Frequency Tracking in *iQ* Systems

Introduction:

Dukane's Frequency Tracking feature can improve the consistency of starting an acoustic stack. The operating frequency of many ultrasonic stacks can change as much as several hundred Hertz as heating and cooling occurs. Dukane's Frequency Tracking feature overcomes these changes in frequency by averaging the acquired frequency from the last several successful weld cycles, and uses this frequency instead of the Free Run Frequency as the starting point for the next weld cycle. This averaged starting frequency is referred to as the "Tracked Frequency".

When Frequency Tracking Should Be Used:

1. If U106 Peak Overload alarms occur at the beginning of a cycle or U104 Frequency Overload alarms occur, especially if the alarms start occurring after running weld cycles for a time.
2. If the operating frequency of the ultrasonic stack changes significantly during a shift or a day.
3. The Free Run Frequency setting is not typically adjusted by the operator from the default value, or the Stack Test Scan feature is not used to optimize the Free Run Frequency setting for a given stack.
4. Automation systems utilizing Dukane's Multi-Probe Controller operating multiple stacks from a single generator setup.

When Frequency Tracking Will Not Help:

1. U104 Frequency Overloads are not encountered.
2. U106 Peak Overloads are present, but occur after the amplitude ramp up is complete, especially if the overload occurs near the end of the weld cycle.
3. The operating frequency of the ultrasonic stack doesn't change due to process related heating/cooling.
4. The operating frequency of the ultrasonic stack during the weld is within 50 Hz of the Free Run Frequency setting.

Background Information:

To better understand how the Frequency Tracking feature helps to start a stack, a brief description of the *iQ* generator operation is required. Dukane *iQ* generators provide a feature referred to as Digi-Trac Tuning. This feature adjusts the generator operating frequency to match the resonant frequency of the acoustic stack (horn, booster, and transducer). This resonant frequency is changes dynamically based on horn wear, amplitude output, power output, and environmental factors such as heat and the applied load during a weld. Digi-Trac operation can be broken down into two separate segments - acquiring the resonant frequency during cycle startup, and maintaining the frequency during the remainder of the cycle. Since the resonant frequency of a stack is dynamic and therefore is not exactly known before the stack is running, Dukane's Frequency Tracking feature considerably improves the chances of acquiring the frequency by making sure the Starting Frequency for a cycle is close to the resonant frequency of the stack. This significantly reduces the chances that a U106 Peak Overload alarm or a U104 Frequency Overload alarm may occur. Either of these alarms will terminate the weld cycle.

Frequency Tracking Details:

Dukane's Frequency Tracking feature works by automatically setting the Starting Frequency to the Tracked Frequency value instead of the Free Run Frequency setting value. The Tracked Frequency value is the average of the acquired operating frequencies from the last several successful weld cycles. The Starting Frequency for the next cycle is displayed on the live data screen when the generator is idle (between weld cycles).

Upon power up of the generator, the Tracked Frequency is initialized to the current setup's Free Run Frequency setting. After several weld cycles, a change in the Starting Frequency should be apparent if the Free Run Frequency setting is different than the operating frequency. The Tracked Frequency is NOT stored between power-cycles of the generator, all averaging information is lost when the generator is powered down. It should be noted that on power up a front panel message prompts the user to perform a Stack Scan. See "Scan On Power Up" below.

There are several ways the operator can change the Tracked Frequency while Frequency Tracking is enabled.

1. Change the Free Run Frequency setting. Changing the Free Run Frequency setting of the current setup will initialize the Tracked Frequency value to that new setting. The next weld cycle will start using this value.
2. Run a Test cycle. Following a successful test cycle, the Tracked Frequency value is initialized to the acquired frequency of that test cycle. Be aware that a test cycle will NOT use the Tracked Frequency value as the Starting Frequency to start the stack, it will use the current setup's Free Run Frequency setting.
3. Scan the stack. Using Dukane's Stack Scan feature is the best way to determine a stack's optimal Starting Frequency under the current environmental conditions, see Application Note 512 for details. After a successful Stack Scan, the operator is typically prompted with the option to apply the scan result to the Free Run Frequency setting. Applying the Test Scan result while Frequency Tracking is enabled will initialize the Tracked Frequency to the Test Scan value. Not applying the Test Scan result while Frequency Tracking is enabled will leave the existing Tracked Frequency unaffected.

