display Mode” pushbutton or proper I/O is activated.

5.4 Internal Interlock Reset

If any of internal interlocks is activated it will be reset when HV ON pushbutton is activated – if the interlock condition is removed. Sometimes it is necessary to power down X2A-400E in order to reset it even if the condition is removed afterward. If it is not reset after power up sequence, then check the system for persistence of the condition that is in question (filament current, arc or over temperature)

6. External Interlocks

One of the enhancements of X2A-400E is addition of up to 12 external interlocks that can be monitored and then as result of those inputs external interlock signal is generated and tied internally to the main card, JB3 to JB1 pin 30/60. There are LEDs to display status of external interlocks that will be described later in this manual.

All inputs are suitable to TTL levels as well as to any sensor with open collector output. Input impedance of any interlock is 10K or higher.
Interlock 1, Interlock 2, Interlock 3 and Interlock 6 are predetermined for enabling signal from computer, "chamber sensing", Water Flow detection and the X-ray tube thermistor respectively.
Rest of the interlock inputs are general purpose that could be configured for normally low or normally high input.

6.1. External Interlock Reset

One important characteristic about all interlocks is that they are memorized on the board until reset signal is applied. So if, interlock "X" is open and closed afterward, then "external interlock open" signal will be activated and LED's "Interlock open" and "Interlock X" will be ON. If an I/O is used instead of LED's then controller's input "X" will be low. To reset interlock error condition there are two possible ways.

1. By PC
2. By starting X-ray power ON, it will reset interlocks and start ramping power to the tube.

6.1.1. Reset by PC

To reset external interlock by PC it is necessary to follow this procedure:

1. Pull low HV OFF By S/W input (JB3 pin 11/60)
2. While HV OFF input is low pull HV ON By S/W input (JB3 pin 10/60) low for no longer then 1 sec
3. Pull high HV ON input (JB3 pin 10/60)
4. And when HV ON is high, pull also high HV OFF input (JB3 pin 11/60).

Procedure just described above will reset all "interlock open" errors if they do not exist anymore in the system.

6.1.2. External Interlock Reset by X-ray ON Push Button

The quick way to reset any interlock error, external and/or internal, is when X-ray ON push button is activated. At the same time it will start ramping power to the X-Ray tube. If any of interlocks are still open it will not be possible to apply power to the X-Ray tube and the proper LED will be ON to indicate which interlock is still open.
Please note that external interlock reset signal can not be generated until ALL interlocks are closed. To speed up troubleshooting it is recommended that No Memory option is activated (JB5 pin 6/14 pulled low) and only corresponding LEDs for open interlocks will be ON. Also power down and then power up HV power supply (24VDC) if an interlock “X” is cleared to quickly update interlock LEDs or I/Os.

6.1.3. External Interlock Memory – No Memory Capability

The X2A-400E high voltage power supply has capability to memorize external interlock states when they occur. Interlock will be open and appropriate LED will be ON until reset signal is applied.
If memory option is not desirable in the system then it simply can be bypassed by pulling low Interlock Memory input, JB5 pin 6/14. In this case interlock will be open and appropriate LED will be ON only when the actual condition exist in the system.

6.2. System Enable by PC - External Interlock I1 - JB5 pin 5/14 - *RESERVED*

Interlock 1 is controlled via System Enable signal that is sent from PC via JB5 pin 5/12. When this signal is pulled and held low then "system enable" interlock is true. In order to clear any interlock open related message after initial power up sequence it is recommended to pull and hold low "enable system" signal and then reset X2A-400E using procedure described in chapter 7.1.1.

To confirm that X2A-400E is enabled by PC there is signal "system enabled" on JB5 pin 9/14 that should be high when system is enabled and vice versa.

6.2.1. Chamber Interlock - External Interlock I2 - JB6 pins 1/16 and 2/16 - *RESERVED*

In order to maintain flexibility and portability of the system special design is applied for chamber interlock. There are 2 inputs available to accommodate chamber sensing and proper easy interlocking. Connector JB6 pin 1 and JB6 pin 2 are used for this purpose. If both of them are left floating (not connected) this interlock will be automatically closed and as a result it will not "look" for chamber interlock input. This option is suitable for systems without chambers and there is no need for any type of jumper to bypass it, which may become safety hazard if jumper is accidentally left in position and chamber is used.
If chamber is used with the system, then signal "enable door switches" - JB6 pin 2 should be pulled to +5VDC to acknowledge presence of the chamber to the X2A-400E. This will disengage chamber interlock and at this point it will be necessary to pull signal "Door switch" - JB6 pin 1 - to GND in order to close chamber interlock again.
For proper operation of this interlock mechanical switches must be used for both signals, "Enable Door switches" and "Door switch".

6.2.2. Water Flow - External Interlock I3 - JB6 pin 3/16 - *RESERVED*

With the newest version of the X2A-400E V.4.1 there is one more enhancement on the interlock board. Now, there is added circuitry for Hall-effect sensor signal conditioning, so the flow meter can be connected directly to the X2A-400E without the interface board as it was case before. For proper connection please see Appendix A. Also note that in this case input on JB6 pin 3/16 can not be used. There is an internal jumper on the

interlock board to select which type of the flow meter is used; Hall effect sensor directly, default setup, (JB6 pins 14/16 - +12VDC, 15/16 – Flow sensor unconditioned signal and 16/16 - GND) or NO switch/transistor (JB6 pin 3/16).

6.2.3. General Purpose External Interlocks I4 and I5 - JB6 pin 4/16 and pin 5/16 respectively

These interlocks are internally connected to be active (open interlock condition) when input voltage is higher then 2.5VDC.
For interlock-closed condition input voltages should be 0-2VDC. They are referred as normally low Interlocks.

6.2.4. Thermal Interlock - External Interlock I6 - JB6 pin 6/16

To protect X-ray tube from overheating there is "thermal" interlock available and it is designed to work with 100K thermistor (that is grounded on the another end) as a temperature sensor. Usually this interlock is tuned as per request of the customer and in case of any modification or change of the thermistor Alfa Engineering should be contacted for assistance. Most of X-ray tubes operate safely up to 60°C, so this interlock input is calibrated to open Thermal interlock when this temperature level is reached.

