7SG164 Ohmega 400 Series

Distance Protection Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02	Document reformat due to rebrand

Contents

1 Introduction

The following document defines the technical and performance specification of the standard features in this series of relays. Optional features are described in the last part of the document.

Performance Data to:
IEC60255-6, IEC60255-6A and IEC60255-16.

2 Technical Specification

2.1 Rated Current

Three possible current ratings can be obtained by programming the correct rating.
1, 2 or 5 Amps

2.2 Rated voltage

The relay requires a four wire voltage system, phase A, B, C & N
Rated voltage 63.5 Volts ac Phase - N

2.3 Rated Frequency

Two operating frequencies are available
Frequency - 50 or 60Hz

2.4 Characteristic Angle

The characteristic angle can be adjusted to suit any composition of line or cable circuit. This angle is used for all zones.
Angle - 0° - 90° in 5° steps

2.5 Zone impedance settings

Distance relays usually quote the boundary of performance in terms of SIR (System Impedance Ratio) plotted against the accuracy of the relay. This is a powerful method of describing the relays performance.

Adjustment of the positive sequence zone impedance is made by the menu selection. Each zone has the same setting range

Rating	Zone Range
1A	0.1-250 Ohm
2A	0.1-125 Ohm
5A	0.1-50 Ohm

Any zone is selectable within the setting range specified. Step sizes within the ranges are as follows:
0.1-10ohms - 0.01ohm step,
10-100ohms - 0.1ohm step,
100-250ohms - 1ohm step.
The protection provides the option of using the 5A (or 2A) tap on a 1A CT in order to attain a lower range.

2.6 Residual Compensation

The residual compensation applies to all zones.

Z_O/Z_1 0-10 in steps of 0.01
Z_O angle – 0 to 355° in steps of 5°

2.7 Zone 4 Settings

The zone 4 element is a reverse of zone one and has independent impedance settings with the same range as zone 1. The angle is a mirror image of the forward fault angle.

2.8 Voltage Memory

Under fault conditions the relay adds a replica of the positive sequence voltage to the polarising voltage of each comparator.
Voltage memory is applied for a maximum of 200ms, after which time the zone 1 and, where fitted, zone 4 comparators will be either inhibited from operating or have their operation latched until the fault is cleared.

2.9 Timers

2.9.1 Distance Function Zone Timers

Zone Timers (Z1T through Z4T)
0 to 10 s in steps of 10ms

2.9.2 Additional Timers

Timing functions for scheme operation and other protection functions are available. These are model specific and the relay setting section must be consulted for the individual timing range and step setting.

2.10 Measuring Elements

2.11 Zone 1 and Zone 2 elements

Both zone 1 and zone 2 have six measuring elements each. Three are for phase fault and three are for earth fault. Each element is independent giving the relay full scheme capabilities. The characteristic shapes available are circular polarised MHO for phase and earth fault and an option of quadrilateral characteristic for earth fault.

2.12 Zone 3 elements

Zone three has three phase fault phase fault elements and three earth fault elements The characteristic shapes available for both phase and earth fault are:-
Circular polarised MHO forward
Circular polarised MHO reverse
Circular offset MHO

Phase fault characteristics have the additional feature to allow for load encroachment and can be shaped.

An option of quadrilateral characteristic for earth fault is also available.

2.13 Zone 4 elements

This provides a reverse polarised MHO characteristic or E/F quadrilateral zone and is normally used in schemes which require reverse fault coverage or blocking schemes.

3 Additional Features

3.1 High Set Overcurrent

A High Set transient free overcurrent element is available this can be selectable to Instantaneous or Definite Time Lag (DTL). It has the following range of settings:-
0.1 – 6.0I_n in steps of 0.1
6.25 – 35I_n in steps of 0.25
0 – 1.0 s in steps of 0.001 s

3.2 Voltage Transformer Supervision (VTS)

Modes of operation:-
Alarm only
Alarm & inhibit
Inhibit can be selected to either block operation of phase & earth fault elements or to only block operation of earth fault elements during loss of voltage conditions.

