The IQ Analyzer is a powerful and flexible solution for monitoring and analyzing electrical distribution systems. It provides extensive metering, power quality analysis, remote input monitoring, control relaying, analog input/outputs, and communications capability. With this power and flexibility come a large array of settings that specify the general setup, the function of inputs and outputs. and set triggers and their thresholds, demand timing, and display preferences.

General Setup

Type of System

The Analyzer supports four configurations: three-phase/4-wire (wye), three-phase/3-wire (delta), single-phase/2-wire, single-phase/3-wire (e.g., 120 volts line-to-neutral and 240 volts line-to-line). Both the wye and delta configurations have a phase rotation (ABC or CBA). If the rotation setting does not agree with the incoming voltages, the Analyzer displays **"REVERSE SEQUENCE, MISWIRING LIKELY!"**. As a default, the delta configuration disables the display of line-to-neutral voltages. In any case, the neutral terminal on the power module must be connected. In a wye configuration, merely connect the four wires. Similarly, in a single-phase configuration, connect the neutral wire to the neutral terminal. However, in a delta system, connect the neutral terminal to the chassis ground (see the wiring diagrams section). **It is very common to have mislabed phases throughout a factory such that the actual rotation is the opposite of how the wires are labeled. If a reverse sequence alarm appears, check the phasing by entering the analysis portion of the Analyzer by pressing the HARM softkey (F3), capturing an event with the NEW softkey (F4), and observing the phase angle of the fundamental Vab and Vca. An ABC rotation will have a phase angle of -120 degrees for Vab fundamental.** Regardless of the configuration, the voltage between the neutral terminal and ground terminal is measured such that leaving either terminal disconnected may cause the alarm, **"HIGH NEUTRAL VOLTAGE, MISWIRING LIKELY!" (Acknowledging an alarm screen inhibits alarms again until the screen saver becomes active. This allows the use of the device in situations with persistent alarms.**

Frequency

The Analyzer has four default frequencies, 25Hz, 40Hz, 50Hz, and 60Hz. Upon power up in the absence of a phase-A voltage [in which to frequency lock], the Analyzer samples according to the set default. This setting is also used for comparison when programming a trigger on frequency deviation.

Incoming Line-to-Line Voltage

Line-to-line voltages of up to 600vrms can be wired directly into the Analyzer without the need for potential transformers (PTs). For this reason the analog outputs need to define full scale based upon the incoming line-to-line voltage. That is, a full scale analog output is defined by the rated current and voltage. However, this setting has no effect on the use of the pulse-initiator relays. The incoming line-to-line voltage may be set between 100 and 600 volts.

PT Primary Line-to-Line Rating

When no potential transformers (PTs) are used the PT ratio is 1:1 (i.e., 120:120). For example, a 480-volt system that is wired directly has a PT primary line-to-line rating of 120 and with an incoming line-to-line voltage of 480 volts. This setting in conjunction with the incoming line-to-line voltage and CT primary rating define the full scale range for analog outputs. The PT primary rating may be set from 120 volts and 500 kilovolts.

CT Primary Rating

The rating of the current transformers (CTs) is relative to 5 amps. Normally, a system rated at 2000 amps per phase would have a CT ratio of 2000:5. However, **since the Analyzer has 8x overranging capability, as much as 40 amps can run continuously** through the CT inputs. If only a small fraction of the rated current is used, one can increase the resolution 8 times by making the ratio relative to 40 amps instead of 5 amps. For example, the same 2000 amp system may be specified as 2000:40, which is 250:5. This setting along with the PT primary rating and incoming line-to-line voltage define the full scale range for analog outputs. The CT primary rating may be set between 5 amps and 10000 amps and applies to Ia, Ib, Ic, and In.

Ground CT Primary Rating

This is the CT primary rating of the ground current input. Alternatively, one may substitute a zero-sequence CT, run the residual of Ia, Ib, Ic and In through the input, or leave the input terminals disconnected. As with the other current inputs, **the Analyzer has 8x overranging such that , there is 8x overranging such that 40 amps can run continuously** through the ground current input. Typically, one selects a lower CT ratio for the GND CT primary rating than for the other current inputs. The GND CT primary rating may be set between 5 amps and 10000 amps.

Program via IMPACC

While the IMPACC network has its own safeguards for program settings, additional security is afforded by disabling the downloading of settings via IMPACC. Enabling the downloading of settings via IMPACC is only possible at the front panel.