6.2.5. General Purpose External Interlocks I7 and I8 - JB6 pins 7/16 and 8/16 respectively

These interlocks are internally connected to be active (open interlock condition) when input voltage is less then 2.5 VDC.
For interlock-closed condition input voltage should be 3-5VDC. Must not exceed 5 VDC otherwise it will not operate properly or even it may damage the board.

6.2.6. General Purpose External Interlocks I9, I10, I11, I12 - JB6 pins 9/16, 10/16, 11/16, and 12/16 respectively

These Interlocks are not used and therefore they are not connected. Any of them can be configured per request from customer at the time of order of X2A-400E X-ray tube power supply.
For detailed external interlock input connections, please see Appendix A.

Pin #	#	JB6 Description
1/16	I2H	Chamber Enable Input
2/16	I2L	Chamber Door Input
3/16	I3	Water Flow (if NO switch/transistor is used only)
4/16	I4	General Purpose Interlock Input (Low Input Enables)
5/16	I5	General Purpose Interlock Input (Low Input Enables)
6/16	I6	X-ray tube Thermistor (100K)
7/16	I7	General Purpose Interlock Input (High Input Enables)
8/16	I8	General Purpose Interlock Input (High Input Enables)
9/16	I9	General Purpose Interlock Input (Not Connected)
10/16	I10	General Purpose Interlock Input (Not Connected)
11/16	I11	General Purpose Interlock Input (Not Connected)
12/16	I12	General Purpose Interlock Input (Not Connected)
13/16	GND	GND (can be used for Inputs 1/16 to 6/16)
14/16	12 VDC	+12VDC (power for Hall-effect water flow sensor)
15/16	I3H	Flow Sensor Signal Input (unconditioned Hall-effect sensor)
16/16	GND	GND (for Hall-effect water flow sensor)

Figure 1.

6.3. External Interlock Status Port JB7

For easier monitoring and error message displaying there is interlock status port that shows individual interlock status: open or closed. This port is opto-isolated and each output is suitable to drive general-purpose I/O device,

small relay or LED. All outputs are Darlington, open collector type and they can drive max 100mA@30VDC
Refer to schematic diagram for proper interfacing circuitry.

For detailed Interlock status port connections, please see Appendix A.

Pin #	JB7 Description
1/14	/System Not Enabled by PC
2/14	/Chamber Open
3/14	/Water Flow Failure
4/14	/Interlock #4 open
5/14	/Interlock #5 open
6/14	/X-ray Tube Overtemperature
7/14	/Interlock #7 open
8/14	/Interlock #8 open
9/14	/Interlock #9 open
10/14	/Interlock #10 open
11/14	/Interlock #11 open
12/14	/Interlock #12 open
13/14	GND – From I/O card (must be connected to I/O GND)
14/14	+5VDC (LED power source for 1/20 to 12/20 via 220 Ohm resistor)
15/20	+12 VDC (For Water Flow Indicator LEDs – 16/20 to 20/20)
16/20	Water Flow LED5 (proper water flow)
17/20	Water Flow LED4 (satisfactory water flow)
18/20	Water Flow LED3 (barely sufficient water flow)
19/20	Water Flow LED2 (insufficient flow – opens water flow interlock)
20/20	Water Flow LED1 (very low flow – water flow interlock open)

Figure 2.

7. I/O Port JB5

The purpose of I/O port JB5 is to interface X2A-400E with any common type controller with minimum of 8 digital outputs and 3 digital inputs, please refer to Figure 3. and Appendix A.

7.1 Controlling X2A-400E by remote host

Pins 2/14, 3/14 and 4/14 are /CS, DIN and SCLK respectively and they are designated for MAX532, serial D/A converter, as it is described in the Paragraph 3.
”System Enable” - pin 5/14 is used for software interlock. Please refer to the Paragraph 6.2.
“Interlock Memory / No Memory” - pin 6/14 is used for software controlled interlock memory option.
Please refer to the Paragraph 6.1.3.
Pins 7/14 and 8/14 are used for the **shutter control** by host computer, please refer to Paragraph 9.
Pins 1 through 8 can be connected directly to the controller’s outputs.

7.2. Monitoring X2A-400E by remote host

“System Enabled” - pin 9/14 is used to check if the X2A-400E is properly enabled by software. This is opto-isolated signal and can be interfaced directly to the controller’s I/O. System is enabled when this signal is high.
“Shutter Open” - pin 10/14 is shutter sensor status signal that is opto-isolated and can be directly interfaced to the controller’s I/O. When this signal is low then the shutter is open.
“HV ON” - pin 11/14 is X-Ray power ON/OFF monitor. When this signal is low then X-Ray is ON. This is also opto-isolated signal and can be directly interfaced to controller’s I/O.
Pin 11/14 is GND used to connect controller’s GND with the X2A-400E GND for proper operation of the system.

Pin #	JB5 Description
1/14	Not Used
2/14	/CS for MAX532
3/14	DIN for MAX532
4/14	SCLK for MAX532
5/14	/Enable System
6/14	/Interlock Memory
7/14	/Open Shutter
8/14	/Enable Shutter
9/14	System Enabled
10/14	Shutter Open
11/14	/HV ON
12/14	I/O GND
13/14	Not Used
14/14	Not Used

Figure 3.

8. HV ON/OFF control

To start ramping up power to the X-ray tube (10 sec needed to reach 100% of preset values) it is necessary to meet all interlock closed conditions and then momentarily apply +5VDC on JB3 pin 25/60. Usually +5VDC is supplied from JB3 pin 24/60. Normally open low current momentary pushbutton is best for such application. To shut off power to the X-ray tube momentary short JB3 pin26/60 GND. Power will shut down immediately without ramping down in order to maintain maximum safety for personnel working with the system. Also, if any of interlocks is open it will shut down power in the same manner.

In addition to manual control of HV power supply there is also possibility to control its ON/OFF state by remote host computer. Momentary pulling low JB3 pin 10/60 will turn power ON to the X-ray tube. To shut down power to the X-ray tube momentary pull low JB3 pin 11/60. Please note that holding low JB3 pin 11/60 will prevent from turning ON HV power supply.

8.1. High Voltage ON Beacon

HV ON beacon current is monitored and interlocked. Internal circuitry monitors current and if the bulb filament is broken it will not be possible to turn ON HV power. Use 24VDC beacons (incandescent or LED) up to 15W of power. For the best results and energy saving use 10W beacons. X2A-400E can sink up to 0.75A on JB3 pins 49/60 and 50/60 that are tied together to increase a current conductivity capability. This line is internally fused with 0.75A thermal fuse. The X-ray ON beacon will be illuminated if any of the following conditions is met.

