# *iQ Series*

## ULTRASONIC PROBE SYSTEM

# *AiM*

**HAND PROBE**  **AUTOMATED**  PRESS

# Automation Interface Guidelines

## Contents

## Programming the AiM Generator for use with hard wired connections using iQ Commander

IQ Commander is a PC based utility that can be used to communicate to Dukane generators that contain a USB port. This utility can be downloaded from the following location:
https://update.dukane.com/

**The following control parameters are available via iQ Commander™:**
1. Set weld method and associated values.
2. Set Amplitude, Ramp Up Time, and Ramp Down Time.
3. Enable iQ Control and program Weld Methods.
4. Enable and set Trigger by Power or Trig. Distance parameters. (See App Note AN506 for Trigger by Power settings)
5. Enable and set Hold and Afterburst.
6. Enable checking for Good, Suspect and Bad Parts.
7. Configure advanced I/O settings.

**Parameters that can be obtained via *iQ Commander™***
1. All parameters that are configured via *iQ Commander™*.
2. Real time data which includes welder state, frequency, power, position, and amplitude.
3. Weld cycle data from previous weld.

**Operations that can be done via *iQ Commander™***
1. Scan an ultrasonic stack to determine the optimal Free Run Frequency value. (See App Note AN512)
2. Test the ultrasonic Stack for operating frequency and power.
3. Weld a part.
4. Select a probe when an MPC module is connected.



NOTE: If Weld Time is not used as a control parameter, a weld Timeout needs to be programmed.

## Generator Cloning:

If a generator needs to be swapped and a new generator put in its place, it is possible to clone the generator setups and complete configuration so that it can be loaded into the new generator. This is done through iQ Commander by going to the File menu and selecting "Clone Generator to File". This will save the complete generator configuration and setups for later use. Cloning can only be performed on generators where the model number precisely matches both generators. If the model number does not match exactly, cloning will be prohibited.

## Saving Setups:

Setups can be saved by opening the FILE menu and clicking on "Save As…"

## System I/O Cable Pinouts

| Pin | Color | Description |
|---|---|---|
| J5-1 | BLK/RED | +22V CURRENT LIMITED POWER SUPPLY (*500mA MAX*) |
| J5-2 | RED/BLK | +22V RETURN (*iQ CHASSIS GROUND*) |
| J5-3 | BLK/WHT | E-STOP OUTPUT |
| J5-4 | WHT/BLK | E-STOP INPUT |
| J5-5 | BLK/GRN | REMOTE SETUP SELECTION BIT 0 INPUT |
| J5-6 | GRN/BLK | REMOTE SETUP SELECTION BIT 1 INPUT |
| J5-7 | BLK/BLU | REMOTE SETUP SELECTION BIT 2 INPUT |
| J5-8 | BLU/BLK | REMOTE SETUP SELECTION BIT 3 INPUT |
| J5-9 | BLK/YEL | AUTOMATION CYCLE STOP INPUT |
| J5-10 | YEL/BLK | FRONT PANEL LOCKOUT INPUT |
| J5-11 | BLK/BRN | ISOLATED INPUT COMMON |
| J5-12 | BRN/BLK | ULTRASOUND ACTIVATION/CYCLE START INPUT |
| J5-13 | BLK/ORN | ISOLATED ULTRASOUND COMMON |
| J5-14 | ORN/BLK | ANALOG DISTANCE INPUT (0-10VDC) |
| J5-15 | RED/WHT | ANALOG AMPLITUDE INPUT (0-10VDC) |
| J5-16 | WHT/RED | ANALOG GROUND |
| J5-17 | RED/GRN | ANALOG POWER OUTPUT (1mV = 1 WATT)  (0-10VDC) |
| J5-18 | GRN/RED | ANALOG AMPLITUDE OUTPUT (0-10VDC) |
| J5-19 | RED/BLU | ULTRASOUND STATUS OUTPUT |
| J5-20 | BLU/RED | ANY FAULT STATUS OUTPUT |
| J5-21 | RED/YEL | OVERLOAD STATUS OUTPUT |
| J5-22 | YEL/RED | BAD PART STATUS OUTPUT |
| J5-23 | RED/BRN | GOOD PART STATUS OUTPUT |
| J5-24 | BRN/RED | READY STATUS OUTPUT |
| J5-25 | RED/ORN | MPC READY STATUS OUTPUT |
| J5-26 | ORN/RED | ISOLATED OUTPUT COMMON |

**Note:** The descriptions shown are for the default I/O settings. Almost all Inputs are programmable to other input functions and all outputs to other output functions. The exception is the ULTRASOUND ACTIVATION / CYCLE START INPUT which cannot be programmed to another function. For other functions and detailed signal descriptions, please refer to the product manual.

## System Input/Output Cables

| Part Number | Length |
|---|---|
| 200-2119-03M | 3 meters |
| 200-2119-05M | 5 meters |
| 200-2119-07M | 7 meters |
| 200-2119-09M | 9 meters |
| 200-2119-11M | 11 meters |
| 200-2119-13M | 13 meters |

## System Inputs Description

All System Inputs are optically isolated from the internal circuits and can be connected to sinking or sourcing PLC output cards. The inputs will draw approximately 10mA with a 24Vdc supply. The Systems Inputs can also be configured for a contact closure if necessary.

## Connecting an Input to a PLC Sourcing Output Card
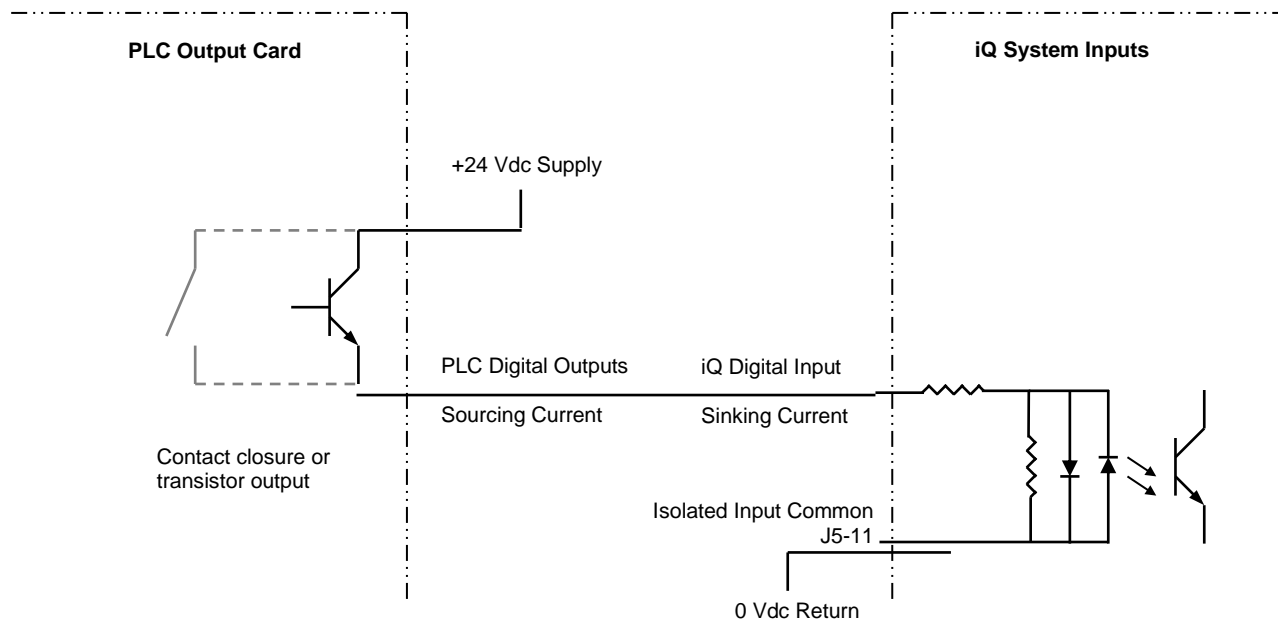


**Notes:**

1. All System Inputs share the same isolated common (J5-11) except Ultrasound Activation/Cycle Start Input (J5-12) which has a separate isolated common (J5-13). It is critical that the isolated commons are connected to +24 Vdc Supply or 0 Vdc Return.