VTS Ires level 0.05 – 2.0 I_n in steps of 0.1I_n
VTS Vres level 1 – 100V in steps of 1V

Output configuration:-

Instantaneous operation/reset
Minimum delayed alarm 100ms
Delayed alarm/reset 0.1 – 60s

3.3 Switch On To Fault

Two arrangements provide instantaneous tripping when switching on to a bolted three-phase fault.
a) D.C. Line check
This arrangement is energised from the circuit breaker closing circuit and allows instantaneous zone 3 coverage for a period of 400ms after energising the line.

b) A.C. Line check
This arrangement is not dependant on the circuit breaker closing circuit and allows instantaneous zone 3 coverage for a period of 200 ms after the line is energised. After the line is de-energised the line check resets after the programmed time delay. Line de-energisation is detected by three-phase pole-dead logic, while the line check measurement uses this in conjunction with phase current detectors.

3.4 Power Swing

The power swing element has a circular or rectangular offset element that consists of two concentric characteristics. The inner zone impedance is set between the ranges of 0.1 – 250 Ohms and the outer zone has a setting, which is a multiplier of the inner zone. This is set between 1.05 and 2x in steps of 0.01x.
The blocking detector uses a transition time between the inner and outer boundaries this is adjustable between 0 – 1000 ms in 5 ms steps.
The power swing blocking function will be released during an unsymmetrical fault.
The blocking can be arranged to block any zone.

3.5 Fault Locator

The fault locator is triggered by the fault recorder in the event of a general trip. It uses information from the waveform record associated with the fault to determine both the fault type and the line impedance between the relay and the fault location, ignoring any fault resistance. This information is then displayed as part of the relay fault record. By default, the location is displayed as a percentage of the positive sequence line impedance. This can be set in the range 0.1 – 250 ohms in magnitude, and uses the relay line angle as set for the distance protection.
The fault location can be displayed instead as a distance in miles or kilometres by selecting the required display units, and by setting an appropriate value for the secondary positive sequence impedance per unit length. This can be set in the range 0.001 to 5.000 ohms.

4 Indication

Indication is provided by 32 red LEDs; these are fully configurable to the user. Adjacent to each column of LEDs is a removable strip on which the LED function can be printed, allowing comprehensive fault indication. It is possible to print the indicator strip in languages other than English. The LCD provides further fault indication and can be used for programming the relay. See section 1 for a detailed explanation for the programming of the relay.

5 Output contacts

As with the indication the output contacts are fully programmable the basic I/O module has 5 output contacts three of which are change over. Additional modules can be added to provide more contacts. These are added in-groups of eight.

6 Status inputs

As with the indication and output contacts the status inputs are fully programmable the basic I/O module has 3 status inputs these can be set to high speed for signalling. Additional modules can be added to provide more inputs. These are added in-groups of eight.

7 Optional Features

7.1 Directional Earth Fault Setting Range

Polarising Quantity
1V polarising voltage

Characteristics:
DTL, IEC-NI, IEC-VI, IEC-EI,IEC-LTI, ANSI-MI, ANSI-VI, ANSI-EI.

DEF OverCurrent Setting
0.05 x I_n to 4 x I_n in steps of 0.05

DEF IDMTL Characteristic setting
0.05 x In - 4 x In in 0.05 steps.

DEF Characteristic Angle Setting
0° to 85° lagging in steps of 5°

DEF DTL Timer (DT1)
0 to 5 secs in steps of 10ms

DEF IDMTL Time Multiplier:
0.025-1.6 in steps of 0.025

RESET Characteristics:
DTL, Instantaneous, ANSI Decaying.

8 Performance Specification

Throughout the performance specification accuracy statements are made at reference conditions. These reference conditions are as follows:

Reference Conditions

General	IEC60255 Parts 6, 6A & 16
Auxiliary Supply	Nominal
Frequency	50 or 60Hz
Characteristic Line Angle	75°
Ambient Temperature	20°C

Zone 1 impedance 6.0 Ohms
Zone 2 impedance 6.0 Ohms
Zone 3 impedance 6.0 Ohms
Zone 4 impedance 6.0 Ohms

Neutral impedance Z_O/Z_1 ratio 2.5
Z_O angle = 75°

8.1 Accuracy General

Transient Overreach of Distance Protection for X/R = 35	±-5%
Disengaging Time	30ms

Note: Output contacts have a minimum dwell time of 100ms, after which the disengaging time is as above.

