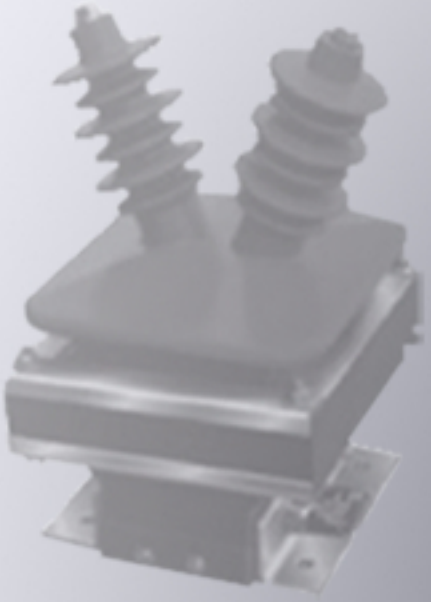
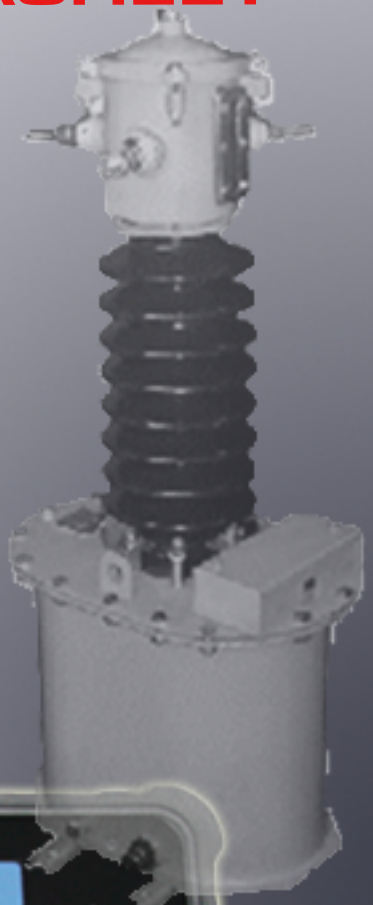
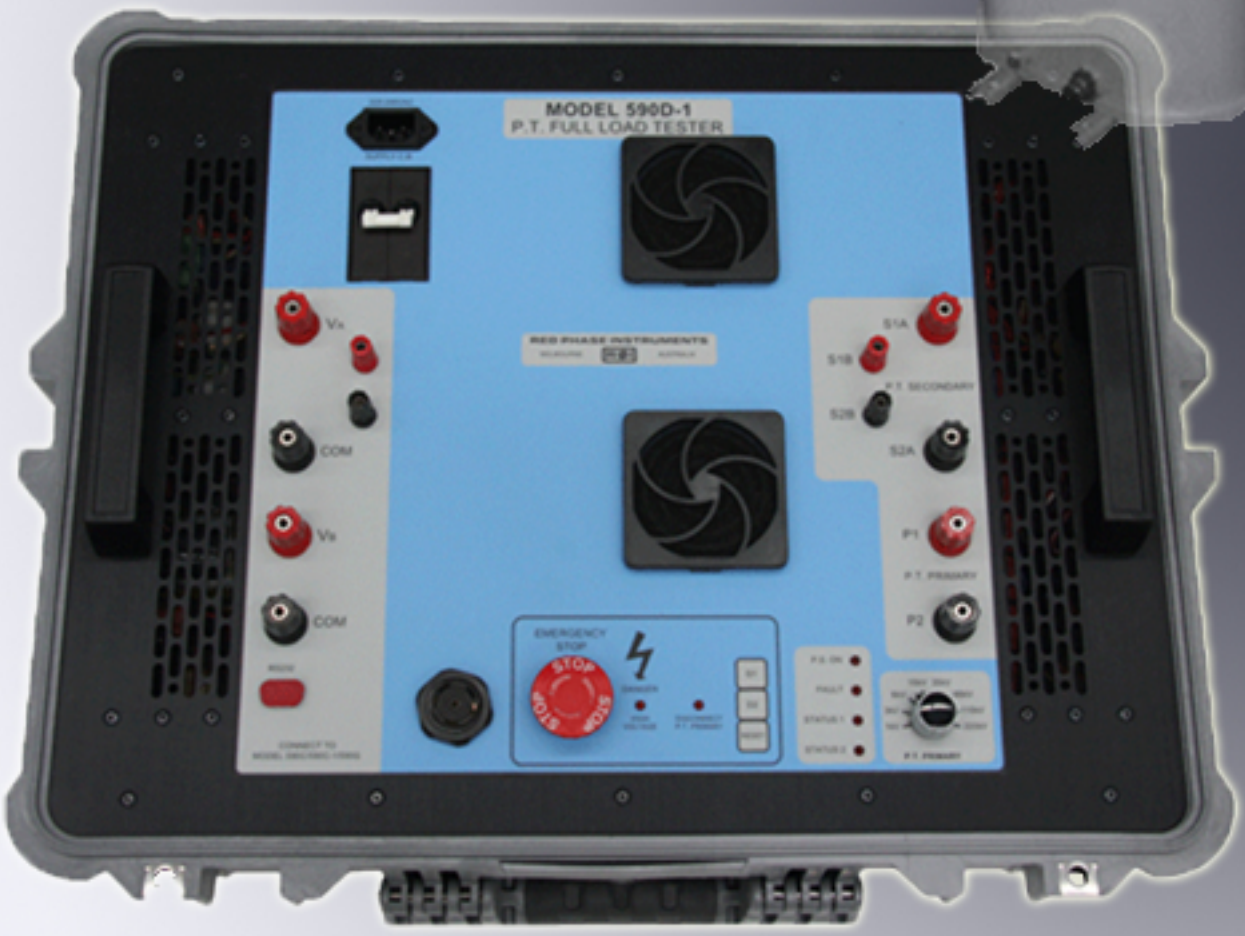
FULL LOAD P.T. TESTER
590D-1 DATASHEET