2. J5-1 can be used in place of the 24 Vdc supply. If so, J5-11 must be connected to J5-2. Use J5-13 in place of J5-11 for the Ultrasound Activation/Cycle Start Input.

**Warning:** Any connection to the Ultrasound Activation/Cycle Start Input (J5-12) should be disabled during an emergency stop condition.

## Connecting an Input to a PLC Sinking Output Card



**Notes:**

1. All System Inputs share the same isolated common (J5-11) except Ultrasound Activation/Cycle Start Input (J5-12) which has a separate isolated common (J5-13). It is critical that the isolated commons are connected to +24 Vdc supply or 0 Vdc Return.

2. J5-1 can be used in place of the 24 Vdc supply. If so, J5-11 must be connected to J5-1 and 0 Vdc Return to J5-2. Use J5-13 in place of J5-11 for the Ultrasound Activation/Cycle Start Input.

**Warning:** Any connection to the Ultrasound Activation/Cycle Start Input (J5-12) should be disabled during an emergency stop condition.

## Connecting an Input to a Relay Contact Closure
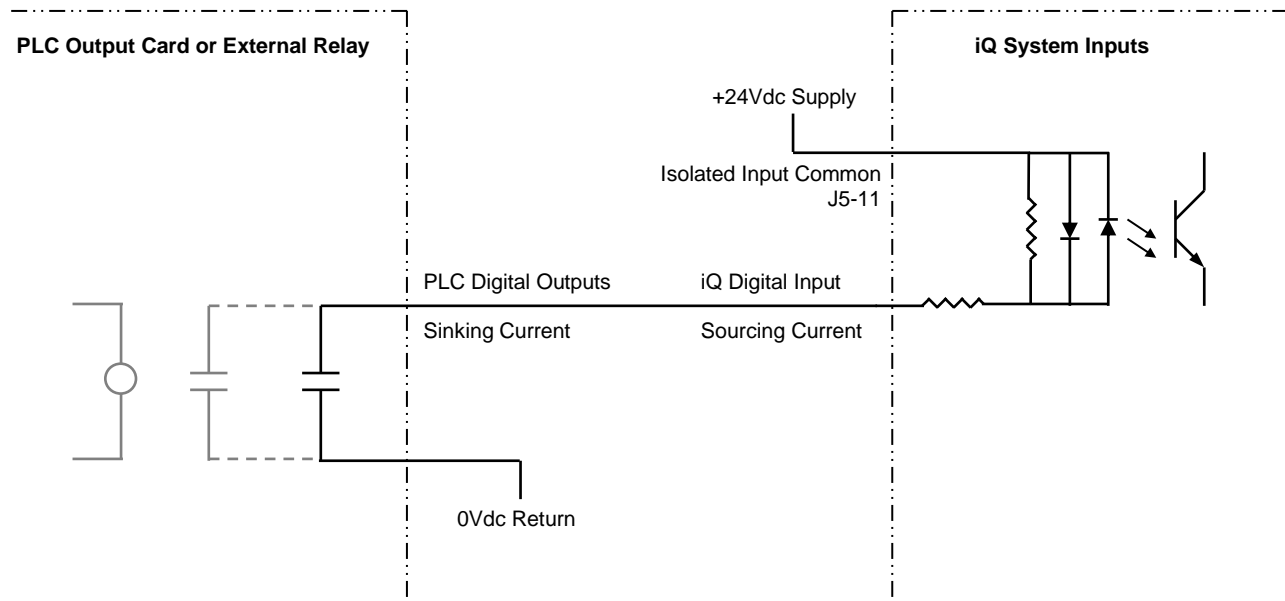
**PLC Output Card or External Relay**

+24Vdc Supply

Isolated Input Common
J5-11

PLC Digital Outputs     iQ Digital Input

Sinking Current     Sourcing Current
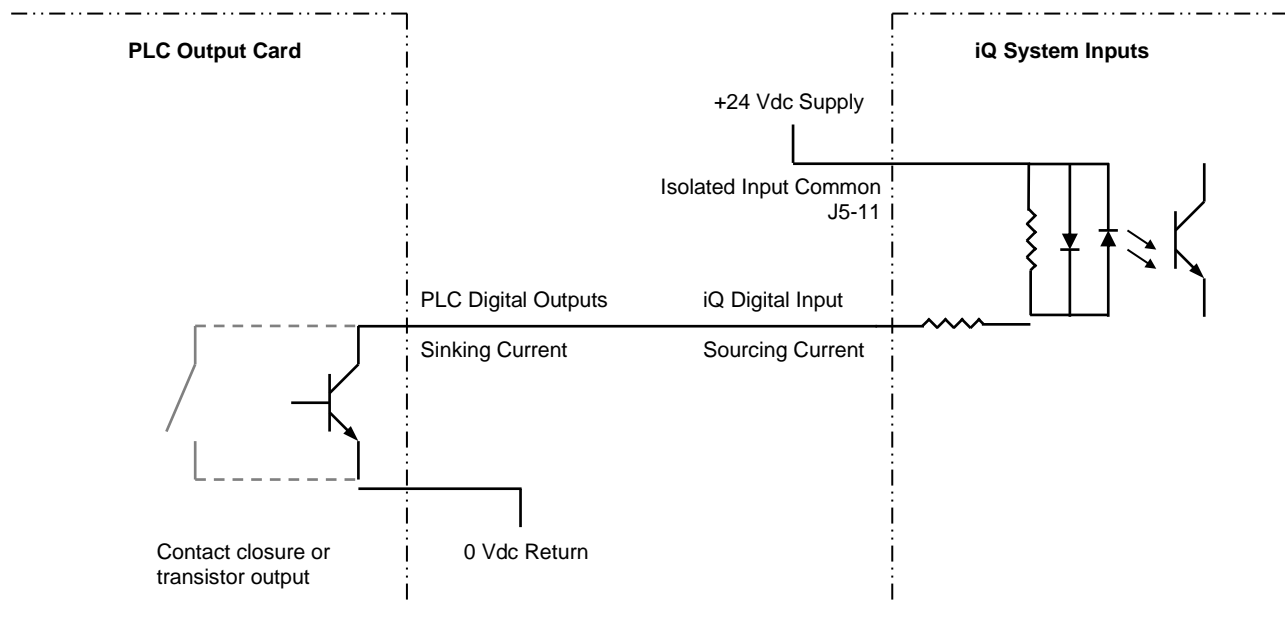
0Vdc Return

**iQ System Inputs**

**Notes:**

1. All System Inputs share the same isolated common (J5-11) except Ultrasound Activation/Cycle Start Input (J5-12) which has a separate isolated common (J5-13). It is critical that the isolated commons are connected to +24 Vdc supply or 0 Vdc Return.

