

## MCE™ Product Information

### 5 kV Electric Motor Analyzer



- Portable and battery powered
- Monitors Power Circuit, Insulation, Stator, Rotor, and Air Gap
- Variable test voltage from 250 to 5000 V
- Automatic IR, PI, DAR, and Step Voltage Tests
- Measures insulation resistance to 3 T $\Omega$
- Precision resistance from 10 $\mu\Omega$  to 2000 $\Omega$  using 4-wire bridge test measurement
- Measures capacitance (pF) and inductance (mH)

### DESCRIPTION

The MCE™ Motor Circuit Evaluation test equipment offers the most versatile approach to troubleshooting and trending de-energized electric motors on the market today.

It is equipped with a fully functional laptop computer and loaded with MCEGold, the gold standard in motor management software.

With MCEGold the entire test history of your electric motor is at your fingertips and equipped with the latest in acceptance criteria from IEEE and NEMA. Red or Yellow color-coded alarms identify any test data that is outside the acceptance criteria immediately following the test.

The case is made of ultra high impact ABS material for ruggedness. It is easy to carry and no AC power is required, making tough to reach motors or starters easier to test.

#### Data Includes:

- Phase-to-phase Resistance
- Phase-to-phase Inductance
- Balance of Resistance
- Balance of Inductance
- Ground Capacitance
- Polarization Index
- Dielectric Absorption Ratio
- Measured Ground Resistance
- Corrected Ground Resistance
- Rotor Influence Check
- Field Inductance
- Field Resistance
- Field Capacitance
- Field Ground Resistance
- DC Armature Tests
- Synchronous Motor Tests
- Wound Rotor Motor Tests
- More...

**Ground resistance test voltages:**

250-5000 V in 50 V steps

Accuracy:

±2.5% 100 KΩ to 1 GΩ @500/2500v

±5% 10 KΩ to 100 GΩ @2500v

±5% 100 KΩ to 100 GΩ @5000v

±20% 100 GΩ to 3 TΩ (≥1000 V)

Short circuit/charge current: 2 mA

**Capacitance measurement:**

±5% 1000 to 999,750 pF

**Inductance measurement:**

±1% 100 to 1000 mH

±2% 1000 to 2500 mH

±5% 2500 to 5000 mH

**Resistance measurement:**

Accuracy/Range:

±1% 10 μΩ to 2000 Ω

Resolution

.00001Ω 0Ω to .02Ω

.0005Ω .02Ω to 2.0Ω

.005Ω 2.0Ω to 50Ω

.01Ω 50Ω to 1000Ω

.1Ω 1000Ω to 2000Ω

**Dimension:**

18.5x14.5x6 in. (46.99x36.83x15 cm)

**Weight:**

19 – 23 lbs (8.62 – 10.43 kg)

**Test Lead set:**

10 ft. (3.05 m.)

**Voltage input range:**

AC 100-240 V, 50/60 Hz (Computer)