Energy Range

As a factory default, energies are displayed in "kilo" units (kilowatt-hours, kilovar-hours, and kVA-hours). However, with extremely high PT and CT ratios, kilowatt-hours tick off very quickly such that one may prefer "mega" units (megawatt-hours, megavar-hours, and MVA-hours).

Date and Time

If one has an IMPACC system that runs Series-III software, no entry is necessary as the time and date will be downloaded upon startup and synchronized once a minute. Otherwise, enter the date and time by selecting the desired item from the menu, modifying the value, and entering. After one enters "hour", the Analyzer displays an "AM/PM" soft-key whose pressing toggles the value. When the desired value is displayed, enter the value.

Password for Program and Reset Modes

The factory default for the password is 44444; however, this is changeable. As a shortcut, the equivalent to **44444 is 10000**, which only requires the pressing of two keys to enter (UP, ENTER). In case one changes the password and forgets, for the first fifteen minutes after power-up, a password of "27116" also works.

Analog Input (1)

The analog input may be set as either 0 to 20mA or 4 to 20mA. The display of the analog input is in the input/output status screen in the custom category of the meter menu. The bottom of the scale is 0%, while the full scale (20mA) is 100%.

Analog Outputs (3)

There are three analog outputs, each of which can be programmed as a 0 to 20mA or 4 to 20mA signal. The output represents: Ia, Ib, Ic, In, Ig, Iavg, Van, Vbn, Vcn, Vab, Vca, Vng, System watts, Phase-A watts, Phase-B watts, System VA, Phase-A VA, Phase-B VA, Phase-C VA, %THD on Ia, %THD on Ib, %THD on Ic, %THD on In, %THD on Van, %THD on Vbn, %THD on Vcn, %THD on Vab, %THD on Vbc, %THD on Vca, or Frequency.

Full Scale

The full scale output varies according to the selection. The full scale value for currents is the CT primary setting. The exception is Ig, which has a full scale value of the GND CT primary setting. The full scale value for line-to-line voltages is the product of the incoming line-to-line voltage and PT primary settings; however, for line-to-neutral voltages the full scale value is that of the line-to-line voltages divided by the square-root of 3. The full scale value for powers is the power given rated current and voltage (i.e., the full scale value of a per-phase watts is the product of the full scale voltage and full scale current). The full scale value for %THD is 100% of selected item's fundamental. Finally, the full scale value for frequency is the system frequency setting.

Analog Output Range
After one selects what the given output represents, one sets the range (0 to 20mA or 4 to 20mA) and the full scale output (100% or 200%). For example, a 200% selection means that at 20mA, the selected parameter is twice its full scale value as described in the previous paragraph. An exception is frequency, in which 100% is 100Hz, so the output would be 20mA at 100Hz.

Analog Output Zero Position (applies to watt and var selections)
For signed power selections there is a setting for what output represents zero watts or vars. "Zero-Scale" causes the output to be smallest output to represent zero (0mA for a 0 to 20mA output or 4mA for a 4 to 20mA output). "Mid-Scale" causes the output to be the middle value to represent zero (10mA for a 0 to 20mA output or 12mA for a 4 to 20mA output). This setting is independent of range such that for a 4 to 20mA output with a range of 200% and Mid-Scale position, a power of minus two times full scale is 4mA; minus full scale is 8mA; zero is 12mA; full scale is 16mA; and two times full scale is 20mA.

Discrete Inputs (3)
There are three discrete inputs, which have multiple functions. Each can trigger an event that captures metered, harmonic, and waveform data. Also, each can reset peak demands, min/max values, one relay, or as many as seven locked event triggers. Discrete input #1 has the alternative function as the sync demand input, which is then tied to the sync demand pulse from the electrical utility. Also see the description of Demand settings. Even when set as a reset input or sync, each discrete input can trigger an event. As a reset input it can reset: peak current and power demands, reset all min/max values, reset individual relays that had a manual reset specified, and reset locked triggers.

Event Triggers (7)

Triggers 1-7
Among the most powerful settings are the seven event triggers and the setting for the number of pre-trigger cycles. Each trigger causes an event, which captures metered, harmonic, and waveform data. Each is one of the following: Magnitude THD, %THD, Minimum (current, power, or power factor), Maximum (current, neutral-to-ground voltage, power, or power factor), demand (current or power), voltage disturbance (sag [alternatively labeled dip] or swell), frequency deviation, current unbalance, voltage unbalance, discrete input, or manual/IMPACC capture request. Normally, one of the seven triggers should be set to manual/IMPACC so that harmonic analysis and waveform capture are available upon request.
Most triggers have a trigger threshold, reset threshold, manual reset option, and delay time. However, discrete input and manual/IMPACC triggers have neither thresholds nor delay settings.