2. Dukane's current limited power supply can be substituted for the +24 Vdc supply above. Connect J5-1 to Isolated Common (J5-11) and 0 Vdc Return to J5-2. Use J5-13 in place of J5-11 for the Ultrasound Activation/Cycle Start Input. Connecting the System Inputs in this way would be similar to activating DPC series System Inputs.

**Warning:** Any connection to the Ultrasound Activation/Cycle Start Input (J5-12) should be disabled during an emergency stop condition.

## System Output Description

All System Outputs are optically isolated from the internal circuits and can be connected to sinking or sourcing PLC input cards. When J5-1 is used to power the outputs, the total maximum output current for all outputs combined is 500mA. If an external supply is used, as shown in the drawing below, each output can sink or source up to 500mA.

## Connecting an Output to a PLC Sourcing Input Card
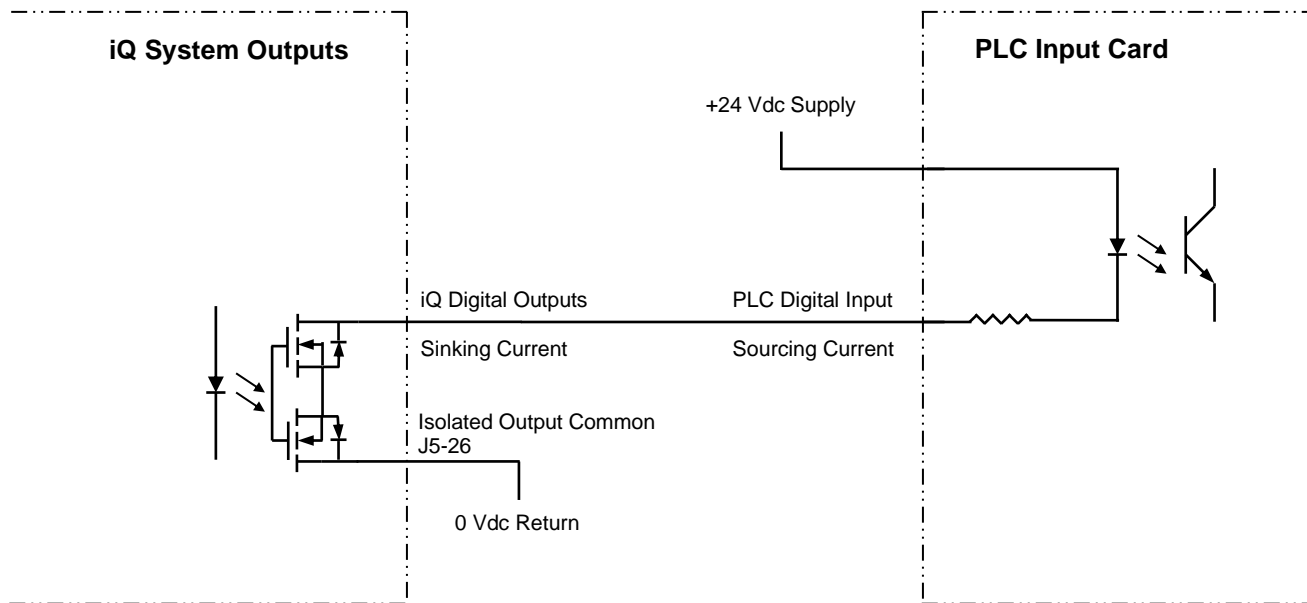
**iQ System Outputs**

**PLC Input Card**

+24 Vdc Supply

iQ Digital Outputs

Sinking Current

Isolated Output Common
J5-26

0 Vdc Return

PLC Digital Input

Sourcing Current

**Notes:**

1. All System Outputs share the same isolated common (J5-26). It is critical that the isolated output common is connected to +24 Vdc supply or 0 Vdc Return.

2. J5-1 can be used in place of the 24 Vdc supply. If so, J5-26 must be connected to J5-2.

**Connecting an Output to a PLC Sinking Input Card**



**iQ System Outputs**

+24 Vdc Supply

Isolated Output Common
J5-26

iQ Digital Outputs
Sourcing Current

**PLC Input Card**

PLC Digital Input
Sinking Current

0 Vdc Return

**Notes:**

1. All System Outputs share the same isolated common (J5-26). It is critical that the isolated output common is connected to +24 Vdc supply or 0 Vdc Return.

2. J5-1 can be used in place of the 24 Vdc supply. If so, J5-26 must be connected to J5-1 and 0 Vdc to J5-2.
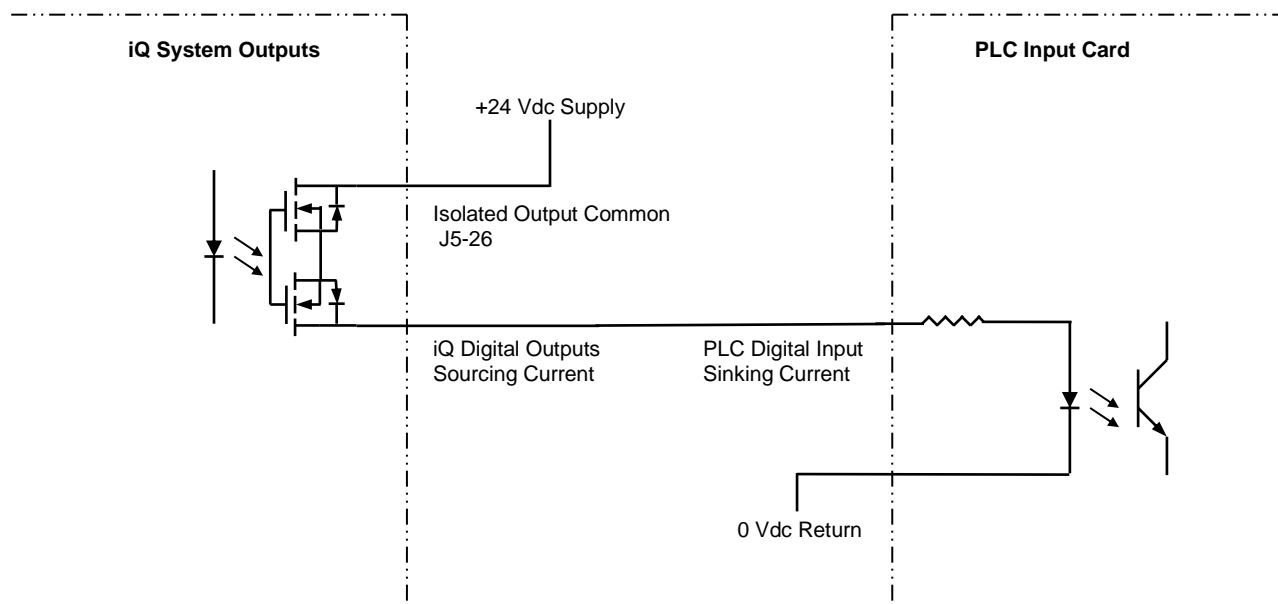
**Connecting an Output to a Relay Contact Closure**



**Notes:**

1. All System Outputs share the same Isolated Common (J5-26). It is critical that the isolated output common is connected to +24 Vdc supply or 0 Vdc Return.