**Environmental**

**Operating temperature:**

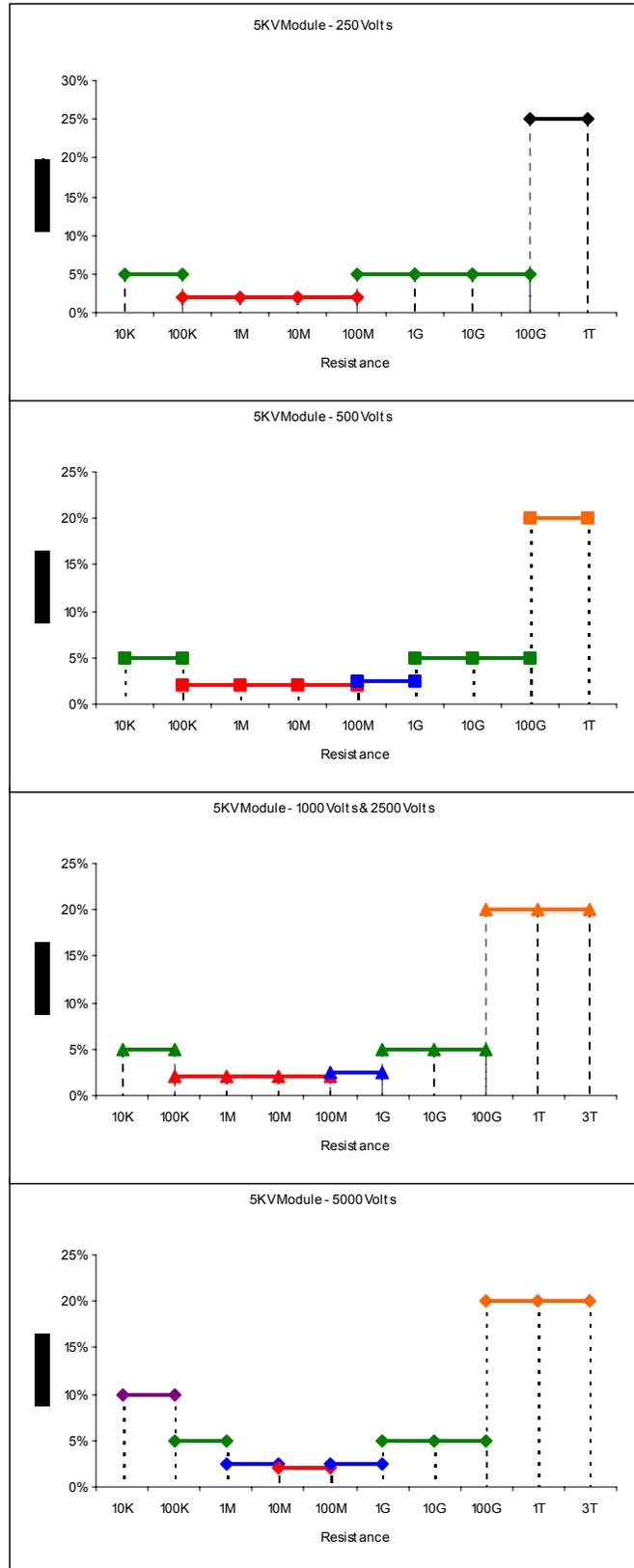
41°F to 95°F (5°C to 35°C)

**Storage temperature:**

-4°F to 104°F (-20°C to 40°C)

