Supersedes TD.17.02.T.E
pages 1-8 dated May 1999

Metering Devices
IQ Analyzer

IQ Analyzer
6400/6600 Series

Applications

- Monitoring of over 150 electrical parameters
- Power Quality Management
- Energy Management

Metered/Monitored Parameters

- RMS sensing
- Phase neutral, and ground currents
- Volts: L-L, L-N, Avg. L-L, Avg. L-N, N-G
- Power: real, reactive, apparent (system and per phase)
- Frequency
- Power factor: apparent and displacement (system and per phase)
- Energy and Demand (Forward, Reverse, Net) real, reactive apparent at four different utility rates
- Individual Current and Voltage Harmonics: magnitude, phase angle
- % THD: Current and Voltage
- Waveform capture
- Min/max values
- Event logging/disturbance recording
- ANSI C12.20 Class 0.5% revenue metering accuracy, ANSI C12.16, IEC687 Class 0.5%

Communications

- Optional interface capability to computer network for data collection, storage and/or printout via the Cutler-Hammer PowerNet System

Physical Characteristics

- Graphical reverse mode LCD display with LED backlight
- Up to seven lines of information

- Height: 10.25 inches
- Width: 6.72 inches
- Depth: 4.70 inches without PONI, 5.83 inches with PONI
- Membrane faceplate NEMA 3R and 12 rated

Listings/Certifications

- UL listed, File E62791, NKCR File E185559 (CE versions)
- CUL listed #1010.1 C22.2
- CE mark EN61010-1 (1993) EN50082-2 (1994)
- Measurement Canada Electricity Meter AE-0782
- CSA Pending

General Description

IQ Analyzer-Comprehensive Electrical Distribution Monitoring

The IQ Analyzer is a complete solution for users who want to monitor and manage all aspects of their electrical distribution system. Based on input from customers and consultants, it provides extensive metering, power quality analysis, remote input monitoring, control relaying, analog input/outputs and communications capability.

Its high performance metering exceeds ANSI C12.16 (1%) specification for revenue meters and meets ANSI C12.20 Class 0.5%, provides quality true rms readings through the 50th harmonic, accurately measures nonsinusoidal waveforms up to a 3.0 crest factor, and displays even and odd multiples of the fundamental current and voltage through the 50th harmonic. Both magnitude and phase angle of the harmonics are displayed①.

The unique operator interface, which includes a reverse mode LCD display, easy to use *Meter Menu* screens and detailed *Analysis* screens, is designed to allow a wealth of real-time and recorded information to be accessed easily by an operator. *All* programming can be accomplished through the faceplate or the communications port. The comprehensive on-line Help feature provides useful information on device operation, programming and troubleshooting.

Disturbance Information

With the communications option and our Cutler-Hammer PowerNet software and Waveform Display software, a *Waveform Analysis* will construct waveforms of up to 56 cycles of all currents and voltages

① For definition of power quality terms, see page 5.

(including neutral and ground) to help troubleshoot undervoltage/sag and overvoltage/swell conditions. (See CBEMA Trend Logging section, this page.) By programming a reset threshold, the duration of the voltage disturbance can also be indicated.

The IQ Analyzer 6600 series with Graphic Waveform Display offers the ability to view the captured waveform right at the device. The 6600 series also offers the ability to detect and capture sub-cycle voltage disturbances.

Extensive Harmonic Distortion Analysis

Current *and* voltage distortion data are displayed at the device and accessible through the communications port. This includes % THD, K-Factor, Crest Factor, CBEMA factor, and both magnitudes and phase angles of all harmonics through the 50th. A snapshot sample of this information may be activated by user commands, discrete inputs or programmable thresholds to capture distortion data during conditions of real interest. To help eliminate nuisance alarms, harmonic distortion information can be captured and relay outputs activated when THD exceeds a programmable percentage of fundamental or a programmable magnitude (e.g., amperes) threshold.