8.2 Accuracy Influencing Factors

Temperature

Ambient range	-10°C to +55°C
Variation over range	≤ 5%

Frequency

Range	47Hz to 52Hz 57Hz to 62Hz
Setting variation	≤ 5%
Operating time variation	≤ 5%

Harmonic Content

Harmonic content of waveforms	Frequencies to 550Hz
Operating time variation	≤ 5%

Auxiliary DC Supply – IEC 60255-11

Allowable superimposed ac component	≤ 12% of DC voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	≤ 20ms

8.3 Distance Function Reach

Reach Accuracy, ± 5% or 0.1 Ω which ever is greater up to an SIR of 30
Reach Accuracy, ± 10% or 0.1 Ω which ever is greater, from an SIR of 30 to an SIR of 60

Typical characteristics for all fault types are shown in Figure 4

Characteristic Angle Setting ≤ ±3°

Zone Timers (Z1T through Z4T)
≤ ±1% or ±10ms (whichever is greater)

8.4 Departure from Reference Angle

The nominal setting of the relay at angles other than the reference angle depends upon the characteristic shape. In general terms the impedance setting (Z) at any angle (Φ) can be expressed in terms of the nominal setting (ZN) at the reference angle (ΦN) as follows,

$$Z = Z_N f(\Phi)$$

Where $f(\Phi)$ is the equation defining the characteristic. Using this method the variation in characteristic shape can be simply specified in terms of class accuracy and the deviation from the reference angle. At nominal voltage the variations are listed below.

Circular characteristic

Φ_N – Nominal characteristic angle

Z_N – Nominal impedance setting

$Z_N{}^1$ – Measured impedance at nominal angle Φ_N

$$\text{For } \Phi = \Phi_N \pm 10°$$

$$Z = Z_N{}^1 * \cos(\Phi_N - \Phi) \pm 0.05 Z_N$$

At other angles within the limits 90° ≥ Φ ≥ 0°

$$Z = Z_N{}^1 * \cos(\Phi_N - \Phi) \pm 0.1 Z_N$$

The departure from reference angle is for a three phase balanced condition.

The above variations can also be applied to offset characteristics by transferring the origin.

8.5 Transient overreach

The class index plus an error not exceeding the class index.

8.6 Departure from reference setting

The class index plus an error not exceeding the class index.

8.7 Departure from reference frequency

Over the range of 47 – 52 Hz (50Hz nominal) or 57 – 62 Hz (60Hz nominal), the variations in accuracy are the class index plus an error not exceeding the class index.

8.8 Departure from reference temperature

The variations in accuracy over the operating temperature range is the class index plus an error not exceeding the class index.

8.9 High Set Overcurrent Function

Operating Current
≤ ±5% of setting

Reset current
>95% of operating current

Overcurrent Time (OCT)
≤ ±1% or ±10ms (whichever is greater)

8.10 Forward and Reverse Directional Earth Fault Functions

Operating Current
≤ ±5% of setting

Reset Current
>95% of operating current

Definite Time Lag
≤ ±1%

DEF DTL Timers (DEFF, DEFR)
≤ ±1% or ±5ms (whichever is greater)

8.11 Power Swing (PS) Impedance Variation Setting Range

Characteristic or Impedance Variation
≤ ±5% error

8.12 Timing

Figures 1, 2 and 3 shown typical timing curves.

8.13 Fault locator

Accuracy is dependant upon circuit configuration and power flow conditions.

8.14 Thermal Withstand

Continuous and Limited Period Overload

AC Current Inputs

12A	Continuous
15A	for 10 minutes
30A	for 2 minutes
AC Voltage Input –3.5Vn	Continuous

Short Term Overload

340A	for 1 sec

240A	for 2 sec
625A	for 1 cycle (Peak)

AC Voltage Inputs

3.5Vn	Continuous

8.15 Burdens

Current Circuits

	AC Burden (VA per phase)
1A tap	0.025
2A tap	0.1
5A tap	0.625

Voltage Circuits
0.01VA per phase

NB. Burdens and impedances are measured at nominal rating.

D.C. Burden

	DC Burden (watts)
Quiescent (Typical)	15
Max	27

9 Output contact performance

Contact rating to IEC 60255-0-2.

