# E MAX Test Descriptions On-Line Testing

Demands in today's industry require motors to run as often as possible. Most proactive companies want to employ predictive maintenance practices on their motors. However, this valuable act can be a double-edged sword-important to do, but often requiring the motor to be shut down for access. Finally, there is monitoring equipment available that gives you the best of both worlds. EMAX, from PdMA Corporation, is a portable dynamic tester that evaluates electrical motor condition without shutting down your process.
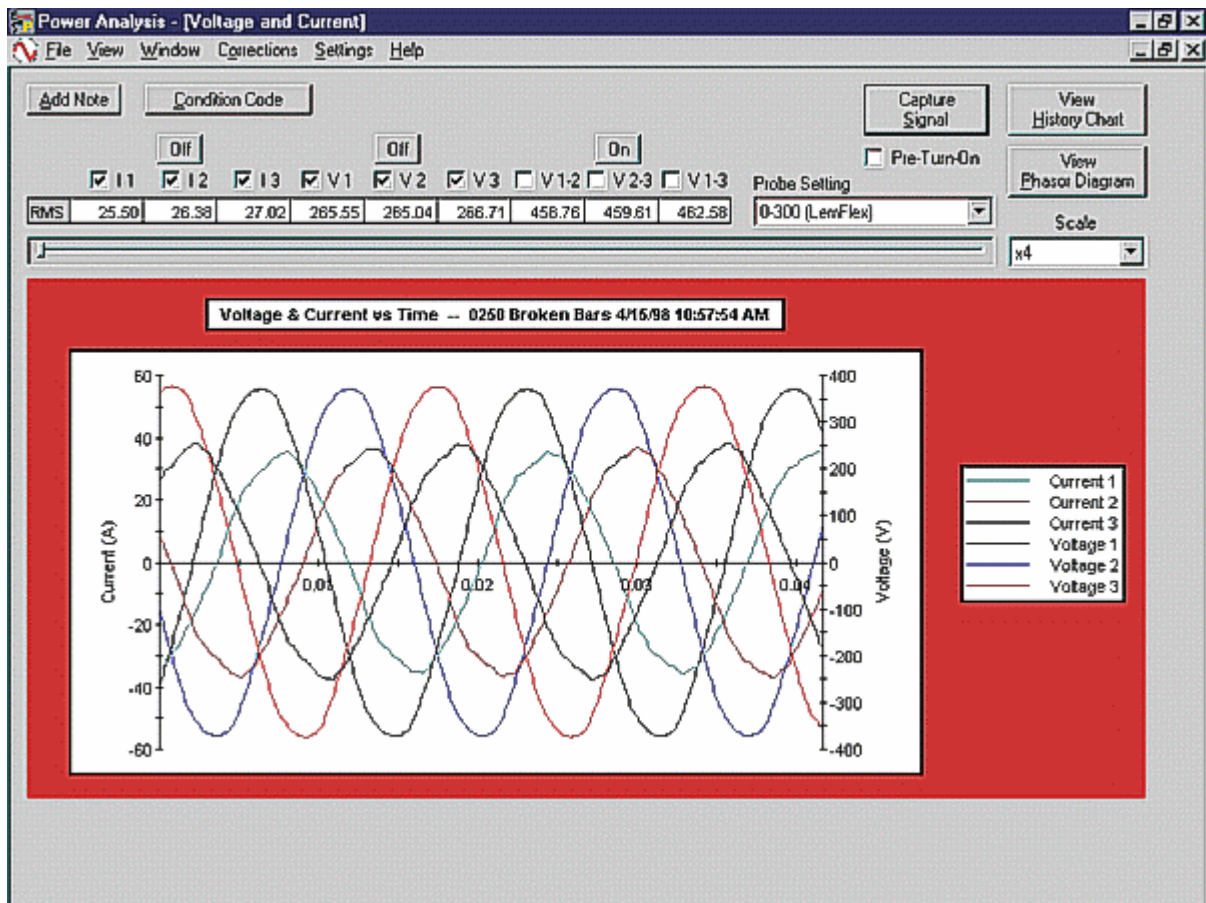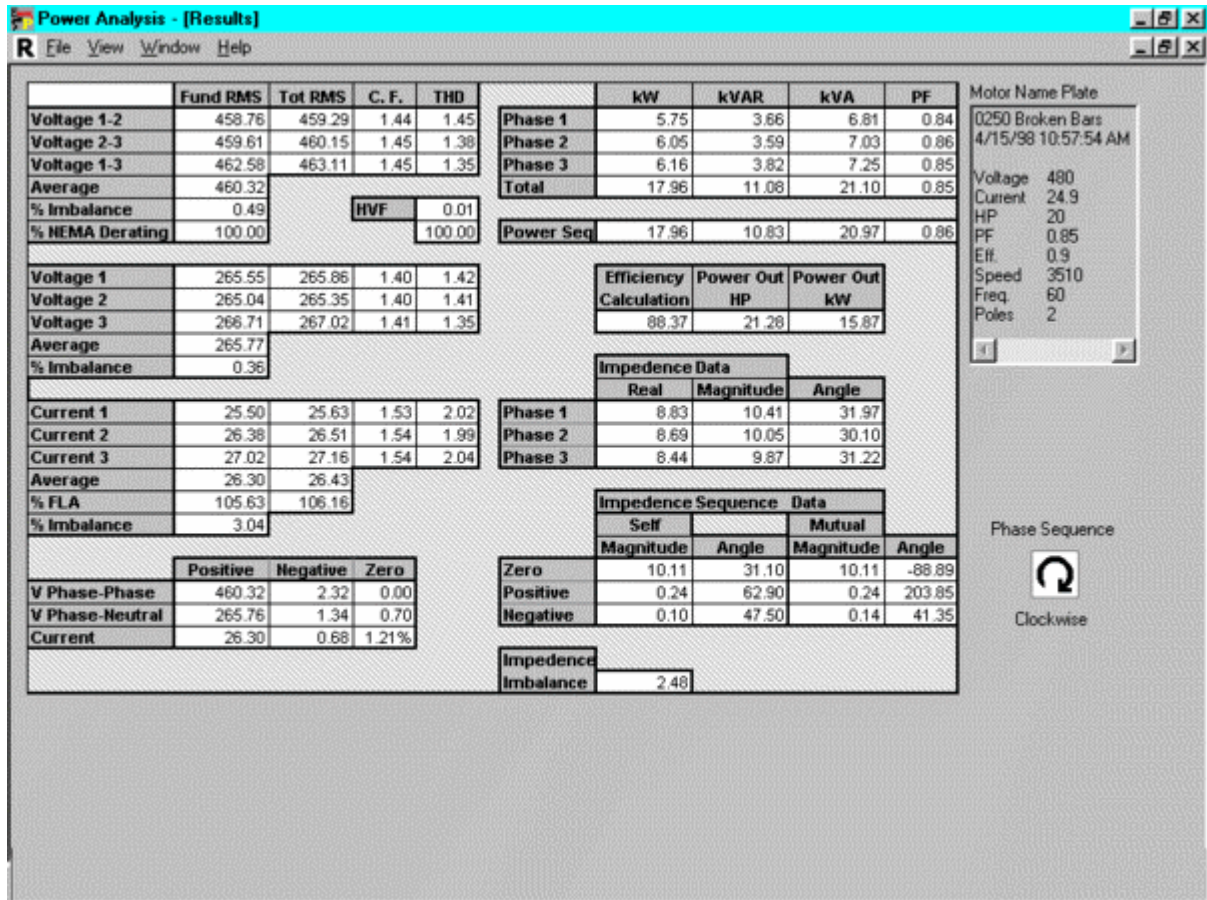