**Humidity:**

20% - 80% non-condensing



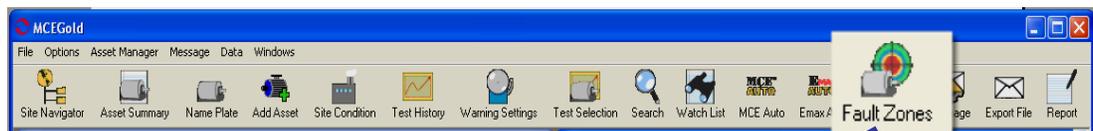
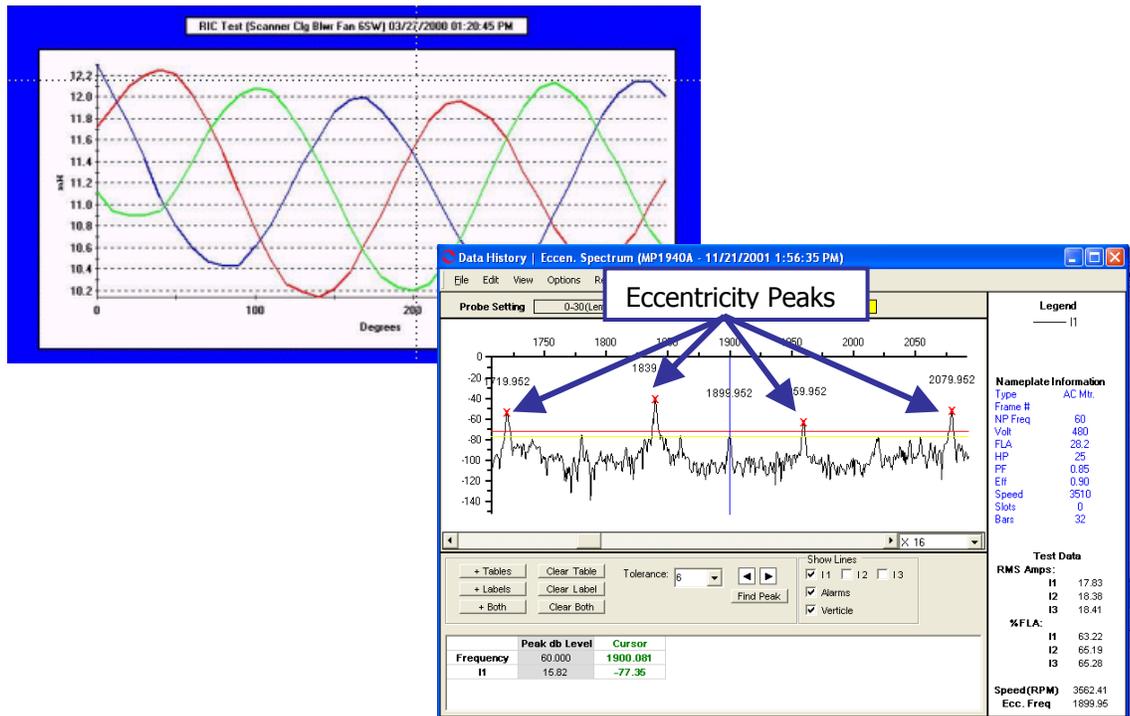
**ATTENTION** Accuracies and Resolutions are subject to change without notice.



# Fault Zone – Air Gap

The Air Gap fault zone describes the measurable distance between the rotor and stator within the motor. If this distance is not equal throughout the entire circumference air gap eccentricity occurs. The varying magnetic flux within the air gap creates imbalances in the current flow, which can be identified in the current spectrum.

Eccentricity analysis using the MCE Rotor Influence Check (RIC) test is most successfully applied in troubleshooting if pre-existing data is available so that trends can be observed. Eccentricity analysis using EMAX technology is performed through a high frequency spectrum of the current signal. If the number of rotor bars and the speed are known, the MCEGold™ software automatically places an (X) at the four peak locations which identify eccentricity.



The screenshot shows the 'Fault Zone Report' for MP1940A. The report is a table with columns for Fault Zone, Test Type, Date, and Condition Code. The report is divided into sections for Power Circuit, Power Quality, Insulation, Stator, Rotor, and Air Gap.

Fault Zone	Test Type	Date	Condition Code
Power Circuit	Voltage Imbalance (%)	0.05 7/21/2003 8:07:59 AM	Good
	Resistive Imbalance (%)	0.28 7/21/2003 12:07:35 PM	Good
	Voltage THD Ph-Ph (%)	0.41 7/21/2003 8:07:59 AM	Good
Power Quality	Current THD (%)	1.30 7/21/2003 8:07:59 AM	Good
	MWF (%)	0.00 7/21/2003 8:07:59 AM	Good
Insulation	RTG (Meg)	508.00 7/21/2003 12:07:35 PM	Severe
	PI	1.68 7/21/2003 12:30:22 PM	Severe
	CTG (pF)	31500.00 7/21/2003 12:07:35 PM	Severe
Stator	Imp. Imbalance (%)	1.80 7/21/2003 8:07:59 AM	Good
	Inductive Imbalance (%)	0.37 7/21/2003 12:07:35 PM	Good
Rotor	Pa Amplitude (Delta dB)	95.35 7/21/2003 8:16:32 AM	Severe
	Eccentricity		
Air Gap	Peak One (Delta dB)	20.40 7/21/2003 8:19:28 AM	Caution
	Peak Two (Delta dB)	1.49 7/21/2003 8:19:28 AM	Caution
	Peak Three (Delta dB)	19.14 7/21/2003 8:19:28 AM	Caution
	Peak Four (Delta dB)	36.28 7/21/2003 8:19:28 AM	Caution
RIC (Eccentricity)	False	7/21/2003 12:11:31 PM	Good