2. J5-1 can be used in place of the 24 Vdc supply. If so, J5-26 must be connected to J5-2.
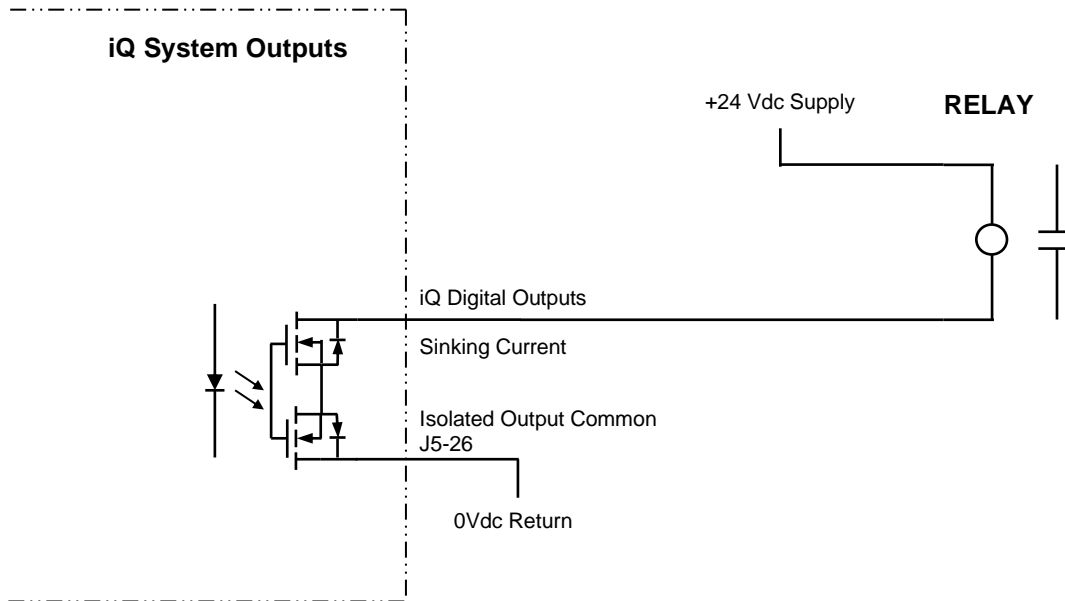
DUKANE

## Connecting a Distance Encoder

The Dukane AiM generator is equipped with two analog inputs. Either input may be used for distance measurement input, or remote amplitude control. Each is designed to except a 0-10 volt input. Voltage range and scaling are programmed through iQ Commander or the display, if equipped.

SICK MPS-xxxTSTP0
or equivelent

| | | | | | iQ System Inputs |

10 - 30 Volts dc **OR** connect directly to J5-1

Vin — 1

Brown

J5-1 — 22 Volts (500mA max)

Vout — 4

Black

J5-14 — Distance Input

Iout — 2

White

GND — 3

Blue

J5-16

0 Vdc Return

J5-2 — Chassis Ground
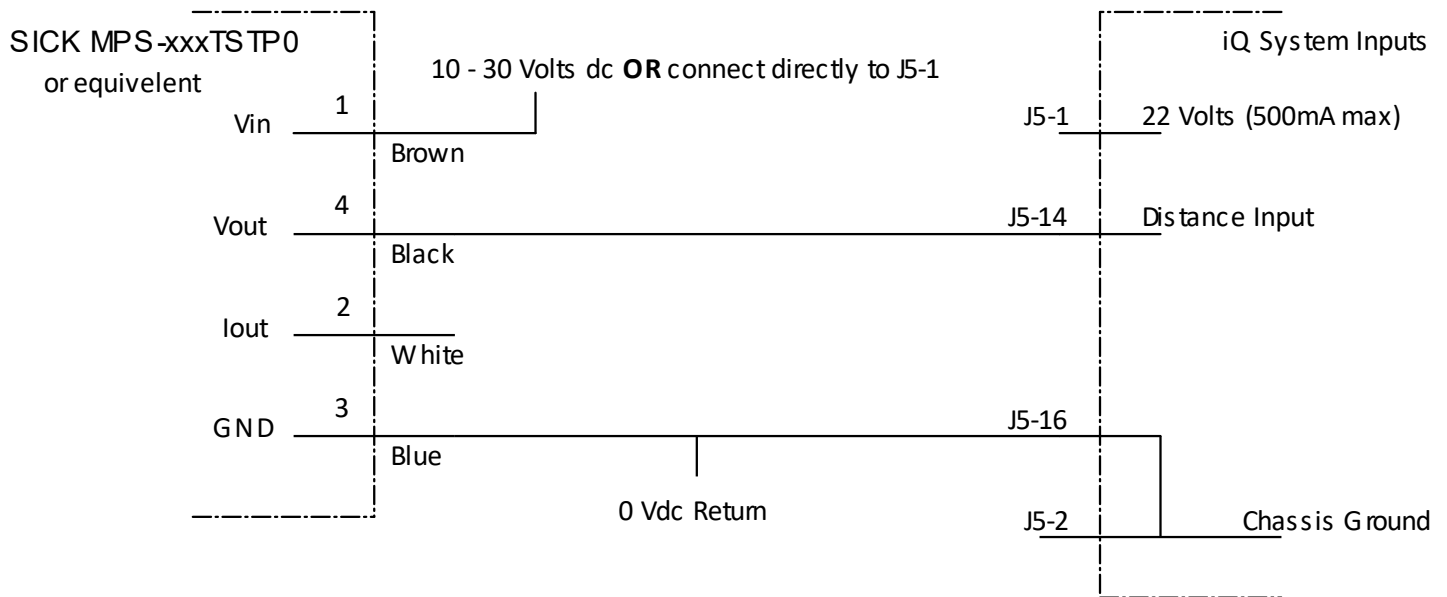
**Notes:**

1. Dukane recommends distance encoder model SICK MPS-xxxTSTP0 where xxx is the encoder length in mm.
2. The distance encoder can receive power from either an external supply, or the generator internal 22 volt supply. Current is limited to 500 mA.
3. Use the voltage output from the encoder.
4. See App Note AN528 for more information on programming to weld by distance.

## Remote Setups

These system inputs receive a Binary code from the automation that is used to select a setup, anMPC probe, or both to be 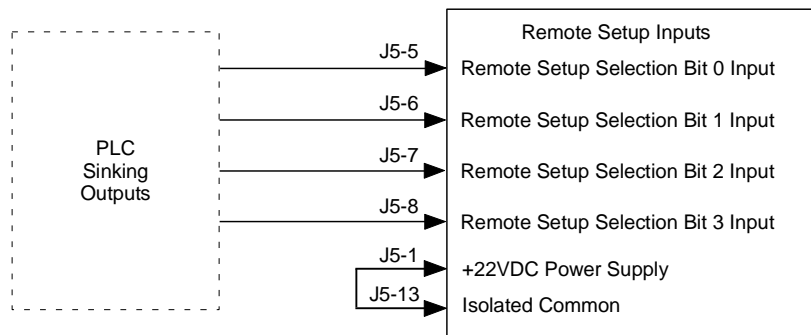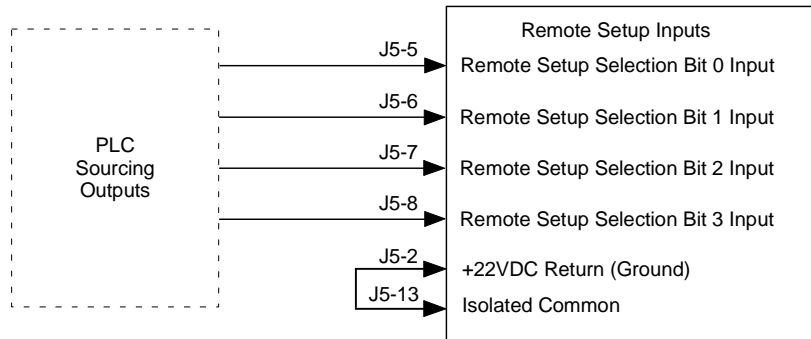used for the next welding cycle. Selections 17-32 are reserved and are not available (N/A). An external +24VDC supply can be used instead of the generator internal supply. See the drawings on pages 4 and 5 for more information.