When using Dukane's Multi-Probe Controller (MPC), the Frequency Tracking feature maintains separate Tracked Frequencies for each MPC channel/probe point, hereafter referred to a point, in the system. This behavior was first added in the iQ Auto Plus v4.02.03 and iQ LS/LS-E/LE/ES v3.13.09 firmware. Setting the Free Run Frequency, running a Test cycle, or running a Stack Scan (and applying its result) will initialize the Tracked Frequency for currently selected point. The Tracked Frequency of all other points is not affected.

The state (enabled or disabled) of the Frequency Tracking feature is stored in the individual setups of the generator. When not using an MPC, selecting a different setup will initialize the Tracked Frequency to the Free Run Frequency setting of the new setup. This behavior was chosen on the assumption that different setups more often correlate to different stacks/horns rather than different welds using the same horn/stack. This behavior needs to be understood if using Setup Sequencing present in the ES series units, Frequency Tracking is not likely to have much effect when not using an MPC.

Selecting a new setup using a communication interface, such as Ethernet/IP, DOES NOT affect the Tracked Frequency for any of the points as long as Frequency Tracking is enabled in the selected setup. The same is true if a setup is selected via the front panel interface of an LS-E or ES generator. However, if the selected setup has Frequency Tracking disabled, the setup's Free Run Frequency is used for all points.

Scan On Power Up - When Frequency Tracking is enabled, the user is prompted to run a Stack Scan on power up. The scan must be run with the stack in free air. Running a scan is highly advised because the scan will determine the optimal Free Run Frequency for the first weld cycle and prompt the user to update the Free Run Frequency and Tracked Frequency with the result of the scan. It is recommended that the Free Run Frequency be updated unless the user determines that the scan result is obviously incorrect. An incorrect result will occur if the scan is run: with the stack touching anything (fixture, part, etc.); or, there is a problem with the stack (components are not tight, cracked horn, etc.).

Scan After Idle Time - After five minutes of idle time, the user will be prompted to run a Stack Scan. The scan must be run with the stack in free air. As mentioned above, the stack will cool down during idle periods which can result in a change to the resonant frequency. Running a Scan after five or more minutes without welding a part insures that the Tracked Frequency is adjusted to account for this change to the resonant frequency of the stack.

Replacing the Stack – Replacing any component can affect the resonant frequency of the ultrasonic stack. It is recommended that the generator be powered down when replacing any component. If the stack is changed without powering down the generator, it is highly recommended that a Stack Scan be run before welding. **This is especially true if Frequency Tracking is enabled since the resonant frequency of the new stack can be significantly different than the current one due to temperature differences, stack wear, etc.**

As mentioned before, when enabled, Frequency Tracking uses an algorithm to determine the optimal Starting Frequency for the next weld cycle. It should be noted that this frequency is not the same as the resonant frequency of the stack, but should be close to it. Also, the optimal Starting Frequency is not necessarily the same as the frequency observed during a weld which is affected by coupling to the part being welded.

iQ ES Series

Security Settings Disabled

iQ Explorer II

Enable Advanced Process Settings: Check the Advanced Process Settings checkbox in the upper-right portion of the Process Settings tab.

Enable Frequency Tracking: Enter the Advanced Process Settings window by clicking the Advanced button which is near the Advanced Process Settings Checkbox. Check the Frequency Tracking checkbox located at the bottom of the Advanced Process Settings window.

Scan the Ultrasonic Stack: A prompt should be displayed requesting that a scan be performed. Follow the instructions to run the scan, and set the Free Run Frequency to the optimal Free Run Frequency. If an optimal Free Run Frequency is not found, verify that the horn is not touching anything and that none of the stack components are loose or damaged. If not prompted, select the Scan button in the Advanced Process Settings to display the prompt. **NOTE**: *For more information on the Stack Scan feature, refer to Application Note 512.*

Run a Test: To verify that the stack will operate correctly using this frequency run a test cycle. If not, perform stack care and maintenance (verify that the horn is not damaged, the surfaces between components are flat and clean, and stack components are tightened correctly). For more information on stack care and maintenance download *Ultrasonic Probes/Stacks – Understanding and Caring for the Heart of Your Ultrasonic System* at **http://www.dukane.com/us/DL_ApplData.asp.**

Front Panel Interface

Enable Advanced Process Settings: From the main menu select the Utilities/Hardware soft key. In the Process Utilities screen select the Hardware Setup soft key. In the Hardware setting screen scroll to Adv. Process Settings which is located near the bottom of the list, press the Enable soft key, and then the YES soft key in the next screen. Advanced process settings are now enabled.

Enable Frequency Tracking: Return to the Main Menu. Select the Process Setup soft key to display the Process Setup screen. Scroll to Adv. Process Settings in the list, and select the Adv. Process Settings soft key. Scroll to Frequency Tracking in the displayed list, and select the Frequency Tracking soft key. Press the Down arrow button in the navigation keypad so that Enabled is displayed. Press the ENTER button to enable Frequency Tracking.