The MCEMAX powered by MCEGold™ provides a Fault Zone Report, which is a one-page summary of the test results relevant to the six fault zones. The Fault Zone Report may be reached directly through the Fault Zones icon on the toolbar.



# Fault Zone – Insulation

The Insulation fault zone refers to the condition of the insulation between the windings and ground. For electrical equipment to operate properly and safely, it is important that the flow of electricity take place along well-defined paths or circuits and that it not be leaking from one path to another. Deterioration of the insulation systems can result in an unsafe situation for personnel exposed to the leakage current

The MCE™ technology allows you to identify potential problems with the insulation by recognizing adverse trends in resistance to ground. After conducting a baseline test, all subsequent tests are compared to the initial data with significant changes in value highlighted in yellow for caution or red for alarm.

AC Standard	Polarization Index	RIC	Step Voltage
	A	B	C
Test Date	9/28/1996	3/23/1998	3/29/1999
Test Time	9:47:45 AM	9:11:11 AM	12:32:07 PM
Test Location	Motor Leads	Motor Leads	Motor Leads
User	Administrator	Administrator	Administrator
	Baseline		
Frequency	1200	1200	1200
Charge Time	30	30	30
Voltage	1000	1000	1000
Motor Temp	40	34	42
Measured Mohm	770.00	850.00	430.00
Corrected Mohm	770.00	505.00	490.00
mH Ph 1 to 2	1.975	1.990	1.980
mH Ph 1 to 3	1.985	1.995	1.985
mH Ph 2 to 3	1.970	1.985	1.965
Average Inductance	1.977	1.968	1.977
Imbalance	0.19	0.63	0.18
Imbalance	0.42		

VOLTAG	Fund RMS	Test RMS	C.F.	THD
Voltage 1-2	452.99	453.46	1.40	1.28
Voltage 2-3	0.09	0.10	5.12	34.48
Voltage 3-1	452.72	453.20	1.40	1.30
Average	301.93	302.25		
% Imbalance	99.97	99.97		

Trend degradation of insulation over time.

In an ungrounded voltage distribution system, the EMAX technology immediately assesses and displays any component on the distribution system that may be grounded.



Fault Zone	Test Type	Date	Condition Code
Power Circuit	Voltage Imbalance (%)	1.11	3/28/2002 11:27:57 AM
	Resistive Imbalance (%)	0	3/17/2003 11:08:51 PM
	Voltage THD Ph-Ph (%)	1.83	3/28/2002 11:27:57 AM
Power Quality	Current THD (%)	1.85	3/28/2002 11:27:57 AM
	HVF (%)	0.01	3/28/2002 11:27:57 AM
	Stator		
Insulation	RTG (Meg)	0.80	3/17/2003 11:08:51 PM
	PI	7.61	3/17/2003 11:22:00 PM
	CTG (pF)	18500.00	3/17/2003 11:08:51 PM
Stator	Imp. Imbalance (%)	0.38	3/28/2002 11:27:57 AM
	Inductive Imbalance (%)	0.20	3/17/2003 11:08:51 PM
	Rotor		
Air Gap	Fp Amplitude (Delta dB)	53.64	3/28/2002 11:39:30 AM
	Eccentricity		
	Peak One (Delta dB)	-9.36	3/28/2002 11:48:15 AM
	Peak Two (Delta dB)	9.93	3/28/2002 11:48:15 AM
	Peak Three (Delta dB)	28.80	3/28/2002 11:48:15 AM
Peak Four (Delta dB)	6.78	3/28/2002 11:48:15 AM	
RIC (Eccentricity)	Not Tested		

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# Fault Zone – Power Circuit

The power circuit refers to all of the conductors and connections that exist from the point at which the testing starts through to the connections at the motor. It can include circuit breakers, fuses, contactors, overloads, disconnects, and lug connections. Research on industrial power distribution systems has shown that connectors and conductors are the source of 46% of the faults reducing motor efficiency.