The following is a concise list of settings that are potential triggers and their settings. Underneath each are selections for individual phases or system selections. **Note that each trigger has a list of additional settings for trigger threshold, reset threshold, manual/auto reset, and delay.**

%THD (trigger threshold, reset threshold, manual/auto reset, delay)
On an 8-cycle basis, this trigger takes a snapshot when the entered percentage is exceeded. The raw threshold value is stored as a percentage. This is most useful for voltages because the %THD of the voltage as the voltage sags. That is, the %THD of the voltage is highest when the power quality is at its worst.

The Magnitude THD (trigger threshold, reset threshold, manual/auto reset, delay)
This trigger operates on an 8-cycle basis. It is much more useful for currents than %THD. The problem with triggering on a %THD current is that the percentage may rise when the overall current falls. For example, at night when large linear loads are shut down and only fluorescent lighting remains, the overall current is less but the %THD has increased. Conversely, the magnitude THD for current is largest under when the power quality is at its worst. That is, one is more interested in when the harmonic current exceeds 1/10 of the rated current (100 amps in a 1000 amp system) rather then 10% of the fundamental current, which varies continuously.

Minimum (trigger threshold, reset threshold, manual/auto reset, delay)
This trigger operates on an 8-cycle basis. While this trigger may be set for various currents and powers, it is most useful as a trigger for the displacement power factor or apparent power factor. For example, a trigger may occur as the power factor becomes leading, which indicates too much system capacitance.

Maximum (trigger threshold, reset threshold, manual/auto reset, delay)
On an 8-cycle basis, this trigger captures an event when the trigger threshold for the specified current, power, or power factor is exceeded. For example, a trigger may occur as the power factor drops to an unhealthy level.

Maximum Demand (trigger threshold, reset threshold, manual/auto reset)

This trigger monitors the demand current and powers at each demand subinterval. Note that the current demands update at each current demand interval. The power demands update at each window interval or subinterval — the first of either the Analyzer's internal timer or a sync pulse input (see discrete input#1). For example, a sliding demand window with 15 intervals and a subinterval period of 1 minute would update each minute, giving the average power over the past 15 minutes. **Setting the trigger threshold with a sliding demand window provides an opportunity to alarm and shed loads several minutes before utility limits will be exceeded.**

As a definition, the ***demand interval*** is the number of minutes in the average calculation. The ***subinterval*** is the number of minutes between updates.

Voltage Disturbance (trigger threshold, reset threshold, manual/auto reset, delay)
On a 2-cycle basis, this trigger detects either a three-phase voltage sag or swell (undervoltage or overvoltage). A trigger occurs for a sag when any of the three-phase line-to-line or line-to-neutral voltages drops below the trigger threshold. When the measured value recovers beyond the reset threshold, the trigger threshold is enabled for a subsequent sag.

Frequency Deviation (trigger threshold, reset threshold, manual/auto reset, delay)
On an 8-cycle basis the frequency is compared to the system frequency setting (see general setup). An event is triggered when the measured frequency deviates from nominal by the number of specified Hz.

Current Unbalance (trigger threshold, reset threshold, manual/auto reset, delay)
This trigger applies to a three-phase system only. On an 8-cycle basis, the RMS currents of the three phases are compared. An event is triggered when the percentage difference between the largest and smallest of the three, relative to the average, is greater than the percentage specified by the setting.

Voltage Unbalance (trigger threshold, reset threshold, manual/auto reset, delay)
This trigger applies to a three-phase system only. On a 2-cycle basis, the RMS voltages of the three phases are compared. An event is triggered when the percentage difference between the largest and smallest of the three, relative to the average, is greater than the percentage specified by the setting.

Discrete Input
Each of the three discrete inputs can trigger an event within 2 cycles of an external contact closure.

Manual Capture
In most cases, one of the seven triggers should be a manual capture that allows manual requests for waveform capture, either locally or via IMPACC.