Carry continuously 5A ac or dc

Make and Carry
(limit L/R ≤ 40ms and V ≤ 300 volts)

for 0.5 sec	20A ac or dc
for 0.2 sec	30A ac or dc

Break
(limit ≤ 5A or ≤ 300 volts)

ac resistive	1250VA
ac inductive	250VA @ PF ≤ 0.4
dc resistive	75W
dc inductive	30W @ L/R ≤ 40 ms 50W @ L/R ≤ 10 ms

Minimum number of operations	1000 at maximum load
Minimum recommended load	0.5W, limits 10mA or 5V

10 Auxiliary energizing quantity

DC Power Supply

	Nominal	Operating Range
VAUX	30/34V	24V to 37.5V dc
VAUX	50/110/125V	37.5V to 137.5V dc
VAUX	220/250/260V	175V to 286V dc

DC Status Inputs

Nominal Voltage	Operating Range
30/34	18V to 37.5V
48/54	37.5V to 60V
110/125	87.5V to 137.5V
220/250	175 to 286V

Status Input Performance (30V and 48V)

Minimum DC current for operation	10mA

Reset/Operate Voltage Ratio	≥ 90%

Status Input Performance (110V and 220V)

Minimum DC current for operation	1mA
Reset/Operate Voltage Ratio	≥ 90%

NB Status operating voltage need not be the same as the main energising voltage. 48/54 volt rated status inputs can be supplied with external dropper resistors, for use with 110V or 220V dc supplies, as follows:-

Status Input External Resistances

Nominal Voltage	Resistor Value; Wattage
110/125V	2k7 ± 5% ; 2.5W
220/250V	8k2 ± 5% ; 6.0W

Two types of status inputs are provided, viz:-

a) High speed status inputs.

Typical response time	<5ms
Typical drop off time	<5ms
Typical response time when programmed to energise an output relay contact	<10ms

b) Scheme status inputs. These status inputs will not respond to either 250V RMS 50/60 Hz applied for 1 second or to the discharge of a 10µF capacitor charged to maximum DC auxiliary supply voltage.

Typical response time	<25ms
Typical Drop off time	<25ms
Typical response time when programmed to energise an output relay contact	<30ms

11 Environmental Withstand

Temperature - IEC 6068-2-1/2

Operating range	-10°C to +55°C
Storage range	-25°C to +70°C

Humidity - IEC 6068-2-3

Operational test	56 days at 40°C and 95% RH

Transient Overvoltage –IEC 60255-5

Between all terminals and earth or between any two independent circuits without damage or flashover	5kV 1.2/50µs 0.5J

Insulation - IEC 60255-5

Between all terminals and earth	2.0kV rms for 1 min
Between independent circuits	2.0kV rms for 1 min
Across normally open contacts	1.0kV rms for 1 min

High Frequency Disturbance - IEC 60255-22-1 Class III

	Variation
2.5kV Common (Longitudinal) Mode	≤ 3%
1.0kV Series (Transverse) Mode	≤ 3%

Electrostatic Discharge - IEC 60255-22-2 Class III

	Variation
8kV contact discharge	≤ 5%

Radio Frequency Interference - IEC 60255-22-3 Class III

	Variation

20MHz to 1000MHz, 10V/m	≤ 5%

Fast Transient – IEC 60255-22-4 Class IV

	Variation
4kV 5/50ns 2.5kHz repetitive	≤ 3%

Vibration (Sinusoidal) –IEC 60255-21-1 Class 1

		Variation
Vibration response	0.5gn	≤ 5%
Vibration endurance	1.0gn	≤ 5%

Shock and Bump–IEC 60255-21-2 Class 1

		Variation
Shock response	5 gn 11ms	≤ 5%
Shock withstand	15 gn 11ms	≤ 5%
Bump test	10 gn 16ms	≤ 5%