Time of Use Metering

The IQ Analyzer offers the ability to store energy usage data for time of use revenue metering. It can be programmed for any combination of weekday, Saturday, Sunday, 22 holidays, 8 seasons, 32 schedules, and 10 time periods per schedule. The IQ Analyzer will keep track of the following parameters for four different utility rates:

- Watt hours
- VAR hours
- VA hours
- Current demand
- Watt demand
- VA demand
- VAR demand

Historical Trend Logging

The IQ Analyzer is equipped with on-board logging capability, which includes the ability to log a total of 24 parameters with intervals ranging from 0.13 seconds (every 8 cycles) to twice a week (5040 minutes). The trending function can begin immediately or can be triggered upon receipt of a discrete input into the IQ Analyzer. On-board logging provides a cost-effective means of distributed data storage where real-time communications may not be feasible or for applications where data storage redundancy is desired. Four trend data logs are stored in non-volatile memory aboard the IQ Analyzer and can be retrieved at the display or via communications for viewing using Cutler-Hammer software.

- Up to 24 parameters with storage capacity for up to 90,000 data points.
- Up to 234 days of data can be stored when recording a parameter every 15 minutes.
- Trends 1, 2 and 3 can save data on a discrete contact input.
- Trend 4 can save data on a power quality or meter event.
- Minimum and maximum recording (min./max. 3-phase average current, max. I_G, min./max. 3-phase average VLL and VLN, max. V_{NG}, max. system Watts, vars, and VA, min./max. apparent and displacement PF). Using this feature, minimum and maximums reached during each trend interval are recorded.

CBEMA Trend Logging

The IQ Analyzer can be configured to store the necessary data so that PowerNet can display a sag or swell voltage event on the industry standard CBEMA (now ITIC) curve for predictive maintenance and troubleshooting. This application utilizes the IQ Analyzer waveform capture for high speed events along with historical trend logging for longer term voltage disturbances. Once this data is uploaded to a PC running the PowerNet Event Viewer the information is analyzed, displayed and stored. Automatic uploading of CBEMA events can be selected in PowerNet. A three phase event will be correctly displayed as a single point on the CBEMA curve.

Event Logging

The IQ Analyzer will store in non-volatile memory the time and reason for last 504 events. These events can be viewed from the graphical display or accessed via communications. In addition to all of the meter events listed in the Event Conditions section (page 4), the following events are entered into the event log:

Time and date of:

- Alarms
- Meter power up
- All resets
- All setting changes
- Communications established or lost

Event logging is another powerful trouble shooting tool within the IQ Analyzer.

Extensive I/O and Communications Capability

One analog and three digital inputs are provided to interface with sensors and transducers. Three analog outputs and four relay contacts are furnished to share data with PLCs and control systems and to actuate alarms and control relays. Terminals are captive clamp type and finger safe. With the communications option, the device can be remotely monitored, controlled and programmed.

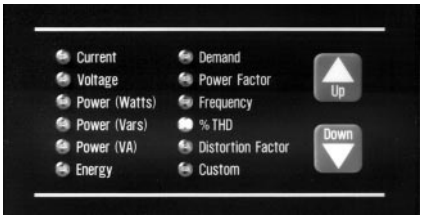
Ratings

- Application to 500 kV, no PTs to 600V
- CT ratios selectable from 5:5A to 10,000:5A
- Standard 120/600 Vac line
- 3-phase power supply module, 100-600 Vac. Separate source power supply module available, 100-240 Vac or 100 to 250 Vdc
- DC only separate source power module also available, 24 to 48 Ddc

