SECTION 2: HARDWARE DESCRIPTION

2-1 GENERAL

The purpose of this section is to familiarize the reader with IQ Analyzer hardware, its nomenclature, and to list the unit's specifications. The information presented is divided into the following four parts:

- Operator Panel
- Rear Access Area
- External Hardware
- Specification Summary

2-2 OPERATOR PANEL

The operator panel, which is normally accessible from the outside of a panel or door, provides a means for:

- Being alerted to specific conditions
- Receiving functional help
- Programming
- Parameter Monitoring/Selection

LEDs, a display window, and pushbuttons make up the front accessible operator panel (Figure **2-1**).

LEDs are either red or green and can be blinking or lit continuously, depending upon their specific function. For detailed information on individual LEDs refer to Paragraph 3-2.

The display window is used to display all IQ Analyzer metered parameters, setpoints and messages in a number of different formats. The information is presented in the form of display screens for a variety of categories. The gas plasma display is approximately 1.5 by 3.0

1	Status LEDs	**5**	Function Pushbuttons	**8**	Up and Down Pushbuttons
2	Reset Pushbutton	**6**	Home Pushbutton	**9**	Program Pushbuttons
3	Display Window	**7**	Display Information LEDs	**10**	Help Pushbutton
4	Previous Level Pushbutton				

Figure 2-1 IQ Analyzer Operator Panel

inches and is able to display up to eight lines of information at a time. For information that is frequently accessed, two custom screens will display up to 14 Meter Menu parameters of the user's choosing. For details concerning the kind of information and the types of screens that can be viewed in the display window refer to Paragraph 3-3.

The front operator panel supports eleven long-life membrane pushbuttons. Pushbuttons accomplish their function when pressed and released. Certain pushbuttons will, however, continue to scroll if they are pressed and not released. Refer to Paragraph 3-4 for information concerning the function of specific pushbuttons.

2-3 REAR ACCESS AREA

The rear access area of the IQ Analyzer is normally accessible from the rear of an open panel door (Figure **2-2**).

All wiring connections to the IQ Analyzer are made at the rear of the chassis. For the sake of uniform identification, the frame of reference when discussing the rear access area is facing the back of the IQ Analyzer with the panel door open. The power module port, for example, is located on the upper left rear of the IQ Analyzer. The communication module port is located on the lower right rear of the unit. Detailed information relative to any connection made to the rear access area is presented in Section 4 entitled "Installation, Startup and Testing."

2-3.1 BACK OF CHASSIS

The back of the chassis provides terminal blocks for 3-phase ac line connections and connections for the three required external current transformers plus neutral and ground (Figure **4-7** and **4-8**). The ac line connections are identified on the terminal block "Phases A, B, C and Neutral." The current transformer connections are identified "Phases A, B, C, Neutral and Ground."