1. Enable Shutter input is pulled low (JB5 pin 8/14)
2. Shutter enable by S/W input is pulled low (JB3 pin 15/60)

8.2. HV ON Elapsed Time Meter

There is an output from X2A-400E, JB3 pin 46/60, to supply signal to elapsed time hour meter in order to record absolute HV ON time of the X2A-400E. This output provides +10VDC signal when HV is ON, and it is 0VDC when HV is OFF. This output requires a high input impedance elapsed time meter to work properly.

9. **Shutter Control**

The X2A-400E is capable of driving 12V/15W solenoid. Other voltages can be internally programmed, up to 24VDC, but total power of the solenoid must not exceed 15W. Solenoid holding voltage can be programmed by R162 on the control board. The shutter solenoid is controlled by two inputs on X2A-400E power supply, pins 7/14 and 8/14 on JB5 connector. To enable shutter operation pin 8/14 must be pulled and held low (to GND) and then “Open Shutter” pin 7/14 should be pulled and held low (to GND) to actually open the shutter. As long as both pins are held low shutter will remain open. As soon as any of them goes high shutter will close. Proper

shutter closing sequence is to release (pull high) “Open Shutter” pin 7/14 and then release “Enable Shutter” pin 8/14. Timing is not critical as long as it does excide above 5Hz for solenoid operation.
However, in some applications it may be required to have shutter solenoid interlocked to some specific conditions, and in such cases input "Shutter Enable", pin 8/14 on JB5, may be used as external interlock for shutter. Then use "Shutter Open", pin 7/14 on JB5, for lonely control of the solenoid. Sequence is: pull "Shutter Open" low to open solenoid and release "Shutter Open" to high to close the solenoid.

9.1 Shutter Open Beacon

As a safety feature there is “Shutter Open Beacon” that will turn ON when shutter is open (shutter status sensor will activate the beacon) or when signal “Enable Shutter” is low even if shutter remained closed (stuck). Shutter Open Beacon current is monitored and interlocked and if bulb filament is broken it will not let you to open the shutter. Use 24 VDC beacons (incandescent or LED) up to 20W of power. Shutter Open Beacon line can sink up to 0.75 A (JB3 pins 51/60 and 52/60) and it is internally fused with 0.75A fuse.
For the best results and energy saving use 10W beacons.

9.2 Shutter Status Sensor

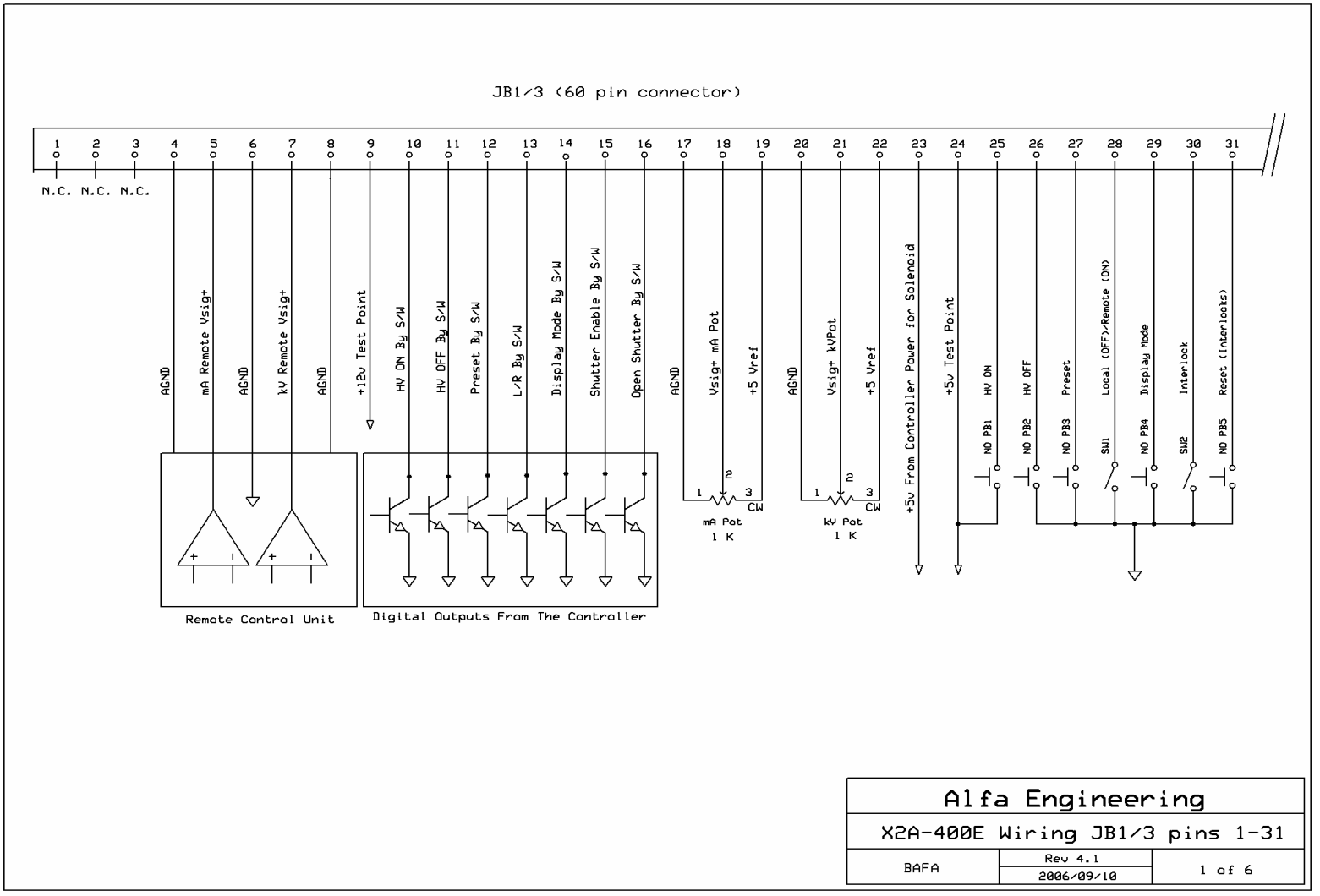
Shutter sensor input, pin 47/60 on JB3, is designed to accept open collector type of sensor, that is capable to sink minimum of 1.2mA @ Vcc=12V. Internal jumper (JP3) can be set for normally open or normally closed type of sensor. Usually X2A-400E is set for normally open input when shipped. The shutter status sensor signal is then conditioned on the board and could be read as “/Shutter Open” on JB5 pin 10/14. When “/Shutter Open” is low then shutter is open, and when it is high then shutter is closed. This is opto-isolated signal that can be interfaced with all common types of I/O devices. Please refer to Appendix 1. for additional information. It is capable to sink up to 100mA @ 30Vmax.