The power analysis portion of the equipment provides valuable insight into incoming power quality, power circuit condition, stator health and motor efficiency. The three phase current and voltage signal is captured in less than a minute and stored for diagnostics and trending.

Utilizing a combination of unbalance parameters and harmonic analysis, EMAX examines the power signal for indications of defects within the different fault zones. Power quality is diagnosed using total harmonic distortion (THD) and crest factor (CF) calculations. Distortion in the signal, often the result of nonlinear loads, produces additional heat within the motor that will reduce life if not acted upon.

The power circuit and stator are evaluated through the use of unbalance parameters and sequence data. Unlike the positive sequence currents that produce useful torque, negative sequence currents are caused by high

resistive connections within the motor or circuit and generate heat-producing counter torque. Rising negative sequence currents coupled with a high impedance imbalance is indicative of developing stator faults.

R File View Window Help

	Fund RMS	Tot RMS	C. F.	THD
Voltage 1-2	458.76	459.29	1.44	1.45
Voltage 2-3	459.61	460.15	1.45	1.38
Voltage 1-3	462.58	463.11	1.45	1.35
Average	460.32			
% Imbalance	0.49		HVF	0.01
% NEMA Derating	100.00			100.00

	Fund RMS	Tot RMS	C. F.	THD
Voltage 1	265.55	265.86	1.40	1.42
Voltage 2	265.04	265.35	1.40	1.41
Voltage 3	266.71	267.02	1.41	1.35
Average	265.77			
% Imbalance	0.36			

	Fund RMS	Tot RMS	C. F.	THD
Current 1	25.50	25.63	1.53	2.02
Current 2	26.38	26.51	1.54	1.99
Current 3	27.02	27.16	1.54	2.04
Average	26.30	26.43		
% FLA	105.63	106.16		
% Imbalance	3.04			

	Positive	Negative	Zero
V Phase-Phase	460.32	2.32	0.00
V Phase-Neutral	265.76	1.34	0.70
Current	26.30	0.68	1.21%

	kW	kVAR	kVA	PF
Phase 1	5.75	3.66	6.81	0.84
Phase 2	6.05	3.59	7.03	0.86
Phase 3	6.16	3.82	7.25	0.85
Total	17.96	11.08	21.10	0.85
Power Seq	17.96	10.83	20.97	0.86

Efficiency Calculation	Power Out HP	Power Out kW
88.37	21.28	15.87

Impedence Data

	Real	Magnitude	Angle
Phase 1	8.83	10.41	31.97
Phase 2	8.69	10.05	30.10
Phase 3	8.44	9.87	31.22

Impedence Sequence Data

	Self Magnitude	Angle	Mutual Magnitude	Angle
Zero	10.11	31.10	10.11	-88.89
Positive	0.24	62.90	0.24	203.85
Negative	0.10	47.50	0.14	41.35

Impedence Imbalance	
	2.48

Motor Name Plate

0250 Broken Bars
4/15/98 10:57:54 AM

Voltage	480
Current	24.9
HP	20
PF	0.85
Eff.	0.9
Speed	3510
Freq.	60
Poles	2

Phase Sequence

Clockwise

Current analysis is performed through a combination of spectral graphs and software automation. Utilizing this portion of the equipment, the user can identify defects in the rotor and air gap fault zones and record motor startup.

Spectrum View

File Spectrum Functions Corrections Markers

High Res Spectrum (dB) -- 0240 Broken Bars 4/16/98 10:09:43 AM

Frequency (Hz) -- [Window Function - Hanning]

I 1

	Frequency	I 1
RMS Amps		12.94
%FLA		50.73
Cursor	58.887	-31.67
Peak dB Level	60.000	19.17

Speed (NP)	1750.00
Speed (RPM)	1783.30
Slip (%)	0.93

Scale x16

Snap to Peak
Find Peak   Tolerance 3

Alarm: I 1   I 2   I 3

Select Speed
+Table
+Label
+Both
Clear Table
Clear Labels
Clear Cursor

Motor Name Plate Info

0240 Broken Bars
4/16/98 10:09:43 AM

Voltage	480
Current	25.5
HP	20
PF	0.9
EFF	0.9
Speed	1750
Freq	60
Poles	4
Bars	26

Current is collected in one of three ways: high resolution, low resolution or eccentricity. Each uses different sampling rates and resolutions to identify anomalies in a specific fault zone. Rotor bar defects and eccentricity, static or dynamic can be detected and trended.