The MCEMAX powered by MCEGold™ provides a unique advantage to test the power circuit and all the associated components. Many times a motor, although initially in perfect health, is installed into a faulty power circuit. This causes problems like voltage imbalances, current imbalances, sequence currents, etc. As these problems become more severe, the horsepower rating of the motor drops, causing temperatures to increase and insulation damage to occur. It is important to evaluate the resistance and inductance of a motor circuit once a motor is installed for service. High imbalances of voltage, current, resistance, or inductance could indicate problems with the motor or power circuit. Identifying minor imbalances early will eliminate catastrophic failures and headaches later.

MCEGold [Todd - MCEGold - MCEGold\_Local] Testing [Test History - Aux Hyd 102 - 000003100702840 - 1124107698]

File Options Asset Manager Message Data Windows

Site Navigator Asset Summary Name Plate Add Asset Site Condition Test History Warning Settings Test Selection Search Watch List MCE

MCE

File Edit View Test Warning Settings Show/Hide Options

All Tests

AC Standard	Polarization Index	RIC	Step Voltage	A	B	C	D	F	I
Test Date	5/20/1996	3/23/1998	3/29/1999	5/23/2000	5/23/2000	1/23/2001			
Test Time	9:47:45 AM	9:11:11 AM	12:32:07 PM	9:40:29 AM	9:52:46 AM	12:00:37 PM			
Test Location	Motor Leads	Motor Leads	Motor Leads	Top Overloads	Top Overloads	Top Overloads			
User	Administrator	Administrator	Administrator	Administrator	Administrator	Administrator			
Baseline									
Frequency	1200	1200	1200	1200	1200	1200			
Charge Time	30	30	30	30	30	30			
Voltage	1000	1000	1000	1000	1000	1000			
Motor Temp	40	34	42	44	44	34			
Measured Motor	770.00	850.00	430.00	450.00	550.00	840.00			
Connected Motor	770.00								
pF Ph 1 to Ground	53000.00	53000.00	52750.00	51500.00	51250.00	50000.00			
ohm Ph 1 to 2	0.18900	0.18400	0.18950	0.20950	0.20150	0.18450			
ohm Ph 1 to 3	0.18750	0.18550	0.18900	0.18950	0.18650	0.18400			
ohm Ph 2 to 3	0.18750	0.18600	0.18950	0.20600	0.20050	0.18350			
net Ph 1 to 2	1.375	1.900	1.900	2.005	2.000	1.900			
% Res. Imbalance	0.18	0.63	0.18	3.64	3.09	0.27			
% Res. Imbalance	0.18	0.63	0.18	3.64	3.09	0.27			
% Ind. Imbalance	0.42	0.42	0.59	0.42	0.42	0.42			

Trend Phase-to Phase resistance over time. If an out of tolerance condition occurs MCEGold will alert you.