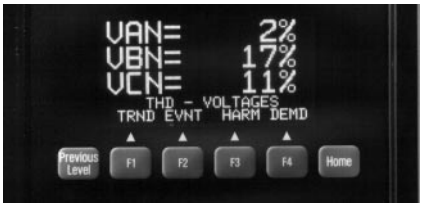
Displayed Information Features

- All information accessible at device or through communications port via Cutler-Hammer PowerNet
- Quality true rms readings through 50th harmonic
- Complies with the accuracy portion of ANSI C12.20 Class 0.5% revenue metering specification
- Accurate readings for nonsinusoidal waveforms with up to 3.0 crest factor
- Screens display auto ranging units, kilo units, mega units as needed
- 10-Digit energy readings
- Displays multiple parameters at the same time
- Programmable Custom Screens

Meter Menu Screens



Meter Menu



Examples of Meter Menu

Custom Screen

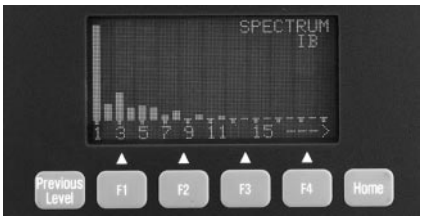
Custom Screen

The IQ Analyzer allows a user to view commonly used parameters by scrolling through its LED indicator Meter Menu.

Meter Menu Displayed Information

- Current – Phases A, B, C, Average
  – Neutral
  – Ground (Separate CT)
- Voltage – Phases A-B, B-C, C-A, Average
  – Phases A-N, B-N, C-N, Average
  – Neutral-Ground
- Power – Real (Watts)
  – Reactive (Vars)
  – Apparent (VA)
  – Phases A, B, C, and system
- Energy (Forward, Reverse and Net)
  – Real (kWh)
  – Reactive (kvarh)
  Apparent (kVAh) –
  no reverse or net
- Frequency, time and date
- Demand – System current (amperes)
  – Systems real power (kW)
  – System reactive power (kvar)
  – System apparent power (kVA)
- Power Factor (Phases A, B, C, System) – Displacement
  – Apparent
- %THD Current – Phases A, B, C, N
- %THD Voltage – Phases A-B, B-C, C-A
  – Phases A-N, B-N, C-N
- K-Factor
- CBEMA (ITIC) Derating Factor (Displayed as "Z")
- Crest Factor
- Discrete Input and Output Status
- Analog Input Reading
- Custom – User may program four screens to show any combination of seven Meter Menu parameters per screen.

Harmonic Analysis Screens



Harmonic Spectrum Available with Model 6600

Minimum and Maximum Values:

- Current – Phases A, B, C, N, G
- Voltage – Phases A-B, B-C, C-A
  – Phases A-N, B-N, C-N, N-G
- Power – Real (Watts)
  – Reactive (Vars)
  – Apparent (VA)
  – Phases A, B, C and System
- Power Factor – Apparent and
  – Displacement (3-Phase and System)
- Frequency
- THD (Amperes, Volts, and %)
  – Current (Phases A, B, C, N)
  – Voltage (Phases A-B, B-C, C-A, A-N, B-N, C-N)

All minimum/maximum values may be reset via reset pushbutton on faceplate, discrete input or communications command. Values are updated at least once every 16 line cycles.

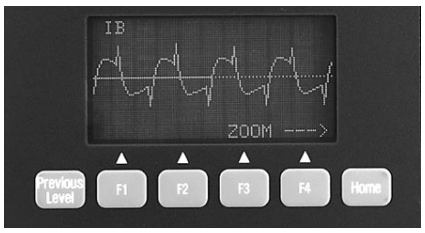
The F3 function key accesses the Harmonic Analysis screens. Two cycles of data sampled at 128 ***samples/cycle*** are ***simultaneously*** recorded for:

- Current – Phases A, B, C, N, G
- Voltage – Phases A-B, B-C, C-A
  – Phases A-N, B-N, C-N
  – Neutral to Ground

Magnitudes (or % of fundamental) of odd ***and even*** multiples of the fundamental from 2nd - 50th are displayed. The phase angle associated with each multiple of the fundamental is also displayed.