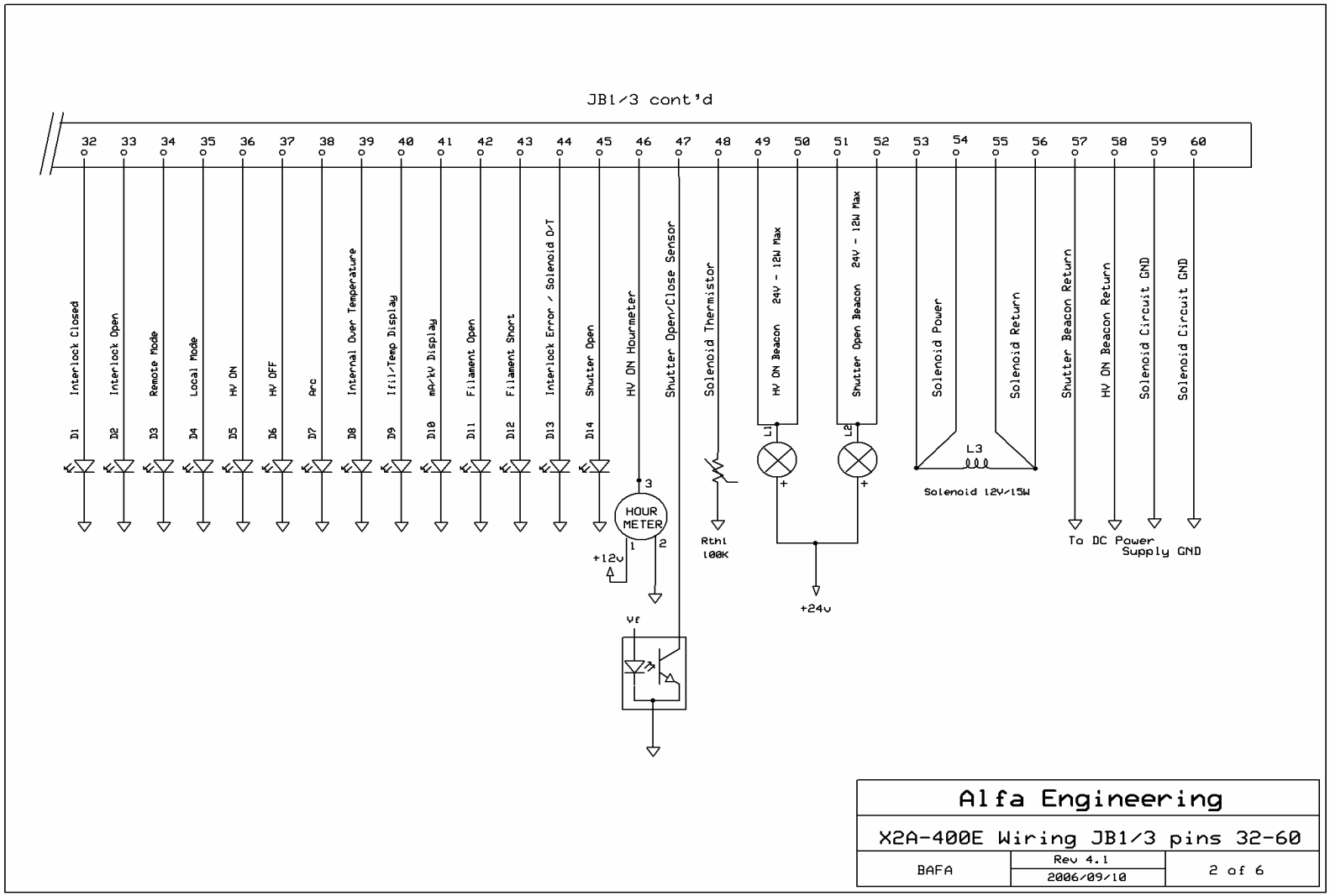
Please note that JB3 pin 23/60 is used to syncronize power on the solenoid control circuit with external I/O power that will prevent solenoid from cycling on power up/down sequence. Pin 23/60 should be connected to the same +5VDC that is used to supply I/O. If there is not available +5VDC from external I/O then connect this pin to +5VDC from X2A-400E, JB3 pin 24/60.

9.3 Shutter Temperature Sensor

Shutter solenoid temperature is monitored by 100K thermistor connected between pin 48/60 on JB3 and GND. If the solenoid temperature exceeds preset value (60°C) it will close shutter until it is cooled down, bypassing all other controls. When solenoid temperature is back to allowable range it will obey to shutter control signals at the time. The temperature treshold can be adjusted by Rp164 on main card.

Appendix A


JB1/3 (60 pin connector)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
N.C. N.C. N.C.
AGND
mA Remote Vsig+
AGND
kV Remote Vsig+
AGND
+12v Test Point
HV ON By S/W
HV OFF By S/W
Preset By S/W
L/R By S/W
Display Mode By S/W
Shutter Enable By S/W
Open Shutter By S/W
AGND
Vsig+ mA Pot
+5 Vref
AGND
Vsig+ kVPot
+5 Vref
+5v From Controller Power for Solenoid
+5v Test Point
NO PB1 HV ON
NO PB2 HV OFF
NO PB3 Preset
SW1 Local (OFF)/Remote (ON)
NO PB4 Display Mode
SW2 Interlock
NO PB5 Reset (Interlocks)
CW
mA Pot
1 K
CW
kV Pot
1 K
Remote Control Unit
Digital Outputs From The Controller
Alfa Engineering
X2A-400E Wiring JB1/3 pins 1-31
BAFA
Rev 4.1
2006/09/10
1 of 6