All three phases of current are calculated and displayed. You are immediately alerted to any over current or imbalance condition

Data History - Power Results (High Pressure Pump #3 - 4/22/2000 10:16:36 AM)

File Edit View Options Related Windows

Probe Setting: 0.100000m PFI0300 Condition Code: Good

WOL TYPE	Fund RMS	Vol RMS	C.F.	THD
Voltage 1-2	480.76	482.78	1.41	1.40
Voltage 2-3	480.95	482.96	1.42	1.41
Voltage 1-3	480.97	482.98	1.42	1.41
Average	480.89	482.91	1.41	1.40
% Imbalance	0.36	0.35	HVF	0.00
% NEMA Overload	100.00			100.00

CURRENT	Fund RMS	Vol RMS	C.F.	THD
Current 1	150.00	152.25	1.48	1.58
Current 2	162.10	163.93	1.46	2.12
Current 3	102.02	104.07	1.43	1.81
Average	138.04	140.08	1.45	1.80
% Imbalance	3.00	3.00		
% F.I.A.	100.99	101.12		

POWER	SW	KVAH	KVA	PF
Phase 1	20.24	22.59	41.43	0.86
Phase 2	42.08	22.74	45.34	0.88
Phase 3	40.09	22.74	45.34	0.88
Total	102.41	68.07	132.11	0.88
Power Temperature	122.40	67.96	140.09	0.88

EFFICIENCY	SW	KVAH	KVA	PF
Efficiency	20.24	22.59	41.43	0.86
HP Output	100.00	100.00	100.00	1.00
HP Input	100.00	100.00	100.00	1.00
Power Output	100.00	100.00	100.00	1.00

SEQUENCE	Phase	Angle	Phase	Angle
Voltage Ph. Ph	0	120	0	120
Voltage Ph. R	0	120	0	120
Current	0	120	0	120
Phase	0	120	0	120
Phase	0	120	0	120
Phase	0	120	0	120



MCEGold

File Options Asset Manager Message Data Windows

Site Navigator Asset Summary Name Plate Add Asset Site Condition Test History Warning Settings Test Selection Search Watch List MCE Auto Emax Fault Zones Page Export File Report

Fault Zone Report - 110671

File Edit Options

Condition Code: Caution

Fault Zone	Test Type	Date	Condition Code
Power Circuit	Voltage Imbalance (%)	Not Tested	
	Resistive Imbalance (%)	3.25	12/7/2005 2:20:22 PM
Power Quality	Current THD (%)	Not Tested	Not Tested
	Voltage THD Ph-Ph (%)	Not Tested	Not Tested
	CTG (pF)	64000.00	12/7/2005 2:20:22 PM
Insulation	Stator		
	RTG (Meg)	1800.00	12/7/2005 2:20:22 PM
	PI	3.49	12/7/2005 2:08:48 PM
	CTG (pF)	64000.00	12/7/2005 2:20:22 PM
Stator	Imp. Imbalance (%)	Not Tested	
	Inductive Imbalance (%)	14.07	12/7/2005 2:20:22 PM
Rotor	Fp Amplitude (Delta dB)	Not Tested	Not Tested
	Eccentricity	Not Tested	Not Tested
Air Gap	Peak One (Delta dB)	Not Tested	Insufficient Data
	Peak Two (Delta dB)	Not Tested	Insufficient Data
	Peak Three (Delta dB)	Not Tested	Insufficient Data
	Peak Four (Delta dB)	Not Tested	Insufficient Data
	RIC (Eccentricity)	False	12/7/2005 12:41:19 PM

Nameplate Information

Type	AC Hz
Frame B	60
HP Enc	400
VOL	500.0
FLA	300.0
HP	300.0
PS	0
CS	0
Speed	0
Slips	0