## Remote Setup Switching

| J5-8 | J5-7 | J5-6 | J5-5 | Setup/Probe Selected |
|------|------|------|------|----------------------|
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 2 |
| 0 | 0 | 1 | 0 | 3 |
| 0 | 0 | 1 | 1 | 4 |
| 0 | 1 | 0 | 0 | 5 |
| 0 | 1 | 0 | 1 | 6 |
| 0 | 1 | 1 | 0 | 7 |
| 0 | 1 | 1 | 1 | 8 |
| 1 | 0 | 0 | 0 | 9 |
| 1 | 0 | 0 | 1 | 10 |
| 1 | 0 | 1 | 0 | 11 |
| 1 | 0 | 1 | 1 | 12 |
| 1 | 1 | 0 | 0 | 13 |
| 1 | 1 | 0 | 1 | 14 |
| 1 | 1 | 1 | 0 | 15 |
| 1 | 1 | 1 | 1 | 16 |

PLC Sourcing Outputs

Remote Setup Inputs

J5-5 Remote Setup Selection Bit 0 Input
J5-6 Remote Setup Selection Bit 1 Input
J5-7 Remote Setup Selection Bit 2 Input
J5-8 Remote Setup Selection Bit 3 Input
J5-2 +22VDC Return (Ground)
J5-13 Isolated Common

PLC Sinking Outputs

Remote Setup Inputs

J5-5 Remote Setup Selection Bit 0 Input
J5-6 Remote Setup Selection Bit 1 Input
J5-7 Remote Setup Selection Bit 2 Input
J5-8 Remote Setup Selection Bit 3 Input
J5-1 +22VDC Power Supply
J5-13 Isolated Common

## Connecting an Automation Safety Circuit

**WARNING:** Consult the appropriate local regulatory agency (OSHA, UL, CE, etc.) regarding all of the safety requirements for your automated machine. Dukane is not responsible for injuries related to improper safety circuits or safety guarding used in an automated machine. EN 12100 and EN 60204-1 safety standards are recommended.

**Automation E-Stop (Abort)**
**Switch or Similar Safety Circuit**

**iQ E-Stop (Abort)**

Internal +22 Vdc Supply

E-stop Output J5-3

N.C.

E-stop Input J5-4

To System E-Stop (Abort) Relay
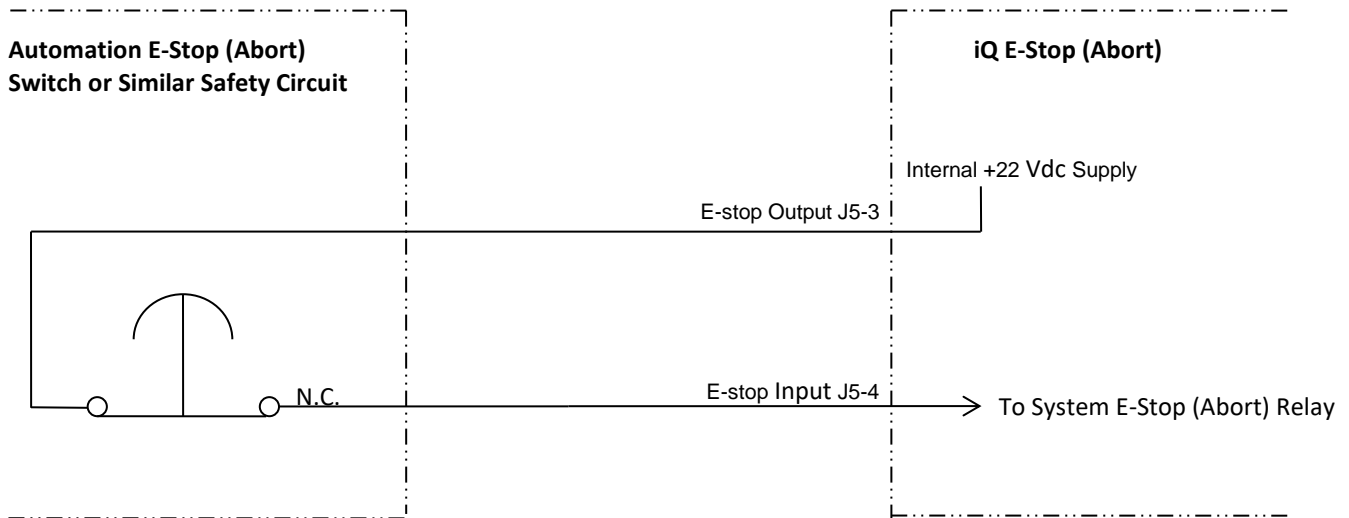
**Notes:**

1.  To operate the AiM Generator, J5-3 and J5-4 must be maintained in a closed connection. If the connection between J5-3 and J5-4 is opened, the ultrasonic output will be disabled.

2.  The iQ AiM generator is shipped whith an E-Stop jumper plug for testing, etc. purposes. However this plug is not reccomended for use during production operation.

# iQ AiM Automation Controlled Probe Generator Timing Diagrams

## AiM Weld-by-Automation Timing Diagram

**Normal Weld Cycle:** A normal weld by automation cycle lasts as long as the U/S Activate input is active. This cycle shows the timing between activation/deactivation of the U/S Activate input, U/S Status output and Ready Status output signals.

**The Ready Status Output:** The Ready Status output is used to determine if the generator is ready to start a new weld cycle. As shown in Figure 1, the Ready Status output requires a minimum of 2ms to change to its deactivated state after the U/S Activate input is activated. At the end of a normal cycle, the Ready Status output requires a minimum of 12ms to change to its activated state after the U/S Activate input has deactivated. It is possible that the stack ring down time (stack stops vibrating), which is stack and application dependent, will make this time much longer. For correct operation, a PLC controlling an AiM generator must account for this timing shown below before checking the Ready Status output.

**The U/S Status Output:** The U/S Status output is used to determine when the generator ultrasound output to the ultrasonic stack is active. As shown in Figure 1, the U/S Status output requires a minimum of 3ms to change to its on state. At the end of a normal cycle, the U/S Status output requires a minimum of 12ms to change to its deactivated state after the U/S Activate input has deactivated. For correct operation, a PLC controlling an AiM generator must take into account the timing shown in Figure 1 before checking the U/S Status output.

**Weld Cycle with an Overload:** This weld cycle shows the same timing relationship as a normal weld cycle except the ultrasound output, indicated by the U/S Status output, is terminated early due to an overload condition.