JB1/3 cont'd
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
D1 Interlock Closed
D2 Interlock Open
D3 Remote Mode
D4 Local Mode
D5 HV ON
D6 HV OFF
D7 Arc
D8 Internal Over Temperature
D9 Ifil/Temp Display
D10 mA/kV Display
D11 Filament Open
D12 Filament Short
D13 Interlock Error / Solenoid O/T
D14 Shutter Open
HV ON Hourmeter
Shutter Open/Close Sensor
Solenoid Thermistor
HV ON Beacon 24V - 12W Max
Shutter Open Beacon 24V - 12W Max
Solenoid Power
Solenoid Return
Shutter Beacon Return
HV ON Beacon Return
Solenoid Circuit GND
Solenoid Circuit GND
L1
L2
L3
HOUR METER
3
1
2
+12v
Rthl 100K
+24v
Vf
Solenoid 12V/15W
To DC Power Supply GND
Alfa Engineering
X2A-400E Wiring JB1/3 pins 32-60
BAFA
Rev 4.1
2006/09/10
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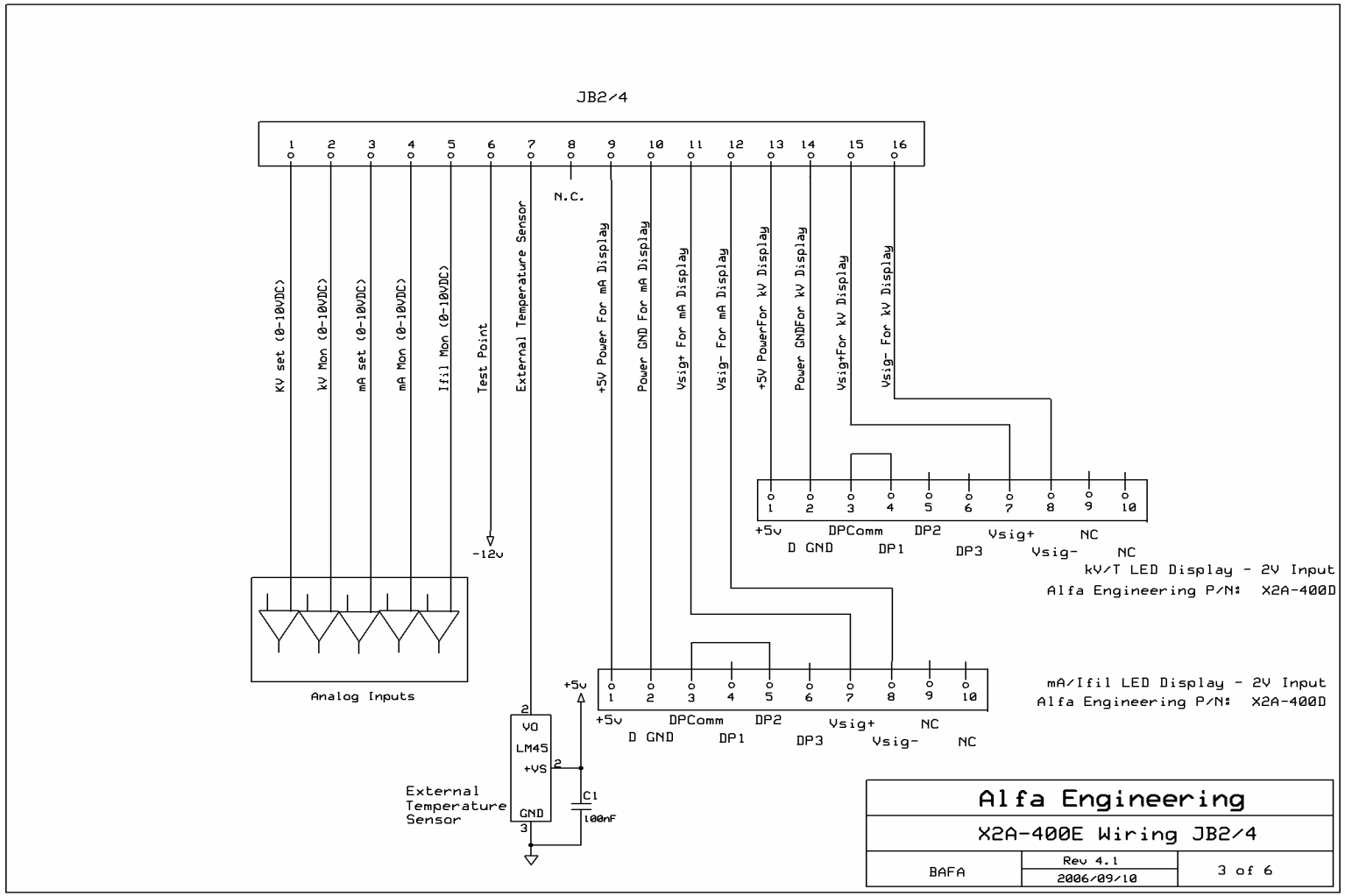