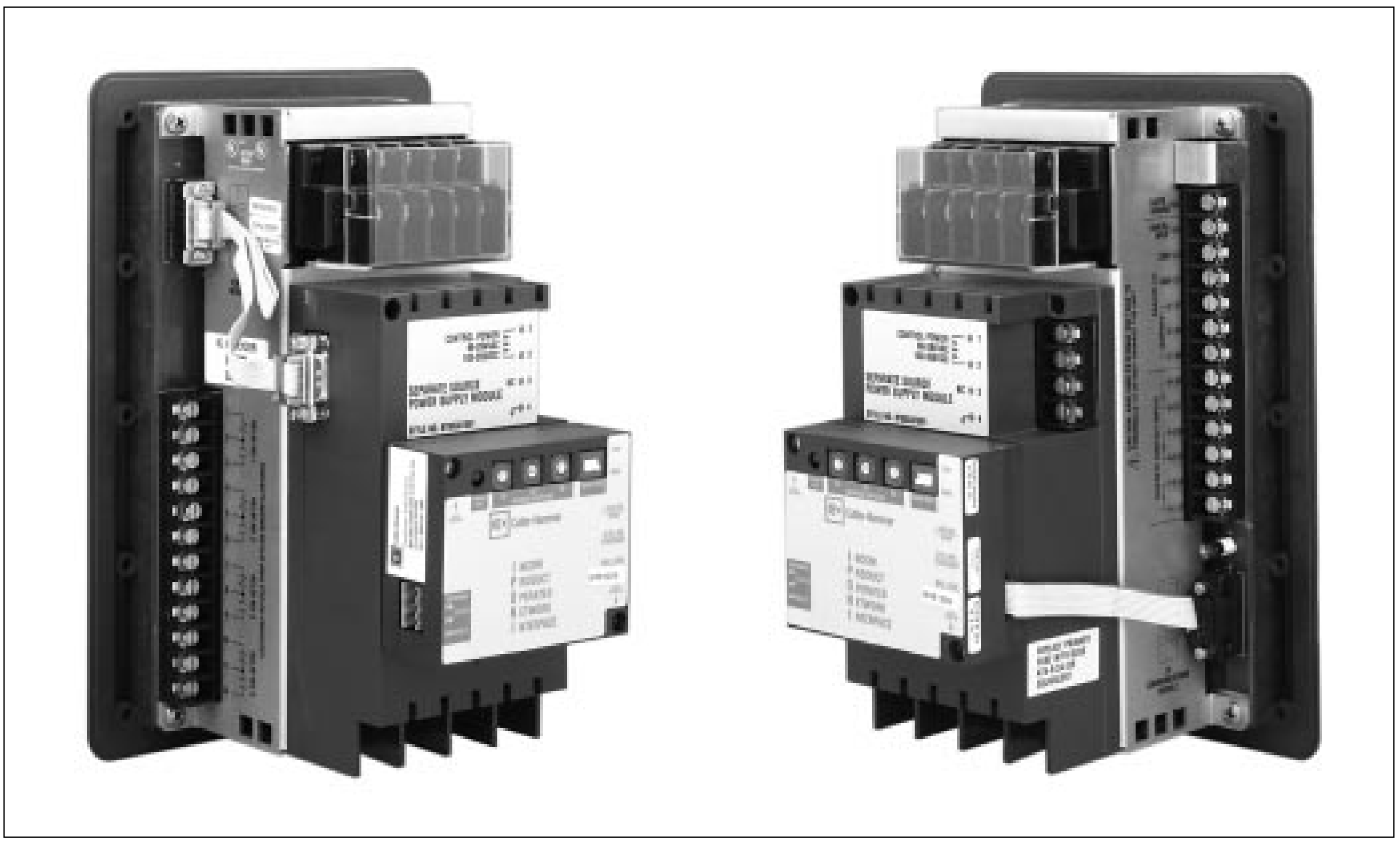

Figure 2-2 IQ Analyzer (Rear Views). See Figures 4-7 and 4-8 for detailed identifications.

In addition, the rear of the chassis, through the use of two stacking screws, provides a means for mounting either the standard 3-phase self-powered power module or an optional separate source power module (Figures **2-3** and **2-4**). If the communication option is part of the IQ Analyzer, an optional communication module (IPONI - INCOM Product Operated Network Interface) is mounted to the power module using the same stacking screws (Figure **2-5**). When a power module is remotely mounted, the IPONI mounts directly to the back of the chassis.

2-3.2 LEFT REAR OF CHASSIS

The left rear of the chassis provides a port that will accept the D-sub female connector of either the self-powered or separate source power module (Figure **2-2**). Four sets of Form C Relay Output Contacts are also provided for control relay connections.

2-3.3 RIGHT REAR OF CHASSIS

CAUTION

EQUIPMENT DAMAGE COULD RESULT IF EXTERNAL VOLTAGE IS APPLIED TO TERMINALS 19-25.

The right rear of the chassis provides a port that will accept the D-sub male connector of the optional Communication Module (IPONI) (Figure **2-2**). Located just above the communication port is an integral fuse unit to control the power to the Analog Outputs and protect against possible unit damage from an externally applied voltage. Three sets of dry contacts for discrete remote inputs are provided. An open contact registers as INACTIVE in the display while a closed contact registers as ACTIVE. Just above the discrete input contacts are

Figure 2-3 Separate Source Power Module (Shown Mounted)

Figure 2-4 Self-Powered Three Phase Power Module (Unmounted)

Analog I/O contacts. Output contacts #19, #20 and #21 are programmable. Contacts #22 and #23 are internally the same and provide additional access since each can only accommodate two wires. Input contact #24 can sense 0-20 mA from a transducer, for example.