**The Any Fault and Overload Status Outputs:** The Any Fault Status output is used to determine when the generator has terminated the weld cycle due to fault such as an overload as shown in Figure 1. When a Peak Overload occurs, the Any Fault and Overload Status outputs activate at the same time. If the overload is an Average Overload the U/S Status output will not deactive until after the 10ms ramp down completes. The Ready Status output will not activate until the U/S Activate input is turned off, but may take up to 2ms to change to its on state. Due to stack ring down it may be longer before Ready Status changes state. The Any Fault Status output will deactivate the next time the U/S Activate input is turned on, but is delayed up to 2ms. For correct operation, a PLC controlling a AiM generator must take into account the timing shown below before checking the Any Fault, Overload, U/S, and Ready Status outputs.
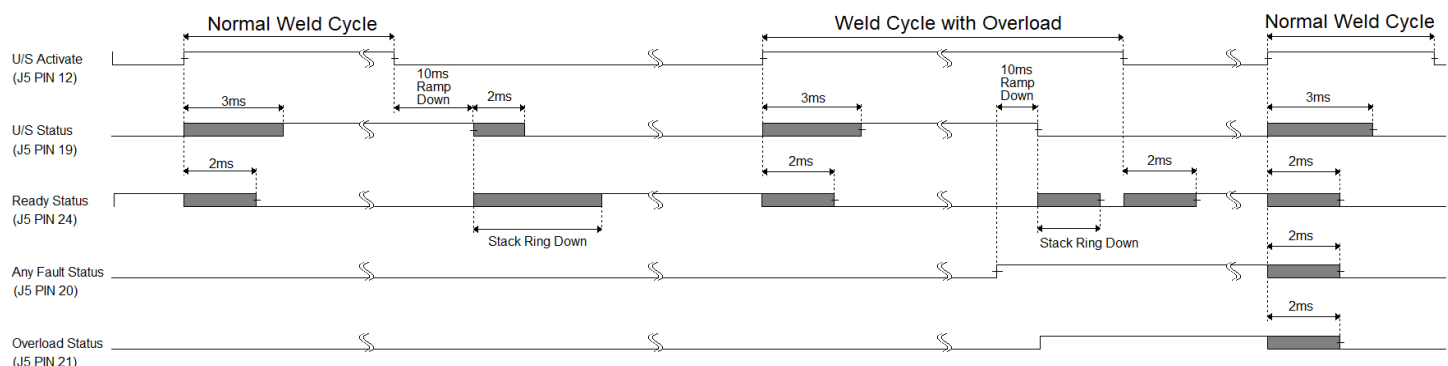


Figure 1 - AiM Weld-by-Automation Cycle Timing Diagram

**Timing Diagram Notes:** All Signals are active high and the Shaded areas indicate that the output could be either high or low. The $\backslash$ symbol indicates a time break so that the time where nothing is happening doesn't need to be shown. Signal name pin numbers are the default values.

## AiM (Weld-by-Time) Timing Diagram

**Normal Weld Cycle:** This is a Weld-by-Time cycle, meaning the Ultrasound output lasts as long as the Time Setting, which is 200ms in this case.

**The Ready Status Output:** As with Weld-by-Automation, the Ready Status output should be used to determine if the generator is ready to start a weld cycle. Figure 2 shows that the Ready Status output requires a minimum of 2ms to change to its off state after the U/S Activate input is activated. At the end of the weld time in a normal weld cycle, there is a 10ms Ramp Down followed by any remaining stack ring down time. Since stack ring down time is stack and application dependent it may make this time much longer. Ready Status output activates a minimum of 2ms after ramp down or when the ring down time is complete, whichever occurs last. For correct operation, a PLC controlling an AiM generator must account for the timing shown in Figure 2 before checking the Ready Status output.

**The U/S Status Output:** The U/S Status output is used to determine when the generator has activated its ultrasound output to the ultrasonic stack. As shown in Figure 1, the U/S Status output requires a minimum of 3ms to change to its activated state. The U/S Status output will deactivate when the weld time plus the ramp down completes and will take up to 2ms to change to it's deactivated state. For correct operation, a PLC controlling an AiM generator must account for the timing shown in Figure 2 before checking the U/S Status output.

**Cycle With an Overload:** This weld cycle shows the same timing relationship except the ultrasound output, indicated by U/S Status, is terminated early, in this case after 100ms, due to an overload condition.

**The Any Fault and Overload Status Outputs:** The Any Fault Status output is used to determine when the generator has terminated the weld cycle due to fault such as an overload as shown in Figure 1. When a Peak Overload occurs, the Any Fault and Overload Status outputs activate at the same time. If the overload is an Average Overload the U/S Status output will not deactive until after the 10ms ramp down completes. The Any Fault Status output will deactivate the next time the U/S Activate input is activated, but is delayed up to 2ms. The Ready Status output has the same timing as in the normal weld cycle. A PLC controlling an AiM generator must take into account the timing shown in Figure 2 before checking the Any Fault, Overload, U/S, and Ready Status outputs.
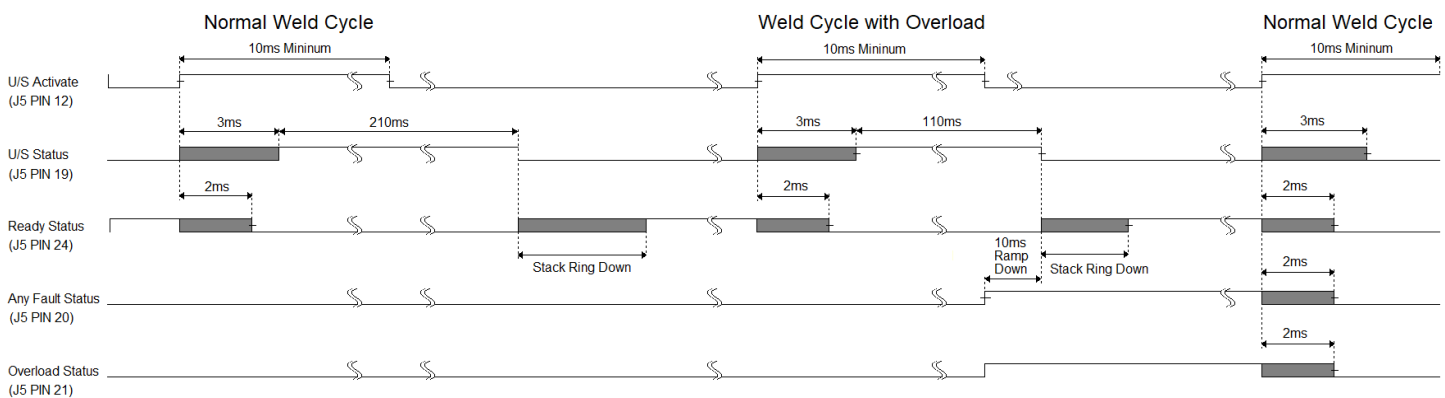


Figure 2 - AiM Weld-by-Time Cycle Timing Diagram

**Timing Diagram Notes:** All Signals are active high and the Shaded areas indicate that the output could be either high or low. The ∫ symbol indicates a time break so that the time where nothing is happening doesn't need to be shown. Signal name pin numbers are the default values.

## AiM (Weld-by-Energy) Timing Diagram

**Good Part Weld Cycle:** This is a Weld-by-Energy cycle, meaning the Ultrasound output lasts until the Energy Setting is reached.

**The Ready Status Output:** As with Weld-by Time, the Ready Status output should be used to determine if the generator is ready to start a weld cycle. As seen in Figure 3, the Ready Status output requires a minimum of 2ms to change to its off state after the U/S Activate input is activated. When the weld energy setting is reached in a normal weld cycle, there is a 10ms Ramp Down followed by the remaining stack ring down time. Since stack ring down time is stack and application dependent it may make this time much longer. The Ready Status output activates after a minimum of 2ms or when the ring down time is complete, whichever occurs last. For correct operation, a PLC controlling an AiM generator must account for the timing shown in Figure 3 before checking the Ready Status output.