JB2/4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
N.C.
KV set (0-10VDC)
kV Mon (0-10VDC)
mA set (0-10VDC)
mA Mon (0-10VDC)
Ifil Mon (0-10VDC)
Test Point
External Temperature Sensor
+5V Power For mA Display
Power GND For mA Display
Vsig+ For mA Display
Vsig- For mA Display
+5V PowerFor kV Display
Power GNDFor kV Display
Vsig+For kV Display
Vsig- For kV Display
-12v
Analog Inputs
1 2 3 4 5 6 7 8 9 10
+5v DPComm DP2 Vsig+ NC
D GND DP1 DP3 Vsig- NC
kV/T LED Display - 2V Input
Alfa Engineering P/N: X2A-400D
mA/Ifil LED Display - 2V Input
Alfa Engineering P/N: X2A-400D
+5v
VO
LM45
+VS
GND
C1
100nF
External Temperature Sensor
Alfa Engineering
X2A-400E Wiring JB2/4
BAFA
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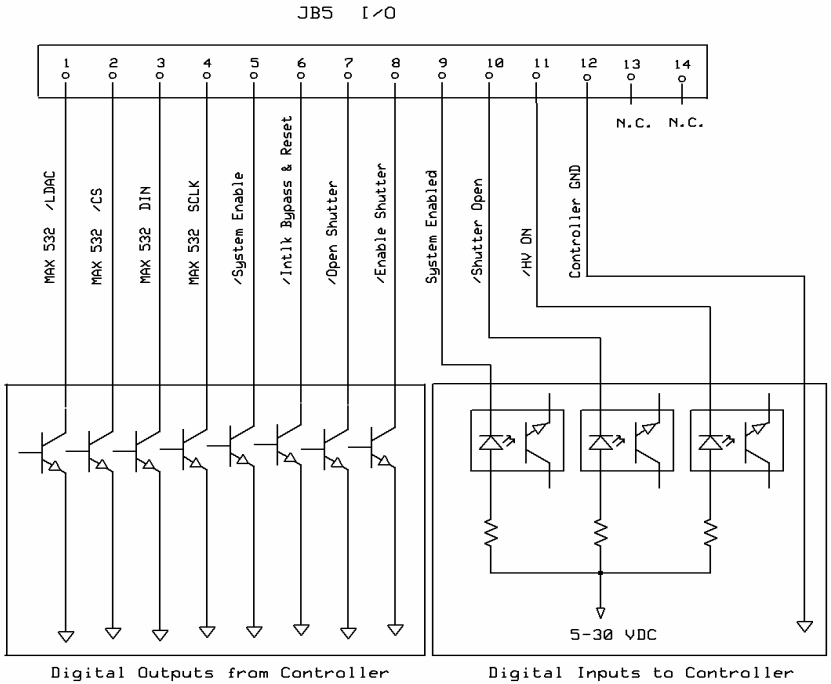
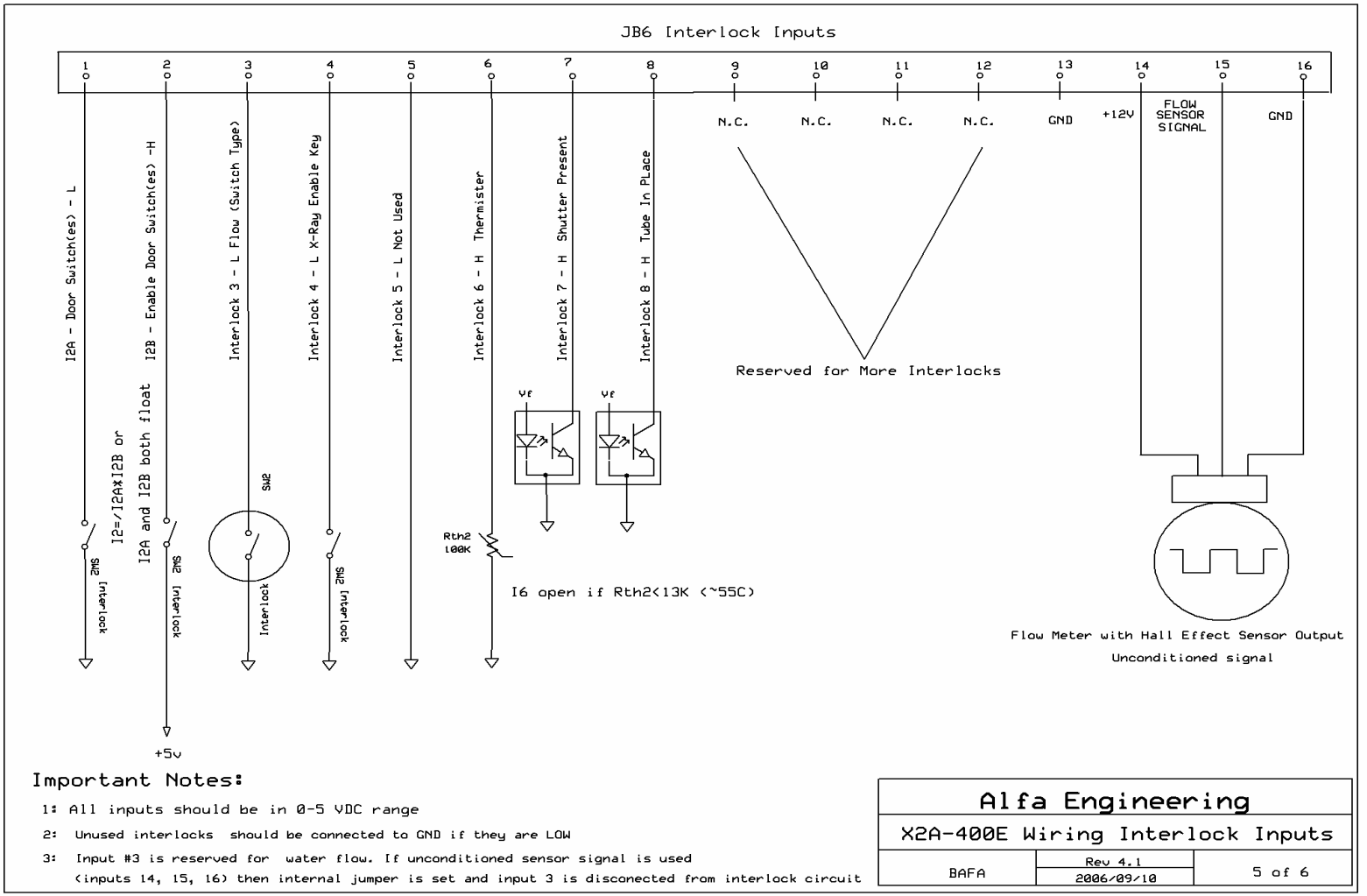