Scan the Ultrasonic Stack: A prompt should be displayed requesting that a scan be performed. If not prompted, scroll to Free Run Frequency in the list in the Advanced Process Setting screen and select the Scan Horn soft key to display the prompt. For information on the Stack Scan feature, refer to Application Note 512.
Set the Free Run Frequency to the Optimal Free Run Frequency.

Run a Test: To verify that the stack will operate correctly using this frequency run a test cycle. If not, perform stack care and maintenance (verify that the horn is not damaged, the surfaces between components are flat and clean, and stack components are tightened correctly). For more information on stack care and maintenance, download *Ultrasonic Probes/Stacks – Understanding and Caring for the Heart of Your Ultrasonic System* at **http://www. dukane.com/us/DL_ApplData.asp.**

Security Settings Enabled

Administrator and Process Engineer security levels have the required permissions to change setup parameters, so they are permitted to enable Frequency Tracking and to scan a stack. The Operator and Setup Engineer do not have the required permissions to do either. As described above, Frequency Tracking requires a stack scan to insure that the Free Run Frequency is set to the optimal value. Operator and Setup Engineer security levels will be shown a prompt indicating a scan is required. However, only users with Administrator or Process Engineer security levels will be permitted to initiate the scan.

Please note that *iQ Explorer II* has a custom security level that can be assigned to allow the user to run a scan of the ultrasonic stack, but still limit what parameters the user can modify.

iQ LE and LS-E Series

Enable Frequency Tracking: Navigate to the ADVANCED SETTINGS menu by first pressing the INFO button and then the ADVANCED SETTINGS soft key. Press ENTER to continue. Scroll down to FREQUENCY TRACKING on the ADV PROCESS CONTROL page, and select the TRACKING ENABLED soft key.

Scan the Ultrasonic Stack: A prompt should be displayed requesting that a scan be performed. If not prompted, navigate to the ADVANCED SETTINGS menu by first pressing the INFO button and then the ADVANCED SETTINGS soft key, scroll to FREE RUN FREQUENCY then press the SCAN HORN soft key to display the prompt. Set the Free Run Frequency to the Optimal Free Run Frequency. For information on the Stack Scan feature, refer to Application Note 512.

Run a Test: To verify that the stack will operate correctly using this frequency run a test cycle. If the test cycle fails, perform stack care and maintenance (verify that the horn is not damaged, the surfaces between components are flat and clean, and stack components are tightened correctly). For more information on stack care and maintenance, download *Ultrasonic Probes/Stacks – Understanding and Caring for the Heart of Your Ultrasonic System* at ***http://www. dukane.com/us/DL_ApplData.asp.***

iQ Auto Plus

Enable Frequency Tracking: Use the iQ Auto Plus Utility application or via any of the supported industrial communication protocols to enable Frequency Tracking.

Scan the Ultrasonic Stack: Click on SCAN in the iQ Auto Plus Utility application. After a successful scan, a prompt will be displayed with the option to apply the scan result to the Free Run Frequency setting. Applying the scan result will initialize the Tracked Frequency to the scan value.

Run a Test: To verify that the stack will operate correctly using this frequency run a test cycle by opening the iQ Auto Plus Utility application and clicking on TEST. If the test cycle fails, perform stack care and maintenance (verify that the horn is not damaged, the surfaces between components are flat and clean, and stack components are tightened correctly). For more information on stack care and maintenance, download *Ultrasonic Probes/Stacks – Understanding and Caring for the Heart of Your Ultrasonic System* at ***http://www. dukane.com/us/DL_ApplData.asp.***

MPC: If an MPC is connected to the iQ Auto Plus, the Tracked Frequency for each probe can be set individually. Open the iQ Auto Plus Utility application, click the "Use MPC select" checkbox, select the specific probe from the Probe pull down menu and run a SCAN. After a successful scan, a prompt is displayed with the option to apply the scan result to the Free Run Frequency setting. Applying the scan result will initialize the Tracked Frequency to the scan value for the specific probe selected. Selecting a specific probe and pressing the TEST button will also initialize the Tracked Frequency.

Compatible Software:

The following software version or higher supports the Frequency Tracking feature:

Color Front Panel: v1.11.00
LE/LS-E Front Panel: v1.03.01
Enhanced Motherboard: v3.11.02
iQ Explorer II: v1.05.346
iQ Auto Plus: v4.02.02
iQ Auto Plus App: v2.4.4.41

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