Last Updated: 8/16/2006 8:38:40 AM

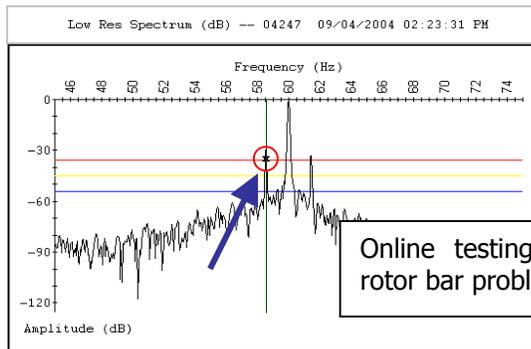
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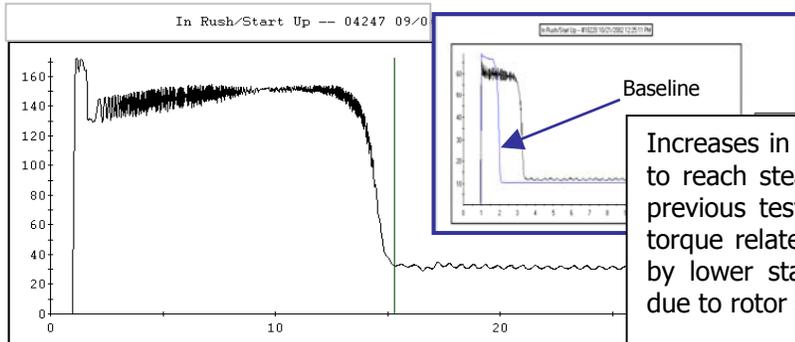
## Fault Zone – Rotor

Rotor health refers to the integrity of the rotor bars, rotor laminations, and end rings of the squirrel cage induction motors. In a joint study by EPRI and General Electric, rotor defects were estimated to be responsible for approximately 10% of the motor failures. The rotor, although responsible for only a small percentage of the motor problems, can influence other fault zones to fail.

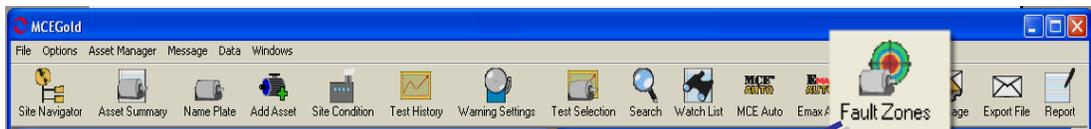
MCE™ motor circuit analysis uses inductance measurements taken from each phase of the stator windings and compares them at different rotor positions to further define the condition of the rotor. Advanced systems like EMAX provide simultaneous analysis of all three phases in its current signature analysis, which is an advantage over analyzing a single current. Using inductance measurements, current analysis, and other rotor testing technology provides the user with the ability to see very early changes in the magnetic signature of the rotor.



Online testing results indicate a severe rotor bar problem at 60% FLA.



Increases in the start-up time required to reach steady state as compared to previous tests are a result of load or torque related issues and are affected by lower start-up current and torque due to rotor defects or lower voltage.



Fault Zone	Test Type	Date	Condition Code	
Power Circuit	Voltage Imbalance (%)	0.39	4/19/2003 12:41:49 PM	Good
	Positive Imbalance (%)	0	4/19/2003 12:45:21 PM	Good
Power Quality	Voltage THD (%)	0.47	4/19/2003 12:41:49 PM	Good
	Current THD (%)	1.43	4/19/2003 12:41:49 PM	Good
Insulation	RTG (Mavg)	2100.00	4/19/2003 2:45:21 PM	Caution
	PS	1.25	4/19/2003 2:58:05 PM	Caution
Stator	CTG (gF)	185500.00	4/19/2003 2:45:21 PM	Good
	Imp. Imbalance (%)	1.18	4/19/2003 12:41:49 PM	Good
Rotor	Inductive Imbalance (%)	0.41	4/19/2003 12:45:21 PM	Good
	Ly Asymmetry (Delta dB)	32.22	4/19/2003 12:44:23 PM	Critical
	Eccentricity			
	Peak One (Delta dB)	-8.34	4/19/2003 12:49:35 PM	Insufficient Data
Air Gap	Peak Two (Delta dB)	1.00	4/19/2003 12:49:35 PM	Insufficient Data
	Peak Three (Delta dB)	-5.02	4/19/2003 12:49:35 PM	Insufficient Data
	Peak Four (Delta dB)	-13.32	4/19/2003 12:49:35 PM	Insufficient Data
	RIC (Eccentricity)	Not Tested		