Startup, arguably the most stressful and informative time in motor operation, is recorded from start to finish. Graphing in-rush current and start-up time is extremely valuable when evaluating motor operation and condition. Changes in the startup characteristics can be attributed to rotor or stator faults.

Trending data is a critical element in any condition monitoring process. But, spotting motor trends is most effective if the data collected can be organized and viewed as quickly and efficiently as it's captured. EMAX generates valuable reports immediately after testing, enabling you to assess the condition of your motors in the field or trend the data for later use.

EMAX reports include a series of graphs, screen plots and historical comparisons. These reporting capabilities clearly illustrate the status of rotors, stators, power quality and other fault zones, allowing you to discover and evaluate possible problems before they result in lost productivity from forced downtime.

In addition, when combined with the MCE, the EMAX provides the most comprehensive condition analysis equipment available in a single package.

Finally, with the professionals at PdMA Corporation behind this product, you can always rely on our expertise and technical support. Call on us for assistance in maximizing your electrical reliability efforts.

Test Descriptions Off-Line Testing

STANDARD TEST

The MCE *Standard Test* is a 2 to 3 minute test which provides a comprehensive view of overall motor and circuit condition. High frequency AC and low voltage DC signals are transmitted through the circuit to collect the parameters utilized for diagnosis. Results are trended, compared to caution and alarm levels, and annotated in red or yellow to alert the user of potential problems.

Initially, lead checks are conducted to ensure accurate readings, preventing rust, dirt or other corrosive contact surfaces from adversely influencing test results. The parameters collected are discussed below.

History Chart for (0244 High Resistance)

File Summary View Graph Settings Notes Delete Test Condition Code

	04/16/1998	04/16/1998	04/16/1998	04/16/1998	04/16/1998
Test Date	04/16/1998	04/16/1998	04/16/1998	04/16/1998	04/16/1998
Test Time	01:48:32 PM	02:53:07 PM	03:06:50 PM	03:29:26 PM	04:06:40 PM
Frequency	1200	1200	1200	1200	1200
	BASELINE				
Mohm Ph 1 to Gnd					
Charge Time	30	30	30	30	30
Voltage	500	500	500	500	500
Motor Temp	20	40	40	20	40
Measured Mohm	0.0	0.0	0.0	0.0	>2000
Corrected Mohm	0.0	0.0	0.0	0.0	OVR
pF Ph 1 to Gnd	15000	15000	14750	14500	8000
ohm Ph 1 to 2	0.50900	1.18500	0.50050	0.53200	0.50800
ohm Ph 1 to 3	0.50250	0.50000	0.49450	0.62450	0.60850
ohm Ph 2 to 3	0.50400	1.18000	0.49450	0.52400	0.51250
mH Ph 1 to 2	10.900	10.900	10.620	10.730	10.680
mH Ph 1 to 3	10.820	10.790	10.470	10.660	10.860
mH Ph 2 to 3	10.670	10.670	9.935	10.750	10.720
Avg. Inductance	10.797	10.787	10.342	10.713	10.753
% Res. Imbalance	0.76	47.64	0.81	11.48	12.06
% Ind. Imbalance	1.17	1.08	3.93	0.50	0.99
$ Power Loss	4.48	473.06	4.14	69.40	69.40
Condition Code					Not Assigned
Test Location	N/A	N/A	N/A	N/A	N/A

- **Resistance-to-Ground** parameters are obtained with either 500 VDC or 1000 VDC in a standard unit. Potentials as low as 100 VDC and as large as 5000VDC are available with our new 5 kV Module. All readings are temperature corrected and standardized to ensure precise trending of insulation condition.

- **Capacitance-to-Ground** This parameter capitalizes on the natural capacitance of the motor and circuit to trend dirt and moisture build-up on the insulation. It is utilized in

combination of with the resistance-to-ground measurements to determine overall insulation condition.