Seismic – IEC 60255-21-3 Class 1

		Variation
Seismic Response	1gn	≤ 5%

Mechanical Classification

Durability	In excess of 10^6 operations

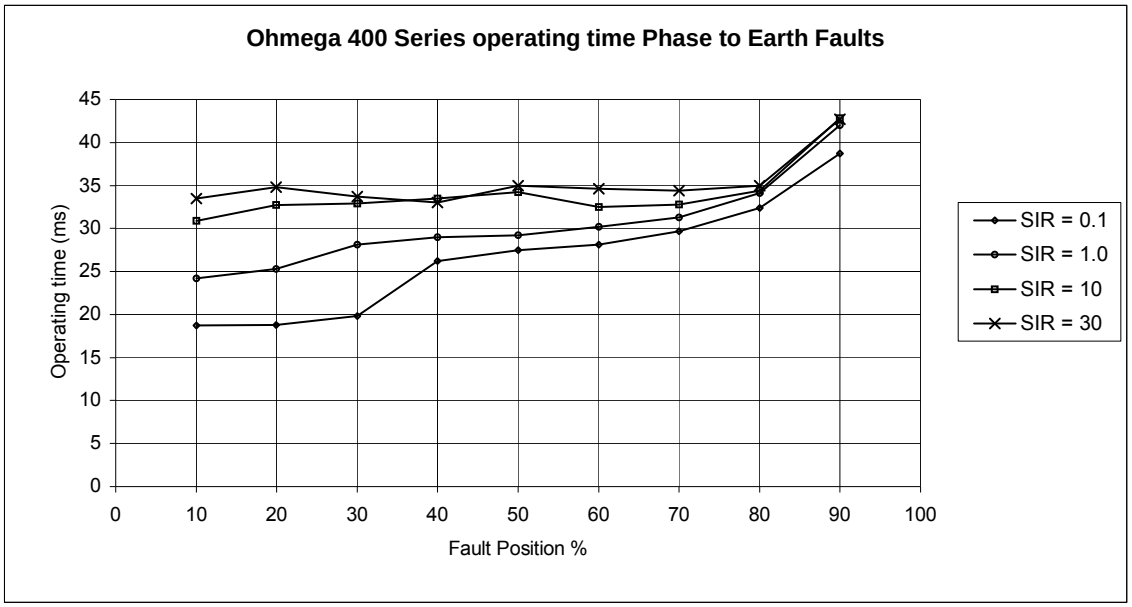