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# Fault Zone – Stator

The stator fault zone is often considered one of the most controversial fault zones due to the significant challenge of early fault detection and the prevention of motor failure surrounding the stator windings. Stator windings are the heart of the motor, producing the rotating magnetic field, induction current, and torque to turn the rotor and shaft. This challenge is further intensified in higher voltage machines, where the fault-to-failure time frame becomes much shorter. The stator fault zone is identified as the health and quality of the insulation between the turns, coils, and phases within the slots and end turns of the electric motor.

Turn-to-turn or phase-to-phase shorts can be catastrophic to the motor and not necessarily be detected by the standard megohmmeter. Excessive inductive imbalance, resistive imbalance, vibration, partial discharge, or poor insulation quality can lead to stator failure and should be monitored regularly to prevent a shortened life of the electric motor stator. Stator analysis using EMAX technology is performed by evaluating the phase relationship of voltage and current for each of the three phases of an AC induction motor.

High current imbalance with a high impedance imbalance points to stator fault.

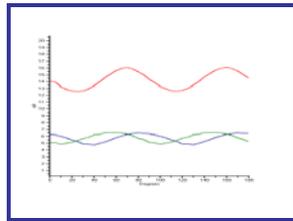
Phase	Real	Imaginate	Angle
Phase 1	1.6	10.6	89.4
Phase 2	3.76	10.66	89.4
Phase 3	2.11	10.66	81.99
% Imbalance			43.46

Stator	A	B	C
Measured Mohm	1900.00	> 2000	> 3006
Corrected Mohm	336.00	> 2000	> 3006
pF Ph 1 to 2	0.04550	0.14550	1.4850
pF Ph 1 to 3	0.04650	0.4450	1.4850
pF Ph 2 to 3	0.04600	1.14550	1.4850
mH Ph 1 to 2	4.250	14.000	1.070
mH Ph 1 to 3	5.145	6.265	2.85
mH Ph 2 to 3	4.200	9.030	65
Average Inductance	4.532	8.432	8.473
% Res. Imbalance	1.09	1.86	2.09
% Ind. Imbalance	13.53	66.04	66.05

% Resistive and Inductance Imbalance trending higher indicates a loss of turns.

What the RIC will look like.



Fault Zone Report | Back Wash Pump #1

Condition Code	Test Type	Date	Condition Code	
Power Circuit	Voltage Imbalance (%)	0.13	3/14/2008 5:10:41 PM	Good
Power Circuit	Phase Inductance (%)	0.29	3/14/2008 4:37:20 PM	Good
Power Quality	Voltage THD Ph-Ph (%)	1.31	3/14/2008 5:10:41 PM	Good
Power Quality	Current THD (%)	1.54	3/14/2008 5:10:41 PM	Good
Power Quality	kVAF (%)	0.01	3/14/2008 5:10:41 PM	Good
Insulation	RTG (Mg)	191.00	3/14/2008 4:37:20 PM	Good
Insulation	PI	2.13	3/14/2008 4:37:20 PM	Good
Insulation	CTG (gF)	79000.00	3/14/2008 4:37:20 PM	Good
Stator	Imp. Imbalance (%)	43.46	3/14/2008 5:10:41 PM	Severe
Stator	Inductive Imbalance (%)	26.56	3/14/2008 4:37:20 PM	Severe
Rotor	F <sub>a</sub> Amplitude (Delta dB)	69.29	3/14/2008 5:09:10 PM	Good
Air Gap	Eccentricity			Not Tested
Air Gap	Peak One (Delta dB)			Not Tested
Air Gap	Peak Two (Delta dB)			Not Tested
Air Gap	Peak Three (Delta dB)			Not Tested
Air Gap	Peak Four (Delta dB)			Not Tested
Air Gap	RIC @ (center)			Not Tested

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