Trigger Threshold

The trigger threshold is the level at which the trigger causes an event. Usually, a threshold is shown in actual units (amps, volts, watts, etc.) and also as a raw number, which is the representation of the setting as stored in the Analyzer's memory. While one may be tempted to use a formula to determine what raw number corresponds to a specific threshold, the best use is much simpler. Merely, adjust the raw number until the threshold value in real units is desirable. For example, with a CT ratio of 5000:5 a raw number of 40 is 100 amps, and 41 is 102.5 amps. In the same example if one desires a magnitude THD trigger on Ia of 250 amps one would find that the raw number of 100 corresponds to the desired 250.00 amp setting. Thresholds whose values are naturally apparent or a percentage are shown only as a raw number (i.e., %THD, power factor, %current unbalance, %voltage unbalance, and frequency).

Reset Threshold

The reset threshold makes the trigger available for another event. This setting applies to both the auto reset only and manual reset. Like the trigger threshold, there is a value in actual units and a raw number. When the selected measurement is below the reset threshold, the trigger threshold is enabled; otherwise, no event is recorded.

Manual/Auto Trigger Reset

The option of manual reset that locks the trigger such that the resulting event cannot be overwritten by a subsequent event. **The auto reset selection is the suggested default** such that one can see as many as the most recent 10 occurrences of the event.

To use the manual reset [locked-first-occurrence], delete any locked events for that trigger, first. That is, the trigger only occurs when the value is below the reset threshold, the value transitions through the trigger threshold, and no locked event exists of that trigger number.

Trigger Delay Time

The delay time specifies how long the trigger threshold must be exceeded before causing an event. Depending upon the trigger selection, the delay is either 0.1 to 60 seconds or 2 to 3600 cycles. Note that the delay is never zero such that the trigger threshold must be exceeded for at least two comparisons before an event occurs. Comparisons occur every 2 cycles for voltages and every 8 cycles for currents, powers, power factors, frequency, and THD. While one may enter any delay within the range, not all are appropriate. For example, Total Harmonic Distortion (THD) is an attribute associated with a steady state distortion — harmonic distortion implying a periodic waveform. While updates of THD occur every 8 cycles, a delay in the order of seconds is more appropriate.

Relay Outputs (4)

Relays can be set to shed a load upon excessive demand, act as a pulse initiator, indicate a reverse voltage sequence, activate upon an event trigger, or activate upon IMPACC command. Some of the options allow either a manual reset (via the RESET button or discrete input) or auto reset following a specified delay time (zero to 60 seconds).

Load Shedding

The load can be shed upon demand amps, demand watts, demand reverse watts, demand vars (capacitive load), demand reverse vars (inductive load), or demand VA. Each load shedding selection has a threshold as if it were a trigger threshold.

Pulse Initiator and Pulse Initiator Scale

The relay can serve as a pulse initiator for all energies — be it forward, reverse, real, reactive, or apparent. Upon entering a selection for the pulse-initiator, the Analyzer requests a pulse initiator scale factor, which is an integer between 1 and 255. A setting of 1 would cause the relay to change state each 0.6(wh, varh, or VAh)*PT primary setting*CT primary setting. For example, if the voltage is at the PT primary rating, the current is at the CT primary rating, and the scale factor is 10, the relay changes state every 12 seconds. Warning, using the pulse initiator with a scale factor of 1 at rated power, continuously, will wear out the relay within several months.

Event/Alarm/IMPACC (manual/auto reset, delay)

Each relay can become active from any of the seven triggers that cause events, any of the three discrete inputs, or from an IMPACC command. The relay becomes active when any of the selected item occurs (i.e., any item with an asterisk next to it on the Analyzer display or a checked box in the IMPACC software. For example, one may desire that the relay become active when any of several things happens, say any trigger or discrete input. With auto reset selected, the relay becomes inactive when all selected items become inactive and the delay time passes.

Use of the IMPACC control should be used alone with auto reset and no delay. Setting the relay in this way allows IMPACC control with a minimum delay and the least confusion.

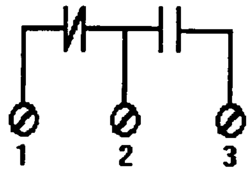
Reverse Sequence Alarm (manual/auto reset, delay)

Each relay can serve as a reverse sequence alarm output. On an 8-cycle basis, the Analyzer compares the actual phase sequencing with the rotation sequence (ABC or CBA) that is specified the general setup configuration for three-phase systems. The relay becomes active immediately upon detection and remains active until reset manually or after rotation is correct and the set delay has passed.