Event/Alarm Analysis Screens

Example of Event Analysis Screens



Waveform Screen Available with Model 6600

Pressing the F2 function key accesses the Event Analysis screens. These display the following data for up to ten event/alarm conditions:

- Description, date, and time of event/alarm with 10 millisecond resolution.
- Current, voltages, power readings, demand readings, frequency and % THD at time of event/alarm.
- Current and voltage distortion information available on Harmonic Analysis screens.

Event data is stored in non-volatile memory. If a reset threshold is programmed, the *duration* of the event (e.g., undervoltage) is also displayed. With the Cutler-Hammer PowerNet communications option and Series III software, waveforms and harmonic profiles may be displayed on a PC.

Event Conditions

Events may be triggered by up to seven of any of the following conditions:

Voltage Disturbances

- Undervoltage/sag – any V_{L-L}, V_{L-N} (40-100%)①
- Overvoltage/swell – any V_{L-L}, V_{L-N} (100-750%)

If zero time delay is programmed, any disturbance lasting 2 cycles (less if magnitude is sufficient to effect rms readings) will trigger a voltage disturbance event/alarm.

- Sub-cycle transient capture/ excess dv/dt on V_{A-N}, V_{B-N}, V_{C-N}②
- Sub-cycle voltage interruption on V_{A-N}, V_{B-N}, V_{C-N}②

Maximum Threshold Exceeded

- Currents – Phases A, B, C, Neutral, and Ground
- Voltage – Neutral to Ground
- System Power – Watts, VA, Vars
- System Power Factor – Displacement and Apparent
- Demand
- Currents – Phase A, B, C and I_{AVG}
- System Power – Watts, Vars, VA
- Frequency
- Percent Total Harmonic Distortion or Magnitude Total Harmonic Distortion
  Currents – Phases A, B, C, Neutral
  Voltage – V_{A-N}, V_{B-N}, V_{C-N}, V_{A-B}, V_{B-C}, V_{C-A}

Minimum Threshold Exceeded

- Currents – Phases A, B, C
- System Power – Watts, Vars, VA
- System Power Factor – Displacement and Apparent
- Frequency

Voltage Phase Unbalance

- Voltage L-L, L-N

Current Phase Unbalance

- Current – Phases A, B, C

Discrete Input Energized

- Input 1, 2, 3

Cutler-Hammer PowerNet Communications

- Remote command though communications port or front panel

All trigger conditions have programmable time delays from 0.1 to 60 seconds in 0.1 second increments (except Voltage Disturbances – programmable from 2 - 3600 cycles in 2-cycle increments, and Cutler-Hammer PowerNet command – no programmable delay).

Demand Recording

Peak Demands are date and time stamped for:

- Current Phases A, B, C, average
- System Power – Real (watts)
  – Reactive (vars)
  – Apparent (VA)

Input/Output

Extensive input/output capability is standard on the IQ Analyzer. In addition to monitoring three-phase currents and voltages, separate inputs are provided for both ground and neutral currents. Voltage of neutral-to-ground is also monitored to indicate the presence of harmonics and potential downstream grounding problems. Analog and digital I/O provide interfaces for transducers, relays, PLCs and control systems.

Current Inputs

Five ampere secondary CT connections for:

- Phases A, B, C
- Ground
- Neutral
- Separate ground and neutral CT inputs.
- CT range 5:5 to 10,000:5 (any integer)

Voltage Inputs

- Phases A, B, C (from 120 Vac – 500 kVac)
- 120/240 Vac control power input standard – not required with optional line power module
- Separate ground-to-neutral voltage reference.
- PT range 120:120 to 500,000:120 (any integer)

External 120-volt secondary PTs are required above 600 Vac, optional from 120-600 Vac.

① 60% minimum for self-powered unit.
② 6600 series only.