- **Phase Resistance** Extremely accurate phase-to-phase resistance values on the micro-ohm level are recorded to determine the quality of connections in the circuit and motor itself. An imbalance figure is then calculated for ease of interpretation and trending. Stator faults, both turn-to-turn and phase-to-phase, may be detected using these parameters.

- **Phase Inductance** Once again, phase-to-phase inductance parameters are collected and an imbalance calculated to help determine rotor, stator and air gap health. Higher or escalating imbalances indicate the presence of an anomaly. Additionally, these parameters can be beneficial in identifying faulty capacitors within the circuit.

POLARIZATION INDEX (PI) AND DIELECTRIC ABSORPTION RATIO (DAR)

PI Test for Motor ID: CTSP 10, Test ID: 08/11/1998 11:08:11 AM

File

| Dielectric Absorption | 1.41 | Polarization Index | 2.69 | Motor Section | Stator |

Time	Megohm
5	316.00
10	489.00
15	660.00
20	740.00
25	840.00
30	920.00
35	1000.00
40	1100.00
45	1100.00
50	1200.00
55	1300.00
60	1300.00
65	1400.00
70	1400.00
75	1500.00
80	1500.00
85	1500.00
90	1600.00
95	1600.00
100	1700.00
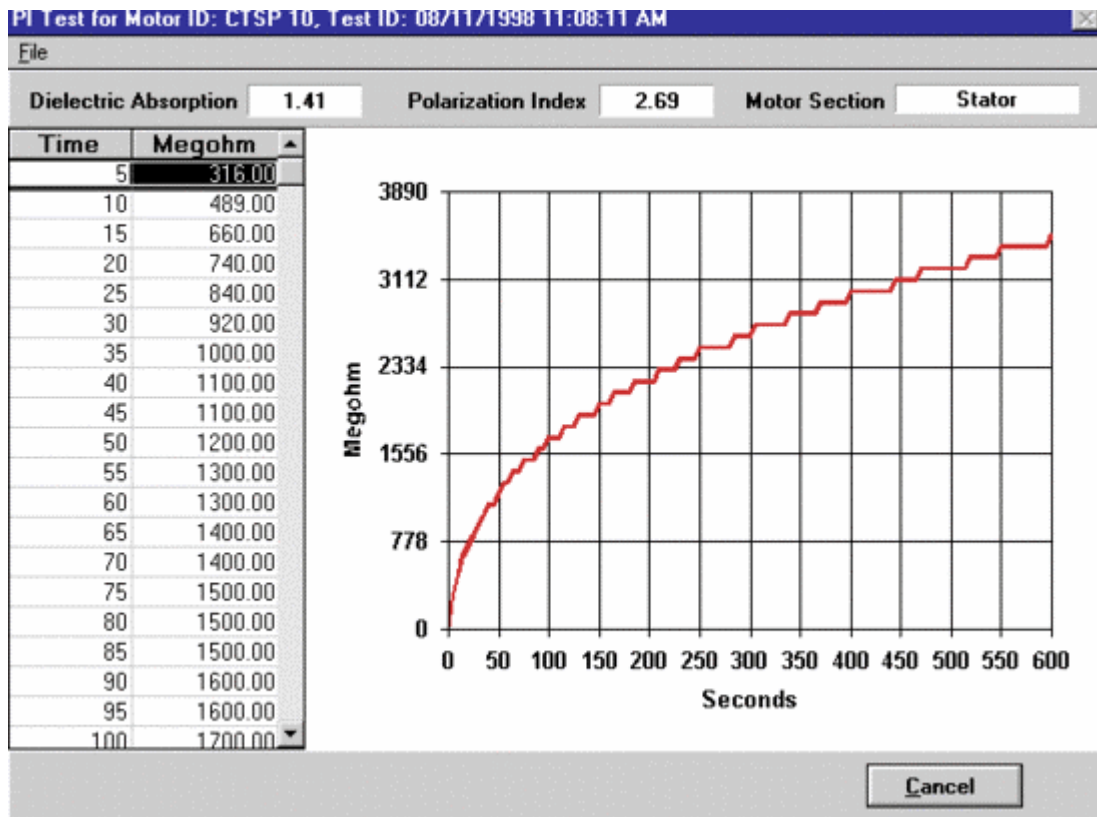
Utilizing detailed graphing and complete automation, the PI and DAR are used as advanced methods of evaluating insulation and can be highly effective at detecting the presence of contamination. Caution and alarm levels are set in accordance with IEEE specifications. The tests voltages selected are the same as those available for the Standard Test insulation-to-ground readings. The DAR applies a steady potential to the circuit for one minute, graphing results every 5 seconds and calculating a ratio of the reading at 60 seconds to that of 30