Relay Mode Options

Each relay has a setting that allows the user to choose between MODE1 (energize relay upon event/alarm) and MODE2 (release relay upon event/alarm). Neither mode is ideal for all situations. Mode2 is ideal as an under-voltage relay, but Mode1 is ideal as an over-current relay. The Analyzer had only operated in Mode2 such that the relays are normally energized but are de-energized upon an event or when the Analyzer loses power.

The relays are shown with the IQ Analyzer de-energized.



Because the Analyzer relays have both normally open and normally closed contacts, one can choose the opposite polarity wiring to the opposite terminal.

Relay Application	RelayMode	Wired Terminals
Undervoltage, open upon alarm	2	2, 3
Undervoltage, close upon alarm	2	1, 2
Overcurrent, open upon alarm	1	1,2
Overcurrent, close upon alarm (shunt trip)	1	2,3
Load shed, open upon alarm, delay power up	2	2,3
Load shed, open upon alarm	1	1,2
Low power factor, close to add capacitance	1	2,3
Reverse sequence, close upon alarm	1	2,3
Reverse sequence, open upon alarm	1	1,2
Pulse-Initiator	Either	Either pair
Alarm only when powered	1	Either pair
Alarm also when not powered	2	Either pair

Note that a variety of other applications are available for the relays by OR-ing several event triggers or discrete inputs. For example, a phase loss is a programmable voltage imbalance or current imbalance. Similarly, a single relay can shed upon the OR of high demand current, high demand power, maximum current, magnitude THD, and discrete input (manual shed).

Demand Windows

Current Demand Window (Fixed Window)

Current demand, which is an average system current over time can be set to average current over a range of 1 to 60 minutes. This is known as a fixed window. For example, setting the current demand window to 15 sets the Analyzer to determine the average current over the past 15 minutes and update the value every 15 minutes.

Power Demand Window (Fixed or Sliding Window)

Power demand, which can be a fixed window as described above, can also be sliding window. That is, one can get a 15 minute average that is updated every 3 minutes. To do this one would set the subdemand interval to 3 minutes and the number of intervals to 5 (i.e., 3 minutes times 5 intervals equals 15 minutes).

As a definition, the ***demand interval*** is the number of minutes in the average calculation. The ***subinterval*** is the number of minutes between updates.

The demand settings are adjustable to simulate a variety of thermal time constants. In the previous example of a sliding power demand window an abrupt change in power achieves 60% of it final value in 9 minute. Beyond the settings of the Analyzer is the possibility of passing the power or demand power measurement to the analog outputs for analog filtering or to IMPACC for digital filtering.

Display Preferences

The Analyzer supports a variety of settings that affect only how data is displayed.

The "Return to meter menu" time is a setting from 1 to 15 minutes (0 for no return). The Analyzer measures the time of inactivity from when a button is pressed last. When the inactivity time reaches the return time setting, the Analyzer returns to the meter menu from program mode, reset mode, help, or analysis screen, and activates its screen saver. If the setting is zero, the Analyzer remains in its present mode but activates the screen saver after 15 minutes.

The screen saver itself can be set to either dim (1/4 brightness for an expected display life of 20 years) or blank. In any case, pressing any button restores the display to full brightness. Pressing the "Previous Level" button is a good choice as it has no effect in the meter menu.

A powerful feature of the Analyzer is the custom screen capability. From a subset of the meter menu are 60 parameters of which 14 can be selected to appear in one of two custom screens. At the end of the custom screen list is "Default Displays", which restores the custom screens to a default set of 14. The "Sel" soft-key selects or deselects parameters. Warning: be sure the press the "Enter" soft-key before exiting the custom screens programming screen or all changes will be ignored.

There have been display options to: select either a blanking or dimming screen saver; choose a time-out period; and program custom screens. In the programming mode under DISPLAY MANAGER there is an additional item, DISPLAY OPTIONS. Presently, there are three options as shown in the following table.

	Program / Display Mgr. / Options	
Bit0 (rightmost)	0= Kilo units (e.g., Kilowatt-Hr)	1=Mega units (e.g., Megawatt-Hr)
Bit1	0=Normal Operation	1=Disable event/alarm screens This is useful when discrete inputs trigger an event either manually or periodically.
Bit2	0=Normal blanking of line-to-neutral parameters in a 3-wire delta configuration. (otherwise, readings for Van, Vbn, and Vcn might be confusing to a user without a neutral)	1=Show all parameters
Bit3-7	Future Options	