Discrete Contact Inputs

Three dry contact discrete inputs may be programmed by the user to:

- Trigger Event Analysis – the information described in "Event Analysis Screens," including Harmonic Analysis information, can be recorded when external devices trip or change state by wiring their auxiliary contacts into these inputs.
- Act as a synch.-pulse input to synchronize power demand windows with utility provided synch. pulse.
- Actuate a relay output
- Reset relay output, peak demands, Trend Analysis records and Event Analysis records.
- With communications option, provide remote status indication on Cutler-Hammer PowerNet network.

Status of input contacts is displayed in the Meter Menu Custom screen.

Relay Output Contacts

Four Form-C (NO/NC) relay contacts may be independently programmed to:

- Act as a kWh, kVarh or kVAh pulse initiator output.
- Actuate on one or more event conditions – including discrete input and Cutler-Hammer PowerNet command (through communications port).
- Reverse Sequence Alarm

Each Relay may be set for Auto or Manual Reset with 0-30 minute release delay (one second increments). Relays are Form-C NO/NC. Relay(s) programmed to actuate on undervoltage also have a programmable 0-30 minute delay on power-up for transfer applications.

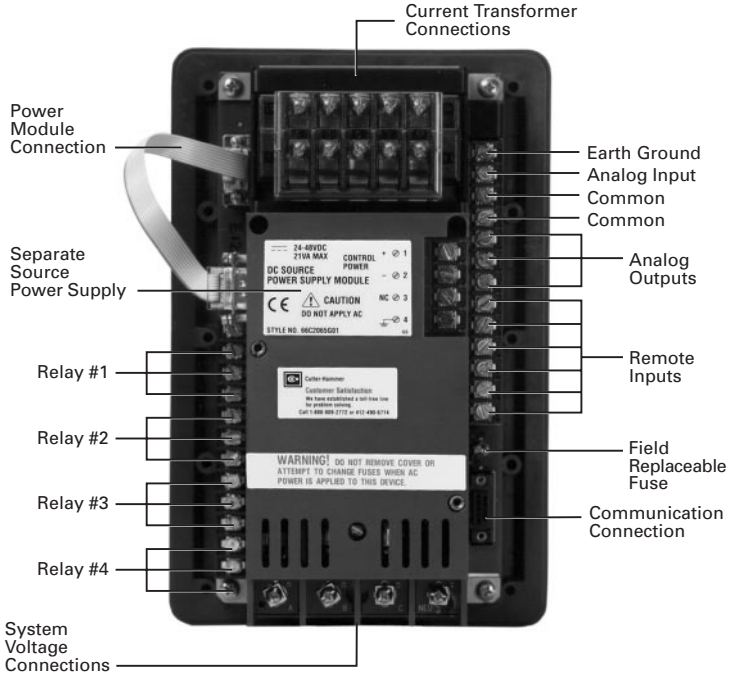
Analog Input and Outputs

One analog input and three analog outputs may be configured as 0-20 or 4-20 mA. The analog input is displayed at the device as a percentage and is accessible through the communications port. The analog input provides an interface with gas flow meters, temperature transducers or other analog devices.

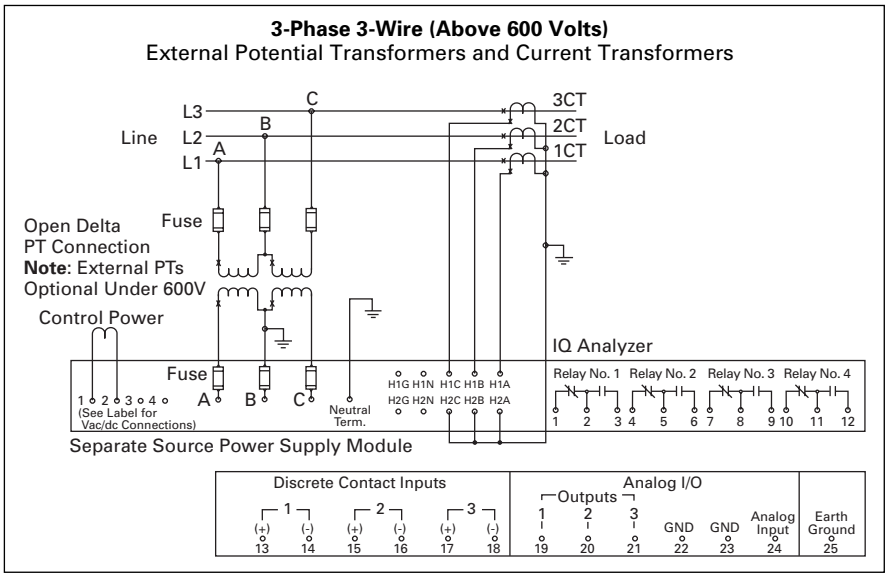
The analog outputs may be programmed to reflect any of the following:

- Current - Phases A, B, C, Average, N, G
- Voltage – L-L, L-N, N-G
- Power – Real (watts)
  – Reactive (vars)
  – Apparent (VA)
  – Phases A, B, C and system
- %THD – Current (Phases A, B, C, N)
  – Voltage (L-L, L-N)
- Frequency – System
- Power Factor
  – System Displacement PF
  – System Apparent PF

Input/Output Capabilities



Field Wiring Connections – Separate Source Power Supply Shown Here (For 3-Phase Power Supply, No Separate Control Power is Required)



Definition of Power Quality Terms

Displacement Power Factor =

$$\frac{W}{\sqrt{W^2 + Var^2}}$$

= Fundamental (60 Hz) watts to (60 Hz) VA.

– A ratio of fundamental (60 Hz) real power to apparent power.

Apparent Power Factor =

$$\frac{W}{VA}$$

= Total rms watts to VA.

– A ratio of total real power (including harmonic component) to apparent power.

K-Factor =

$$\frac{\Sigma h_n^2 \left(\frac{I_n}{I_1}\right)^2}{\Sigma \left(\frac{I_n}{I_1}\right)^2}$$

– A derating factor which is related to the sum of the squares of harmonic currents times the squares of their harmonic numbers (multiples of the fundamental).

CBEMA Factor =

$$\frac{\sqrt{2}}{CF} = \frac{\sqrt{2}\, I_{RMS}}{I_{Peak}}$$

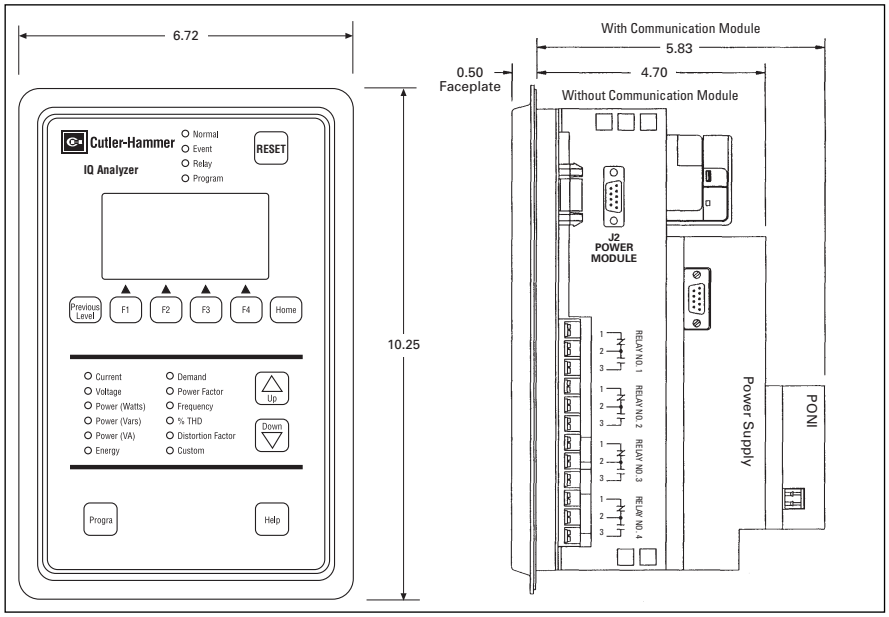
– A transformer harmonic derating factor (THDF) defined as a pure sine wave's crest factor (1.4141) divided by the measured crest factor.