**The U/S Status Output:** The U/S Status output is used to determine when the generator ultrasound output to the ultrasonic stack is active. As shown in Figure 3, the U/S Status output requires a minimum of 3ms to change to its on state. The U/S Status output will deactivate up to 12ms after the weld energy setting is reached. This 12ms consists of the 10ms ramp down and up to 2ms switching time. For correct operation, a PLC controlling an AiM generator must account for the timing shown in Figure 3 before checking the U/S Status output.

**The Good Part Status Output:** The Good Part output deactivates within 2ms after U/S Activate input is activated. Once the weld energy is reached the good part output will activate within 2ms. As shown in Figure 3 the Good part output activation timing is not affected by the 10ms ramp down.

**Cycle With an Bad Part Upper Limit Exceeded:** This weld cycle shows the same timing relationship except the ultrasound output, indicated by U/S Status, is terminated early. In this case the cycle is terminated after 100ms, due to an Bad Part Upper Limit exceeded condition.

**The Good Part Status Output:** The Bad Part Status output activates within 2ms and U/S Status will deactivate within 10ms after the maximum weld time limit is exceeded. The Ready Status output activates within 2ms or when the ring down time is complete, whichever occurs last. The Bad Part Status output will deactivate the next time the U/S Activate input is activated, but is delayed up to 2ms. A PLC controlling an AiM generator must take into account the timing shown in Figure 3 before checking the Bad Part, U/S, and Ready Status outputs.
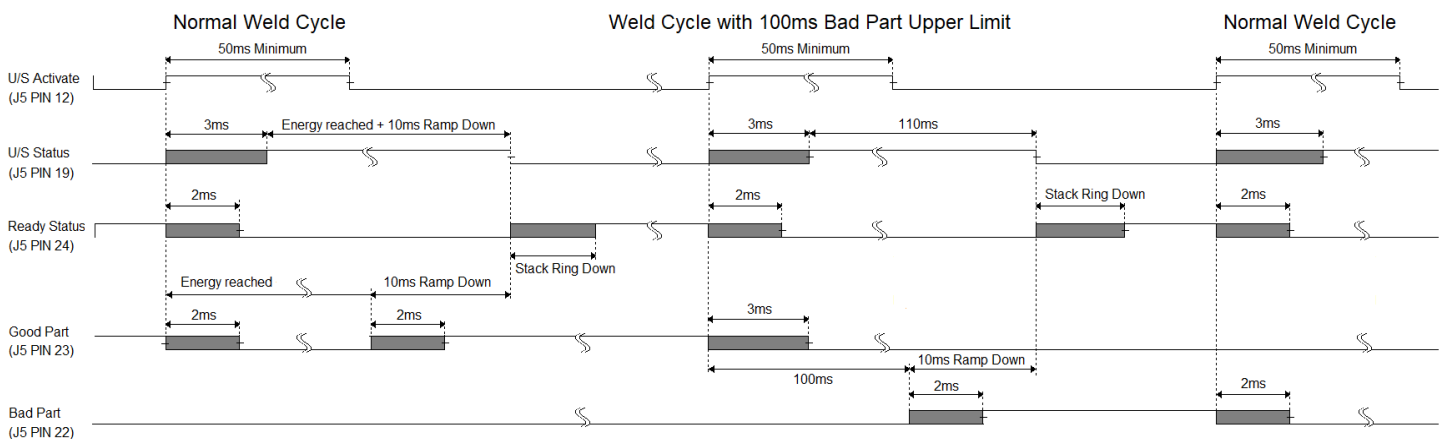


Figure 3 - AiM Weld-by-Time Cycle Timing Diagram

**Timing Diagram Notes:** All Signals are active high and the Shaded areas indicate that the output could be either high or low. The ∿ symbol indicates a time break so that the time where nothing is happening doesn't need to be shown. Signal name pin numbers are the default values.

## AiM With MPCQ or MPC-E (Weld-by-Automation) Timing Diagram

**Probe selection changed between weld cycles:** Although the probe selection can be changed at any time this method is the safest and most predictable. The PLC program should monitor the Ready/MPC Ready output and when it becomes active change the probe selection using the Remote Setup inputs. This will insure that the stack ring down from the previous cycle is finished. After a delay of 4ms, the Ready/MPC Ready output will change to inactive (low in this case) again and stay that way for 10ms (MPC-E) or 32ms (MPCQ). See Figure 4 where Remote Setup 0 changes from low to high. The PLC must monitor the Ready/MPC Ready output and not turn on the U/S Activate input until Ready/MPC Ready is active.

**Probe selection changed during a weld cycle:** Alternately the Remote Setup inputs can be changed during the weld cycle. The MPC circuitry will not select a new probe when the Ready/MPC Ready output is not active. As shown in Figure 4, Remote Setup 0 input is changed to inactive before the weld cycle completes. Once the stack ring down completes the relays switch so that probe 1 is selected almost immediately, but the relay takes up to 8ms to settle. The Ready/MPC Ready output will remain inactive for 10ms (MPC-E) or 32ms (MPCQ) after ring down completes. The PLC must monitor the Ready/MPC Ready output and not turn on the U/S Activate input until the Ready/MPC Ready signal is active.
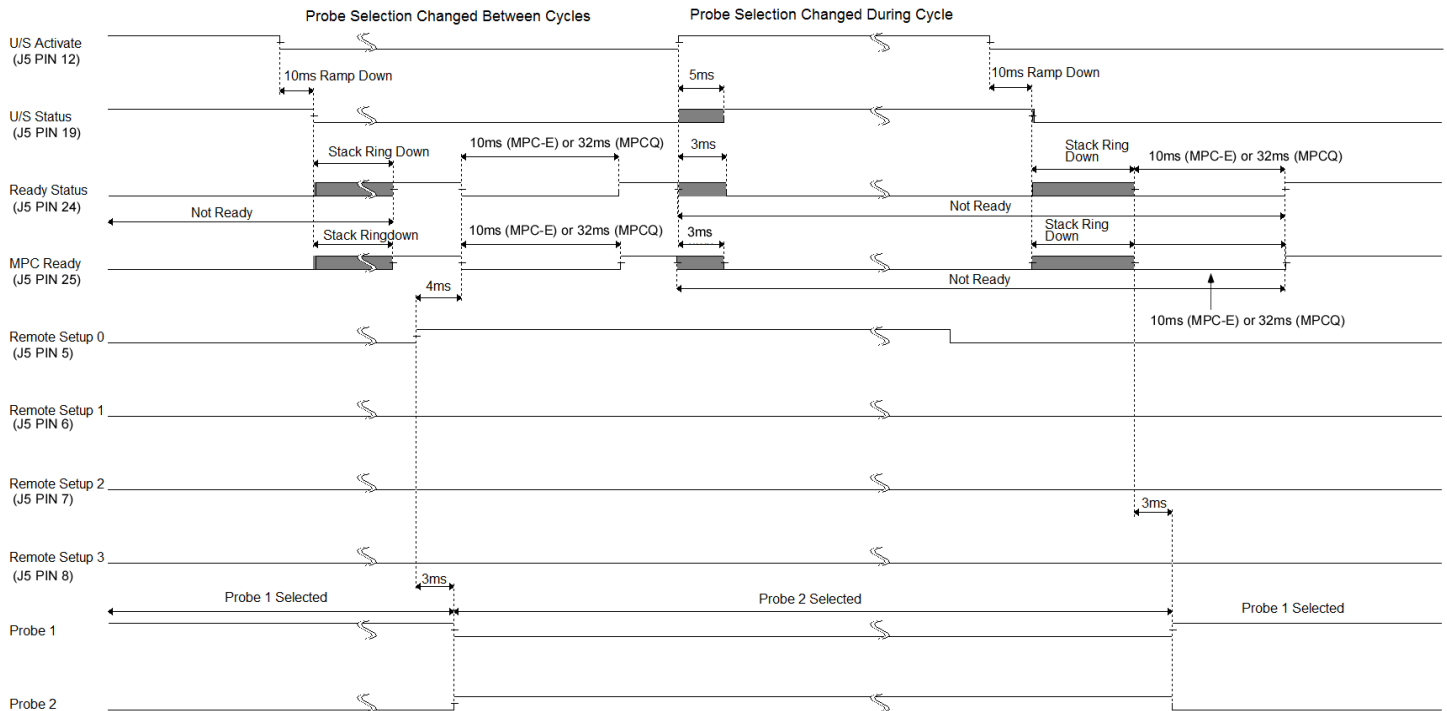