Alfa Engineering		
X2A-400E Wiring JB5 I/O		
BAFA	Rev 4.1 2006/09/10	4 of 6



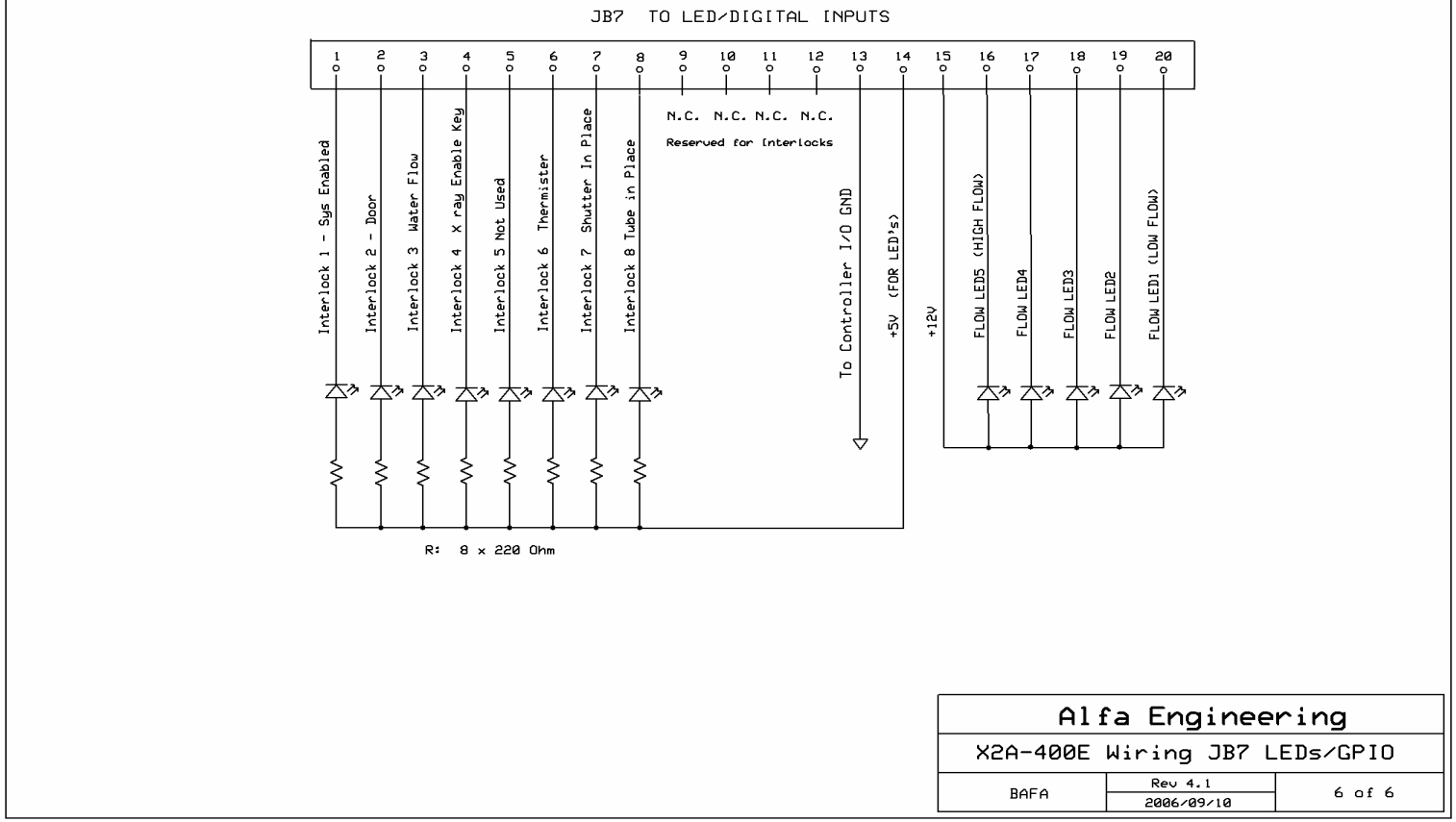
Important Notes:

1: All inputs should be in 0-5 VDC range

2: Unused interlocks should be connected to GND if they are LOW

3: Input #3 is reserved for water flow. If unconditioned sensor signal is used (inputs 14, 15, 16) then internal jumper is set and input 3 is disconected from interlock circuit

Alfa Engineering		
X2A-400E Wiring Interlock Inputs		
BAFA	Rev 4.1 2006/09/10	5 of 6