Crest Factor =

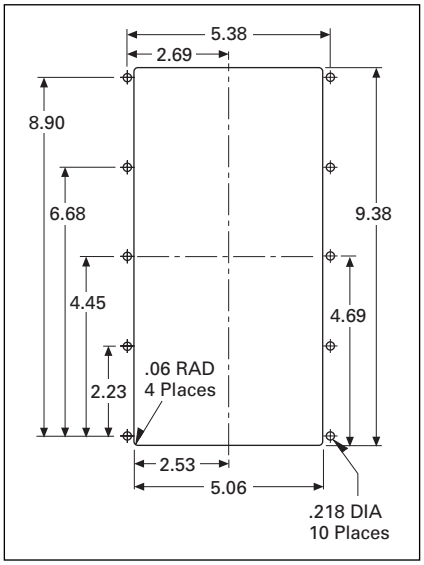
$$\frac{I_{Peak}}{I_{RMS}}$$

– Ratio of peak current to rms current.

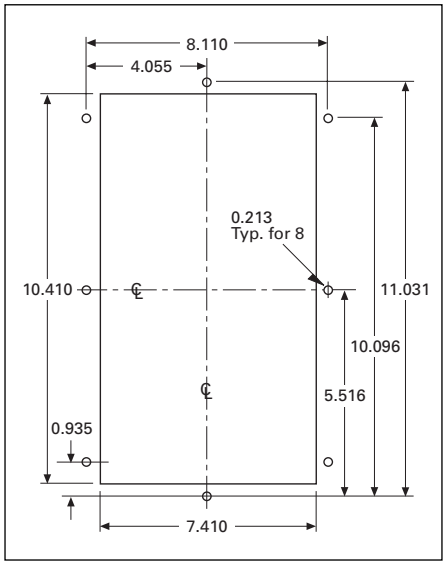
Dimensions and Cutout



Drilling Pattern



Drilling Pattern for Flange Mounting



Specifications

Fuses

- Self powered units with IQMSSPM have 3/4 ampere, 600 volts Bus Type KTK-R-3/4 fuses (3 required).
- Seperate source dual voltage units with IQMSSPM have a single 5 x 20mm 1/4 ampere fuse.
- Seperate source DC units with IQMDCPM do not have user replaceable fuses.

Environmental Conditions

Operating Temperature:	-20° to 70°C
Storage Temperature:	-30° to 85°C
Operating Humidity:	5% to 95% Relative Humidity
Device Weight:	5.8 lbs

Current Inputs (Each Channel)

Conversion:	True rms, 32 sample/ cycle (all samples used in all rms calculations)
CT Input:	5 Ampere secondary (any integer 5:5 to 10,000:5)
Burden:	0.05 VA
Overload Withstand:	40 Amperes ac continuous, 300 amperes ac 1 second
Range:	8 x CT Continuous
Accuracy:	0.1% of CT primary rating, 0.2% of reading above 150% of rating, sinusoidal (see accuracy below for non-sinusoidal specifications)
Input Impedance:	0.002 ohm

Voltage Inputs (Each Channel)

Conversion:	True rms, 32 samples/ cycle (all samples used in all rms calculations)
PT Input:	Direct or any integer 120:120 to 500,000:120
Range:	30 to 660 Vac (separate source and dc source)
Nominal Full Scale:	100-600 Vac
Burden:	21 VA (self-powered only)
Overload Withstand:	635 Vac, continuous 700 Vac, 1 second
Input Impedance:	1 megohm

Frequency Range

20-66Hz fundamental (up to 50th harmonic)

Harmonic Response (Voltages, Currents)

50th harmonic

Accuracy (in percent full scale)

Accuracy from 3-300% of Full Scale and from -0.5. to 1.00 to 0.5 power factor.