2-4 EXTERNAL HARDWARE

External hardware is defined as any required potential transformers, current transformers, power supply modules or communication modules. Power supply modules and communication modules are defined as external devices, even though they are usually directly mounted on the back of the IQ Analyzer.

2-4.1 CURRENT TRANSFORMERS

Each IQ Analyzer requires that at least two external current transformers be wired into the CT input terminal block (Paragraph 2-3.1, Figures **4-7** and **4-8**). Inputs are 5 amperes nominal or up to 40 amperes continuous. Current transformers are supplied by the user and should be Instrumentation Class.

2-4.2 POTENTIAL TRANSFORMERS

Potential transformers are required when the line voltage is above 600 volts line-to-line. They are wired directly to the ac line connection terminals (Figures **4-7** and **4-8**). Potential transformers are also the user's responsibility. Refer to potential transformers in the Glossary before programming, even if potential transformers are not used in the system.

2-4.3 POWER SUPPLY MODULES

WARNING

NEVER WORK WITH POWER SUPPLY MODULES WHEN AC LINE POWER IS APPLIED TO THE IQ ANALYZER. PERSONAL INJURY OR DEATH COULD RESULT.

A standard 3-phase self-powered power module or an optional separate source power module is shipped from the factory mounted to the back of the IQ Analyzer. Two

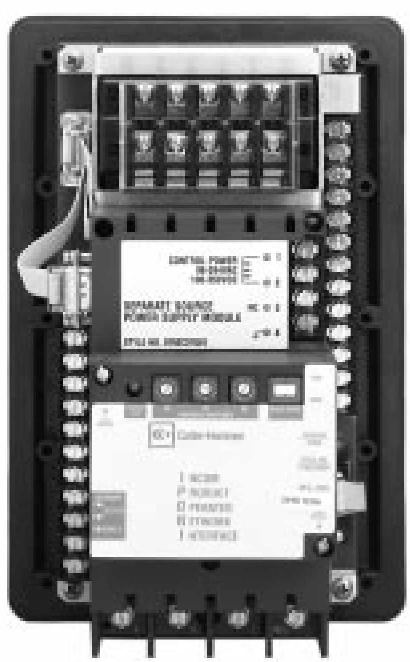

*Figure 2-5 Communication Module - **IPONI** - (Mounted)*

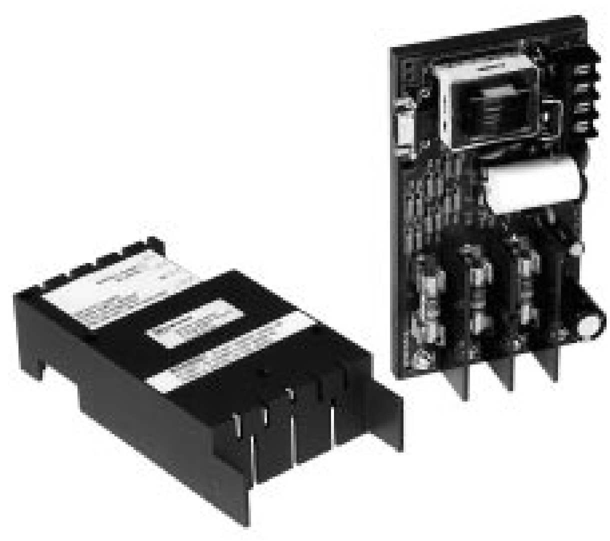

Figure 2-6 Separate Source Power Module with Back Cover Removed

stacking screws secure the power module in position (Figure **2-3**). Power modules can be detached and mounted remotely up to 36 inches from the IQ Analyzer through the use of an optional extension cable (IQACABLE). This may be required if local codes prohibit ac power devices from being located on a panel door. Power modules utilize a D-sub female connector to plug into a power port located on the left rear side of the chassis (Figure **2-2**). The cable also unplugs from the power module to permit the installation of an extension cable.