JB7 TO LED/DIGITAL INPUTS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Interlock 1 - Sys Enabled
Interlock 2 - Door
Interlock 3 Water Flow
Interlock 4 X ray Enable Key
Interlock 5 Not Used
Interlock 6 Thermister
Interlock 7 Shutter In Place
Interlock 8 Tube in Place
N.C. N.C. N.C. N.C.
Reserved for Interlocks
To Controller I/O GND
+5V (FOR LED's)
+12V
FLOW LED5 (HIGH FLOW)
FLOW LED4
FLOW LED3
FLOW LED2
FLOW LED1 (LOW FLOW)
R: 8 x 220 Ohm
Alfa Engineering
X2A-400E Wiring JB7 LEDs/GPIO
BAFA
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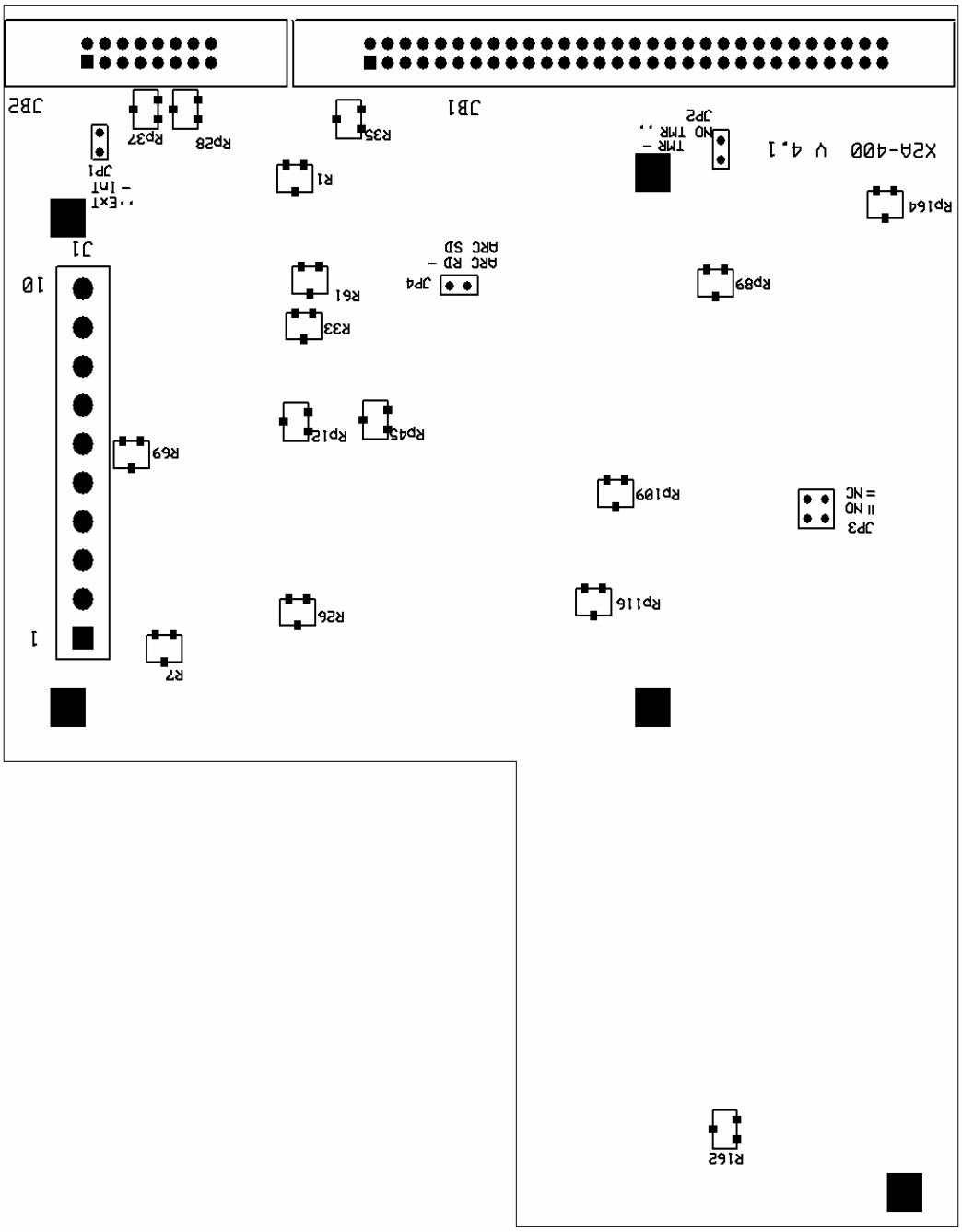
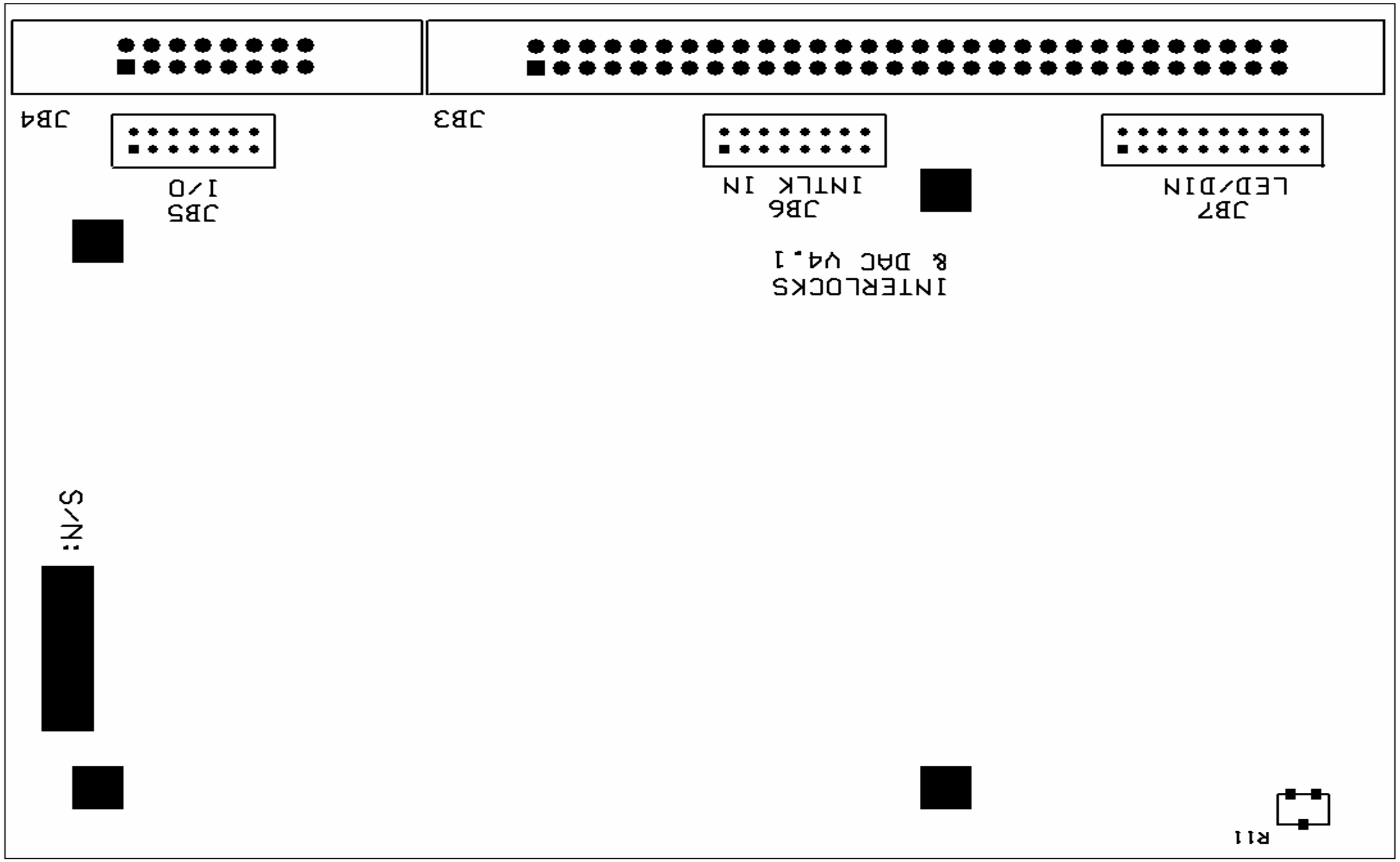
Appendix B


JB2
JB1
RP28
RP37
R35
JP1
R1
JP2
TMR
NO TMR
XZA-400 V 4.1
RP164
J1
10
1
JP4
ARC SD
ARC RD
R61
RP89
R33
RP12
RP45
R69
RP109
JP3
NO
NC
R26
RP116
R7
R162


JB4
JB3
I/O
JB5
INTLK IN
JB6
LED/DIN
JB7
& DAC V4.1
INTERLOCKS
S/N:
R11

NOTES