Figure 4 - AiM with MPCQ or MPC-E Weld Cycle (Weld-by-Automation)

**Timing Diagram Notes:** All Signals are active high and the Shaded areas indicate that the output could be either high or low. The ⟆ symbol indicates a time break so that the time where nothing is happening doesn't need to be shown. Signal name pin numbers are the default values.

## Setting up an Industrial Protocol Network Connection via iQ Commander™

Dukane iQ AiM generators support Ethernet/IP, Modbus TCP, POWERLINK, PROFINET, EtherCAT, CC-Link and Profibus. Documentation and PLC demo code are available via download. Programming the IP address or generator ID is done through the USB port using iQ Commander. Download iQ Commander from the following location: https://update.dukane.com/

Please contact Dukane Technical Support for PLC template code and programming documentation. The Industrial Network connection allows for complete programming and operational control of the generator. Only a connection to the E-stop is required (J5-3 & J5-4). No other control connections are needed.

| Caution: |
|---|
| When using iQ Commander for setting up a network connection to a PLC, it is advised to only setup the IP address or generator ID. It is not recommended to change other parameters using iQ Commander if you intend to communicate using an industrial network interface. The reason for this is that unless all settings are available in the PLC, it is possible to make changes in iQ Commander that are not available through the PLC. |

1. Go to the "Communications" tab.
2. Edit parameters based on which industrial protocol is used.
3. The following protocols use certain parameters in the "Generator Network Settings" group to establish a connection:
    a. Ethernet/IP – IP address, subnet mask, and gateway
    b. Modbus TCP/IP – IP address, subnet mask, and gateway
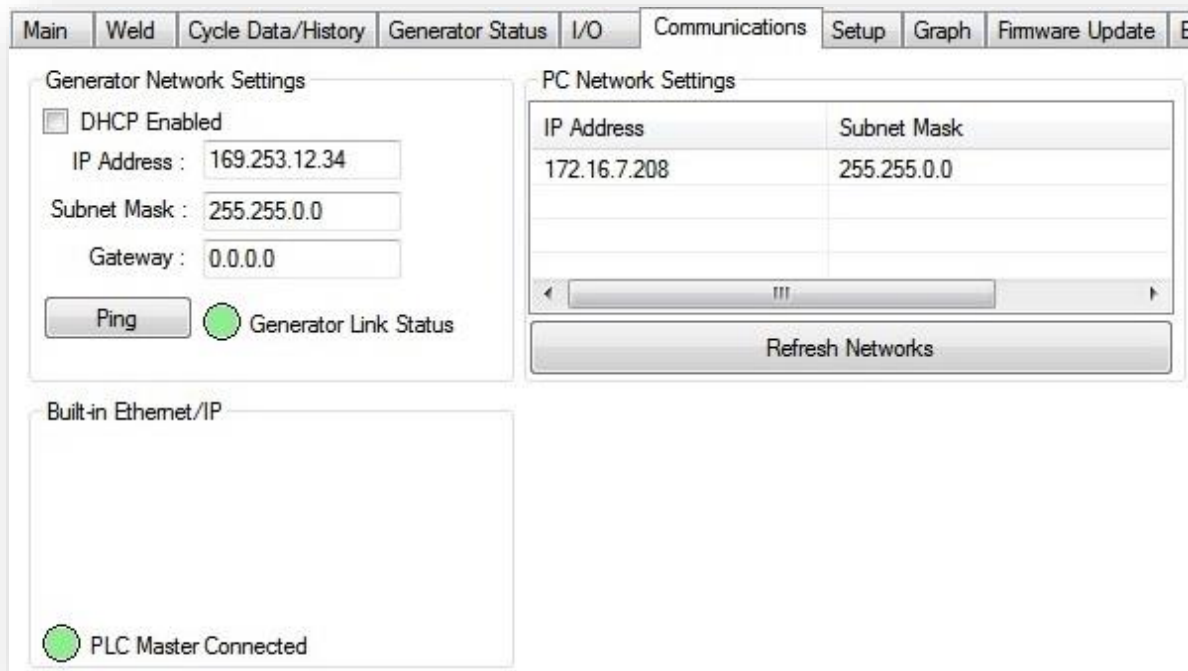


Note: The Generator Link Status indicates the physical connection only.

The following protocols will have custom settings appear below the "Generator Network Settings" group to establish a connection:

    c.    PROFIBUS – Address and enable/disable legacy support
    d.    PROFINET – Station name
    e.    CC-Link – Station number and baud rate
    f.    POWERLINK – Node number
    g.    EtherCAT – Device ID

4.   The "PLC Master Connected" LED will turn green when a successful connection is made.
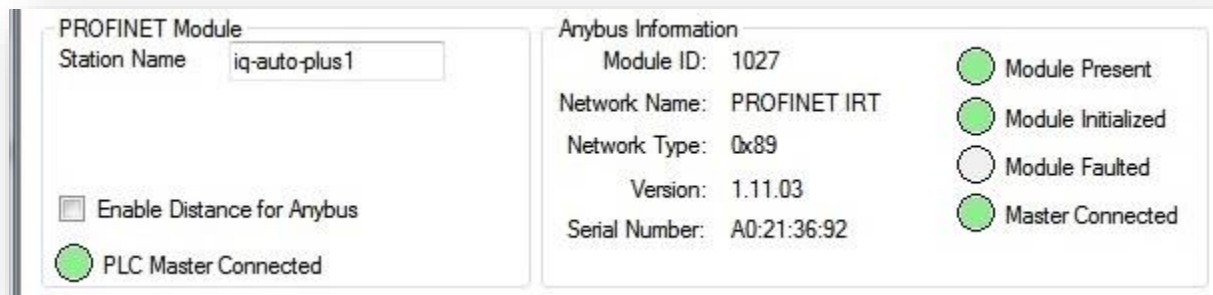


Once the IP or generator ID is setup, connect the PLC and verify communication. Use the PLC to setup the weld parameters.

It is recommended to use Dukane's PLC template code written specifically to communicate to our generators. Please contact Dukane Technical Support for information on how to download this PLC code. Contact info:
Email: ustechsupport@dukane.com or call us at 630-797-4987

Please reference AN526 for more information regarding using Industrial Network Protocol connections:
https://documents.dukane.com/AppNote/AN526.pdf

## Additional information can be found at the following links:

https://documents.dukane.com/AppNote/AN526.pdf  (Industrial Networking Guidelines)
https://documents.dukane.com/AppNote/AN506.pdf  (Trigger by Power)
https://documents.dukane.com/AppNote/AN512.pdf (Stack Scan)
https://update.dukane.com/ (iQ Commander Download)
https://documents.dukane.com/AppNote/AN528.pdf (Weld by Distance)

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