Each power module is supplied with 3 line fuses internal to the power module (Figure **2-6**). The fuses are accessed by removing the screws holding the cover in place. Fuse replacement should only be done with all voltages removed from the IQ Analyzer.

A terminal board, located on the lower rear portion of each power module, provides sensing inputs for the 3-phase voltage being monitored. The inputs are identified from left to right as A, B, C and Neutral (Figures **4-7** and **4-8**). On up to 600 volt systems, direct input can be applied. For systems greater than 600 volts, potential transformers are required.

The separate source power module is supplied with a power input terminal block located in the upper right portion of the power module (Figure **2-3**). Standard self-powered power modules do not require this terminal block input.

2-4.4 COMMUNICATION MODULE (IPONI)

Communications is made possible by mounting a small, addressable communication module (IPONI) to the back of the IQ Analyzer (Figure **2-5**). The Communication Module can be mounted directly to the back of the IQ Analyzer or to a Power Module already mounted on the IQ Analyzer. Since the IQ Analyzer is always supplied with a communications port, the IPONI can be easily retrofitted to the IQ Analyzer at any time. Addresses and BAUD Rates are established on the IPONI itself. Refer to the instruction details supplied with the IPONI for details. The IPONI Module **may be connected to or disconnected** from the IQ Analyzer under power **without risk of damage** to either product.

2-5 SPECIFICATION SUMMARY

Refer to Table **2.1**.

Table 2.1 IQ Analyzer Specifications and Details Summary (continued on next page)

IQ ANALYZER DIMENSIONS:	
Overall Depth	4.70 inches
Overall Height	10.25 inches
Overall Width	6.72 inches
IQ ANALYZER WEIGHT:	6 pounds
TERMINALS:	
Wire Size	# 12 - 22 AWG
Screw Size	# 6-32
Torque	8 - 10 in-lbs
CERTIFICATION;	
ISO:	Manufactured in an ISO9002 certified facility
UL/cUL:	Listed UL-508, File E62791, NKCR Auxiliary Devices
NEMA:	1 (3R and 12 when gasketed)
FCC:	Part 15, Class A
CISPR-11:	Class A
Measurement Canada:	Electricity Meter, Approval # AE-0782
CE:	Units marked with CE comply with IEC1010-1 (1990) incl. Amend 1 & 2 (1995) EN61010-1 (1993), CSA C22.2 #1010.1 (1992) and EN50082-2 (1994)

Table 2.1 IQ Analyzer Specifications and Details Summary (continued on next page)

CURRENT INPUTS (Each Channel):

Conversion:	True rms, 32 sample/cycle (all samples used in all rms calculations)
CT Input:	5 Amp secondary (any integer 5:5 to 10,000:5)
Burden:	0.05 VA
Overload Withstand:	40 Amps ac continuous, 300 Amps 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
Wiring	14 AWG (larger wire requires appropriate terminals)

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 635 (separate source only) Vac
Nominal Full Scale Voltage:	120 - 600 Vac (120 - 440 Vac IQA6020/IQA6220)
Burden:	21 VA (self-powered only)
Overload Withstand:	635 Vac continuous, 700 Vac 1 second
Input Impedance:	1 megohm
Wiring	12 AWG to 22 AWG ②
Transient Overvoltage	Category-III

CONTROL POWER INPUT (Separate Source and Self Powered):

	Separate Source	Self Powered ①	DC Source
Input Range:	110-220 Vac +/- 10% 45 - 66 Hz 110 - 250 Vdc +/- 10%	110-600 Vac +/- 10% 45 - 66 Hz	24-48 Vdc +/- 20%
Burden:	21 VA	21 VA	21 VA
Wiring	12 AWG to 22 AWG ②	12 AWG to 22 AWG ②	12 AWG to 22 AWG ②
Transient Overvoltage	Category-II	Category-III	Category-I

① *When directly wired to 480 Vac, IQ Analyzer can ride through a continuous sag that is 20% of rated voltage.*
② *Wire insulation must support line-to-line voltage per local codes.*