Current and Voltage:	± 0.20%
Power, Energy, and Demand:	± 0.40%
Frequency:	± 0.04%
Power Factor:	± 0.80%
THD:	± 1.00%

Specific Current Accuracies:

±0.20% of Full Scale to 200% of Full Scale and 150% Crest Factor

±0.20% of Full Scale to 150% of Full Scale and 200% Crest Factor

±0.20% of Full Scale to 100% of Full Scale and 300% Crest Factor

±0.40% of reading for Currents to 800% of Full Scale

Power and Energy: Start recording with an average of 3 mA secondary current

Discrete Inputs (Dry Contact)

+30 Vdc differential across each discrete input pair of terminals. Minimum Pulse Width: 1.6 msec

Optically isolated inputs to protect IQ Analyzer circuitry.

Analog Outputs (3)

0 to 20mA/4 to 20mA into maximum 750 ohm load. Accuracy: 1%.

Analog Input (1)

0 to 20mA/4 to 20mA into 200 ohm load. Accuracy: 1%.

Relay Output Contacts (4)

Form C Dry Contact:	10 amperes @ 120/240 Vac (Resistive) 10A @ 30 Vdc (Resistive) 30A make (50 ms) @ 240 Vac/240 Vdc
Minimum Pulse Width:	4 cycles (68 ms)
Withstand Rating:	1000 Vac, 1 minute across contacts 5000 Vac (contacts to coil, 1 minute) 10,000 Vac (contacts to coil, surge voltage)

Relay Response Time

(excluding programmed time delays):

2 line cycles for Discrete Input, Cutler-Hammer PowerNet command (communications port)

4–5 line cycles for Voltage Disturbance, Voltage Unbalance

9–10 line cycles for all others

Control Power Input

Description	Separate Source	Self Powered①	Dc Source
Input Range, ac	110-240 Vac ±10%	110-600 Vac ±10%	N/A
Frequency Range	45-66 Hz	45-66 Hz	N/A
Input Range, dc	110-250 Vdc ±10%	N/A	24-48 Vdc ±20%
Burden	21 VA	21 VA	21 VA

① When directly wired to 480 Vac, IQ Analyzer can ride through a continuous sag that is 20% of rated voltage.

Ordering Information

Description	Catalog Number
IQ Analyzer, 24 to 48VDC power module	**IQA6410**
IQ Analyzer, separate source power module	**IQA6420**
IQ Analyzer, 3-phase power module	**IQA6430**
IQ Analyzer, 24 to 48VDC power module with Waveform Display and Sub-Cycle Voltage Disturbance Capture	**IQA6610**
IQ Analyzer, separate source power module with Waveform Display and Sub-Cycle Voltage Disturbance Capture	**IQA6620**
IQ Analyzer, 3-phase power module with Waveform Display and Sub-Cycle Voltage Disturbance Capture	**IQA6630**
IQ Flange, to provide extra clearnce when mounting	**IQFLANGE**
36-inch extension cable for remote mounting of power module	**IQACABLE**
45-inch extension cable for remote mounting of power module	**IQA45CABLE**
PowerNet Waveform Display Software	**NPWAVEFORM**
24 to 48VDC separate source power module	**IQMDCPM**
100-240VAC and 100-250VDC separate source power module	**IQMSSPM**
3-Phase, self powered power module	**IQM3PPM**
INCOM Communication module	**IPONI**
Ethernet Communications module (10Base-T)	**EPONI**
Ethernet Communications module w/fiber optic port (10Base-T and 10Base FL)	**EPONIF**
IQ Analyzer/IQ DP-4000 auxiliary power supply	**IQDPAUXPS**
Portable IQ Analyzer with IPONI	**IQA6610PORTI**
Portable IQ Analyzer with EPONIF	**IQA6610PORTF**

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