seconds. The Polarization Index (PI) is conducted in identical fashion, with the ratio calculated using the reading at 10 minutes compared to the one recorded at 1 minute.

ROTOR INFLUENCE CHECK (RIC)
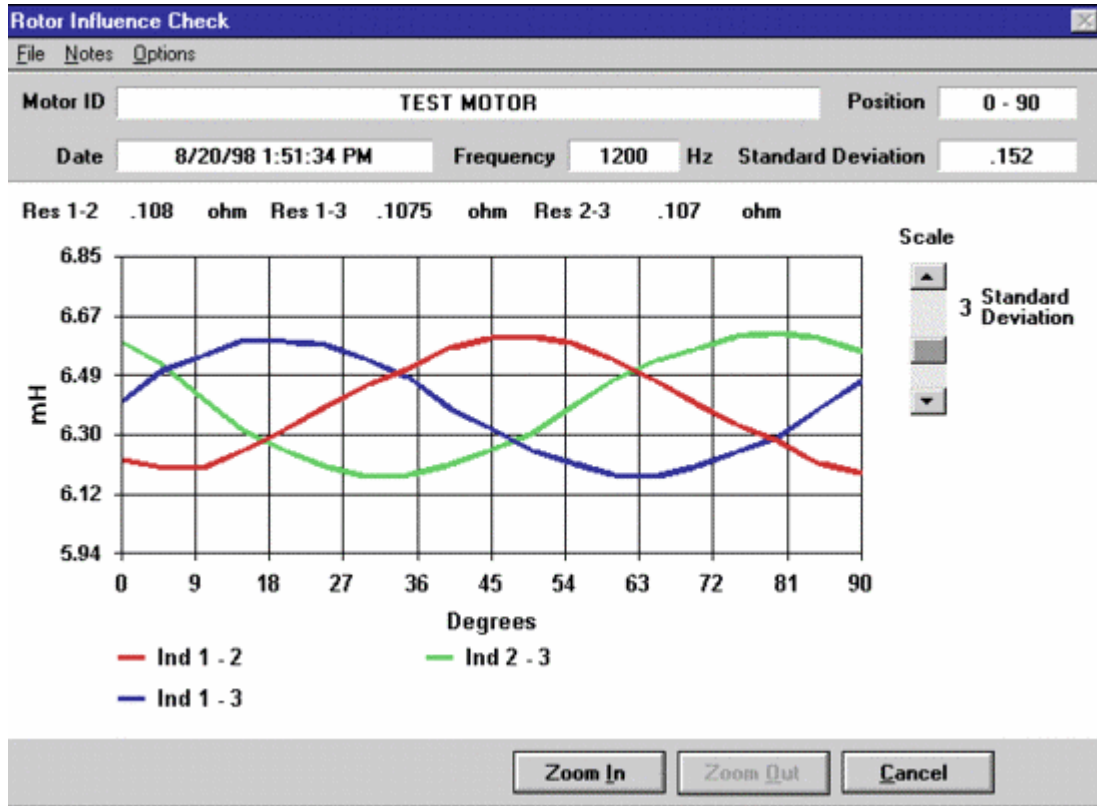
The RIC is a test that examines the relationship between the rotor and stator fields. The rotor is incrementally rotated through one pole face, recording phase inductance at each position. The generated patterns are combined with standard test results to confirm the presence of rotor, stator and air gap problems. The collected parameters are sensitive enough to detect excessive porosity in cast rotors, cracked or broken rotor bars, or other defective conditions.