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%

Table 2.1 IQ Analyzer Specifications and Details Summary (continued on next page)

Current Accuracies at specific peak current limits:
±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: Starts recording with an average of 3 mA secondary current
Current: Starts recording at 0.55% of full scale (27 mA of secondary current)

ENVIRONMENTAL CONDITIONS:

Operating Temperature: -20° to 70° C
Storage Temperature: -30° to 85° C
Operating Humidity: 5 to 95% Relative Humidity (Non-condensing)
Altitude: 5000 m
Polution Degree: 2 (IEC 664)

DISCRETE INPUTS (Dry Contact):

+30 Vdc differential across each discrete input pair of terminals.
Minimum Pulse Width: 1.6 ms
Optically isolated inputs to protect IQ Analyzer circuitry.
Withstand Rating: 120 Vac

ANALOG OUTPUTS:

0 to 20m A / 4 to 20 mA into max. 750 ohm load
Accuracy: 1%
Resolution: 0.25%
Withstand Rating: 120Vac
Wiring Shielded twisted pair cable, Belden 9486 or equiv.

ANALOG INPUTS:

0 to 20 mA / 4 to 20 mA into 200 ohm load (0 to 5 V with external 50 Ω series resistance)
Accuracy: 1%
Resolution: 1%
Withstand Rating: 5 Vdc
Wiring Shielded twisted pair cable, Belden 9486 or equiv.

RELAY OUTPUT CONTACTS:

Pulse initiator (any system power), load shed (any system demand), event trigger, discrete input or IMPACC control

Loading	Voltage	Carry (constant)	Make (50 ms)	Break
Resistive (PF = 1.0)	120 Vac	10 A	50 A	10 A
	250 Vac	10 A	30 A	10 A
	30 Vdc	10 A	30 A	10 A
	60 Vdc	10 A	30 A	1 A
	110 Vdc	10 A	30 A	0.5 A
	250 Vdc	10 A	30 A	0 A
Inductive (PF = 0.4)	120 Vac	10 A	43 A	7 A
	240 Vac	10 A	21 A	7 A

Minimum Pulse Width: 4 cycles (68 ms)
Withstand Rating: 1000 Vac (across contacts, 1 minute)
5000 Vac (contacts to coil, 1 minute)
10,000 Vac (contacts to coil, surge voltage)

Table 2.1 IQ Analyzer Specifications and Details Summary (continued on next page)

MEASURED VALUES ①

Parameter	Accuracy	Range	Time & Date Stamped
Current	0.2%	0 to 800% of CT	Per phase min/max
Voltage	0.2%	0 to 150% of PT	Per phase min/max
watts	0.4% 0.4% of reading 2 % of reading	0-80000MW (PF = 1; 3%-300% of full scale) (PF = ±0.5; 3%-300% of full scale)	Per phase and system min/max
vars	0.4% 2% of reading	0-80000Mvar (PF = ±0.5; 3%-300% of full scale)	Per phase and system min/max
VA	0.4% 0.4% of reading	0-80000MVA (PF = ±0.5; 3%-300% of full scale)	Per phase and system min/max
kWh		999,999,999 kWh	
MWh		999,999,999 Mwh	
kvarh		999,999,999 kvarh	
Mvarh		999,999,999 Mvarh	
kVAh		999,999,999 kVAh	
MVAh		999,999,999 MVAh	
amp demand	0.2%	0 to 800% of CT	Per phase system maximum demand
watt demand	0.4%	0-80000MW	Maximum demand
var demand	0.4%	0-80000Mvar	Maximum demand
VA demand	0.4	0-80000MVA	Maximum demand
Displacement Power Factor (isolates fundamental components)	1%	-.01 to 1 to +.01 and 0	Per phase and system min/max
Apparent Power Factor (includes harmonic components)	1%	-.01 to 1 to +.01 and 0	Per phase and system min/max
Frequency	0.01Hz	20.00 to 70.00Hz	min/max
% amps THD	1.5%	0-9999%	Per phase min/max
Magnitude amps THD	1.5%	0-80000A	Per phase min/max
% volts THD	1.5%	0-600%	Per phase min/max
Magnitude volts THD	1.5%	0-500000V	Per phase min/max
K-factor (during event)	0.5%	0-1.000	Event only
Crest Factor (largest of per-phase values)	0.2%	1.000-3.000	
THDF (CBEMA) (smallest of per-phase values)	0.2%	0-1.414	
Time	10ms resolution	(synchronized via IMPACC with entire system)	
Phase Angle	0.5 degrees	0-360 degrees	Event Only