Figure 1

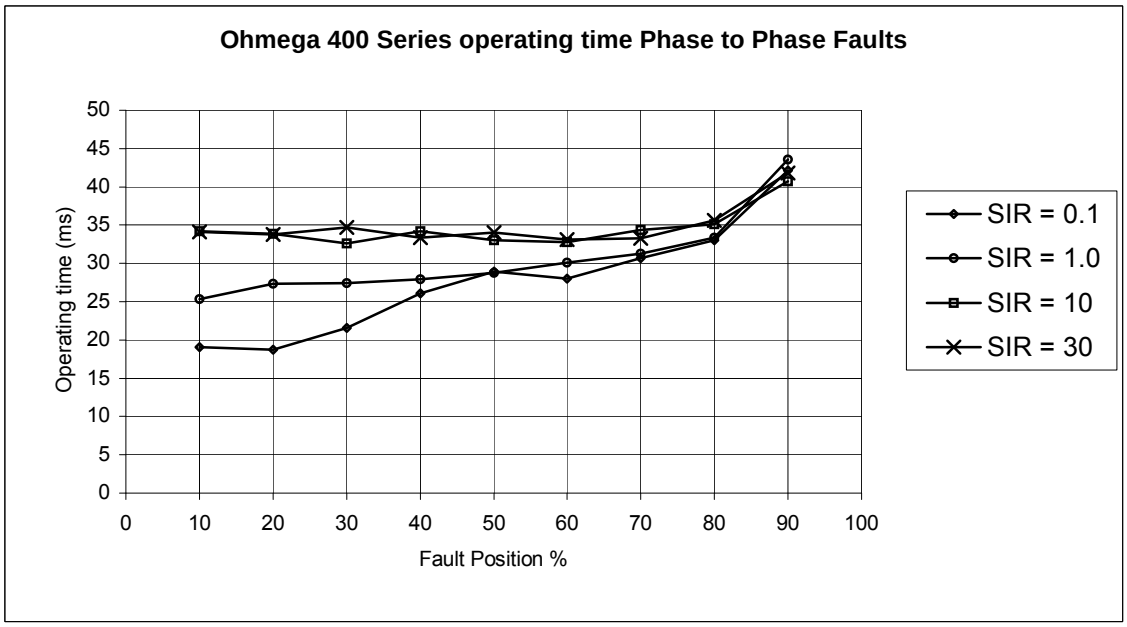

Figure 2

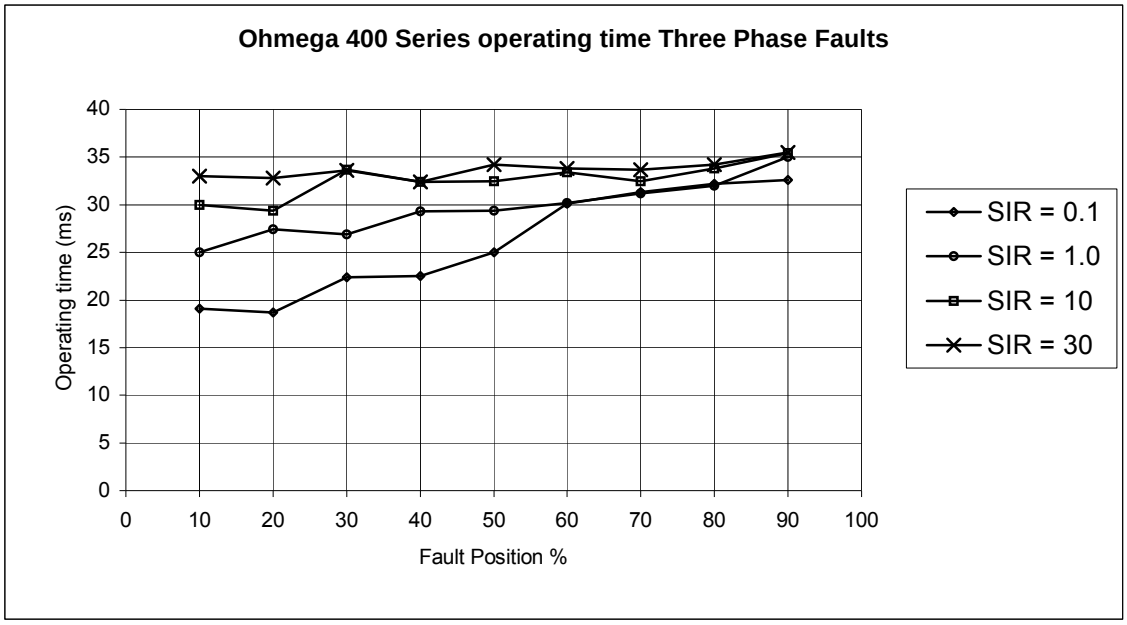

Figure 3

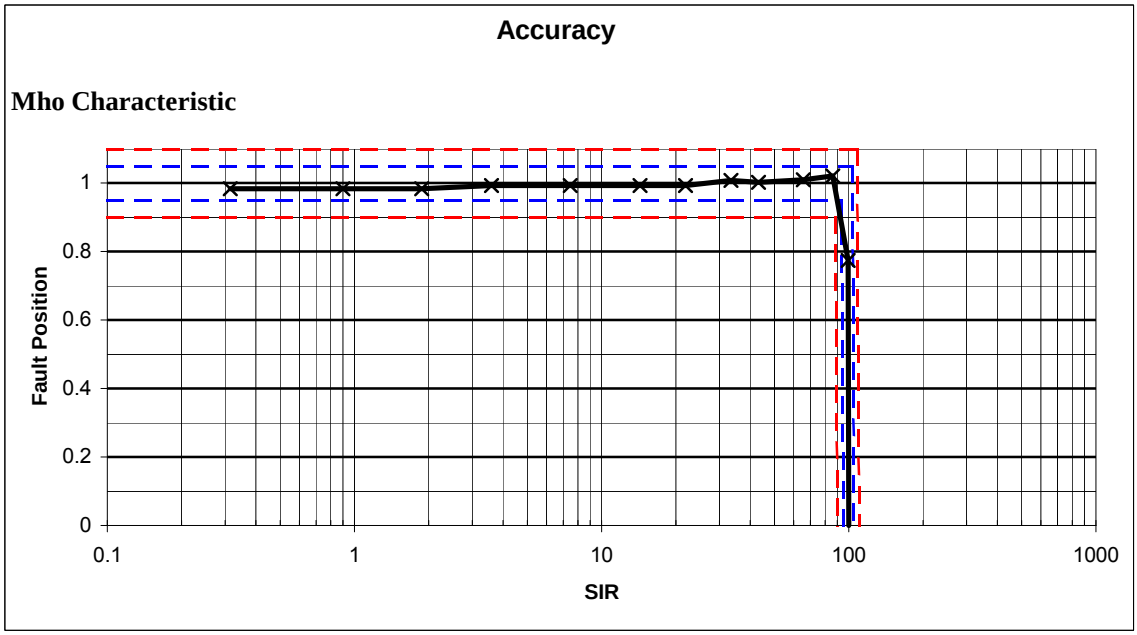

Figure 4