① *All accuracies as % full scale unless noted otherwise*

Table 2.1 IQ Analyzer Specifications and Details Summary (continued on next page)

EVENT TRIGGERS ①

# of Selections	Trigger	Description
2	2	Undervoltage - any V_{LL}, V_{LN} (40-100% of PT primary line-to-line)
2	4	Overvoltage - any V_{LL}, V_{LN} (100-750% of PT primary line-to-line)
1	5	Interruption - any V_{LN} (transient trigger only available in the IQA-6200 series)
1	6	Excess dV/dt - any V_{LN} (transient trigger only available in the IQA-6200 series)
26	7-32	Maximum %THD or magnitude THD - any current, any V_{LL}, any V_{LN}, Ia, Ib, Ic, In, Van, Vbn, Vcn, Vab, Vbc, Vca
7	33-39	Maximum Demand - Ia, Ib, Ic, In, system watts, system vars, system VA
5	40-44	Maximum Current - Ia, Ib, Ic, In, Ig
7	45-51	Maximum Voltage - Van, Vbn, Vcn, Vab, Vbc, Vca, Vng
3	52-54	Maximum Power - system watts, system vars, system VA
2	55-56	Maximum Power Factor - (smallest '+' or largest '-') - system displacement, system apparent
3	57-59	Minimum Current - Ia, Ib, Ic
6	60-65	Minimum Voltage - Van, Vbn, Vcn, Vab, Vbc, Vca
3	66-68	Minimum Power - system watts, system vars, system VA
2	69-70	Minimum Power Factor (smallest '-' or largest '+') - system displacement, system apparent
3	71-73	Frequency - high, low, high/low
2	74-75	Voltage Unbalance - V_{LL}, V_{LN} (as % of average)
1	76	Current Unbalance (as % of average)
3	77-79	Discrete Inputs - Input 1, Input 2, Input 3
5	80-84	Min/Max Update - any combination of min/max current, min/max voltage, min/max power factor, min/max power/freq., or min/max THD
2	85-86	Manual - local or via IMPACC

① *Each of the 7 triggers may be programmed to any of 86 selections*

Table 2.1 IQ Analyzer Specifications and Details Summary (continued on next page)

UPDATE TIMES

Parameter	Time	Comments
Voltage	2 cycles	
Current	8 cycles	
Power	8 cycles	
Energy	8 cycles	
Demand	1-60 min	Programmed or Sync Demand Windows
Power factor	8 cycles	Currents less than 0.05% are ignored
Frequency	8 cycles	Measured each cycle digital filtered with 1s time-constant
THD	8 cycles/ parameter	Parameters: Ia, Ib, Ic, In, Van, Vbn, Vcn, Vab, Vbc, Vca
K-Factor	Of Event	Ka, Kb, Kc K-factor in IMPACC and event data it is the largest of Ka, Kb, Kc
Crest Factor and CBEMA THDF	8 cycles	Largest of Ia, Ib, and Ic crest factors. Currents less than 0.05% are ignored
Discrete Inputs	2 cycles	Dry Contact
Relay Outputs	2 cycles	Plus 15ms (energize), 5ms (de-energize)
Analog Input	8 cycles	
Analog Outputs	8 cycles	
Large Display Text	0.7s per parameter	e.g., a screen with Ia, Ib, and Ic updates in 2.1 seconds
Small Display Text	0.7s per screen	e.g., each 7 parameter custom screen updates in 0.7 seconds
Event Trigger Checks	2 cycles	Note that while triggers are checked every 2 cycles, the actual time depends upon the specified trigger. Those triggers based upon voltage, discrete inputs, or manual/IMPACC update in 2 cycles while others update in 8 or more cycles.

Table 2.1 IQ Analyzer Specifications and Details Summary (continued on next page)

QUALIFICATION TESTS

Dielectric Strength:	2.3kV for 1 minute to Relays, CTs, PTs, power supply
Transients:	ANSI C37.90 Oscillatory 2.5kV/1MHz, Fast Rise 5kV/10ns IEC801-4/EN61000-4-4, 2kV, 5ns rise for 50ns, 5kHz repetition
Dips and Interruptions:	EN61000-4-11 voltage shift at zero crossing
ESD:	IEC801-2/EN61000-4-2, 4kV to terminals, 8kV to faceplate
RFI/EMI:	UL991 10V/m ANSI C37.90.2, 150Mhz and 450Mhz, 10V/m IEC801-3/EN50140 10V/m, EN50204 10V/m IEC801-6/EN50141 10V IEC801-8/EN61000-4-8 30A/m
Surge:	IEC801-5/EN61000-4-5, 4kV common mode 1.2 us rise for 50 us

IQ ANALYZER PARAMETER EQUATIONS

Basic Metering —

(The “fundamental period” is the time for a single cycle leg, 1/60 sec.)

(T1 = time between samples [e.g. $\frac{1000}{60 \times 12}$ = .1302 ms])

If “T1” is the time between samples, then j*T1 = “time = t”, where j = 0,1,2,…,K.

x(j) is the value of function x(t) at a time = j*T1.

v(j) is the value of voltage v(t) at a time = j*T1.

i(j) is the value of current i(t) at a time = j*T1.

Calculation of RMS current and voltage: X = rms value of x(t) = $\sqrt{1/[K + 1] * \sum_{j=0}^{K} \{[x(j)]^2\}}$.

Calculation of watts: WATT = $1/[K + 1] * \sum_{j=0}^{K} \{v(j) * i(j)\}$.

Calculation of VARs: VAR = $1/[K + 1] * \sum_{j=0}^{K} \{v(j + m) * i(j)\}$,

where m = number of samples in “fundamental period”/4.
This is the fundamental “reactive” power.

Calculation of VA: VA = Vrms * Irms (This includes the effects of harmonics).

Calculation of displacement power factor:

PF displacement = WATT/ $\sqrt{[WATT^2 + VAR^2]}$. (60 Hz components for use in power factor correction calculations)

Calculation of apparent power factor: PF apparent = WATT/VA. (includes harmonics)

Table 2.1 IQ Analyzer Specifications and Details Summary

Power Quality —

Calculation of percent THD:

$$\%THD\ x(t) = 100 * \sqrt{\{x_2^2 + x_3^2 + x_4^2 + \dots x_n^2\} / x_1}$$

where n is the highest harmonic number used.

Calculation of crest factor: CF = [peak value of x(t)]/[rms value of x(t)].
THDF (Transformer Harmonic Derating Factor) CBEMA = $\sqrt{2}$/CF

Calculation of "K-factor" (IEEE C57.110-1968):

$$\text{K-factor} = \frac{\sum_{n=1}^{m} h_n^2 (I_n/I_1)^2}{\sum_{n=1}^{m} (I_n/I_1)^2}$$

where: h_n is harmonic number = "n", In is the current of harmonic "n",
I_1 is the first harmonic current (n = 1),
m is the highest harmonic number used.

Calculation of Fourier coefficients:

$$F(n) = \sqrt{[Fsine(n)]^2 + [Fcosine(n)]^2}$$

$$Fsine(n) = 2/[K + 1] * \sum_{j=0}^{K} \{sin[n*w*j*T1] * x(j)\}$$

$$Fcosine(n) = 2/[K + 1] * \sum_{j=0}^{K} \{cosine[n*w*j*T1] * x(j)\}$$

where: n = harmonic number, w = 2*PI*(fundamental freq)
and the sampling is done over an integral number of cycles.

POWER MODULE FUSE:	BUSS KTK-R-3/4 or equivalent (three phase power module) Littelfuse GDB-500mA, or equivalent 5 x 20 mm
I/O FUSE:	Littelfuse Plug-In Microfuse, Catalog # 273.250, 0.25A, 125V or equivalent