REDPHASE INSTRUMENTS

Contents

	Section
Key Features	
Application	1
Where it is used	1.1
Measurements	1.2
Measurements	2
Primary and Secondary Resistance	2.1
Short circuit test	2.2
No Load Voltage ratio test	2.3
No Load errors	2.4
Load effect	2.5
Primary and Secondary Admittance	2.6
Test Procedure & Results	3
Typical P.T. Test	3.1
Multiple secondary winding	3.2
Null test	3.3
Operating ranges	4
Hardware	5
Power Source	5.1
Interface	5.2
590D-1 Case	5.3
Transit Case	5.3.1
Case Sizes	5.3.2
Weight	5.3.3
Protection Features	6
Serial Connection	7

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KEY FEATURES:

An accessory to the Model 590G/G-V2 for the full load testing of an inductive P.T..

An integrated solid state High Frequency transformer, which eliminates the need for an external isolation transformer.

Integrated high power switch mode (typically a 1.2kW) source for full load performance testing of P.T.s under simulated load conditions to 0.1% accuracy.

It uses the existing measuring circuitry and microprocessor of the 590G/G-V2 to the greatest extent possible but also has its own microprocessor to monitor and control its operation.

Communication between with the 590G/G-V2. is via a RS232 serial link.

1.0. APPLICATIONS

1.1. Where it is used

A vital operational feature of a potential transformer is its ability to translate voltage accurately with as little loss of power as possible.
The IEC 60044-2 standard governing voltage or potential transformer operation suggests that to thoroughly test a P.T., the test must simulate the varying application voltage and load conditions which the target transformer would be expected to cope with under real conditions.
The 590D-1 with its integrated power source has been designed to perform just this function within the ratio limits outlined in this datasheet..
In conjunction with the 590G-V2 it is a powerful tool for quickly measuring offline P.T.s on or off site.

1.2. Measurements

The 590D-1 connects to the 590G/G-V2 and the Inductive P.T. under test & measures:

- Primary & Secondary winding resistance.
- Secondary winding admittance with primary short circuited.
- Primary winding admittance calculated from turns ratio.
- Turns ratio/No load voltage ratio.
- Secondary admittance with primary open circuit.
- Finally the microprocessor calculates the P.T. errors from the measurements.

2,0. MEASUREMENTS

2.1. Primary and Secondary Resistance

The primary side resistance, Rp, is measured. It is typically 5kohm to 50kohm.
Usually a voltage of up to 5V DC is used and due to the inductance of the winding, it can take 1 minute to charge up the winding to steady state. A capacitor can sometimes be connected across the primary terminals to aid stabilizing the voltage.
The applied voltage is ramped up and down to prevent voltage spikes.

The secondary winding resistance, Rs, is very small and is typically in the range of 0.2 to 2.0 ohms.
The resistance test confirms the value Zs measured in the short circuit test later.
The core is de-magnetized during the short circuit test.

2.2. Short circuit test

The primary is shorted and a low voltage applied to the secondary. The voltage is adjusted to give 20% to 50% of rated current injection into the secondary. Due to the turns ratio, the primary current will be very small.

Rated current is typically 0.25A to 2A. This typically requires a voltage of 0.05V to 0.5V.
In this test the voltage and current are measured to calculate the secondary series winding impedance, Zs, in ohms.
Further, from Zs the primary winding impedance, Zp, is calculated using nominal turns ratio.

2.3. No Load Voltage ratio test.

The voltage ratio is measured by applying either 150V or 450V (depending on 590G/G-V2 model) to the primary and measuring the secondary voltage. This gives a no load voltage ratio.

2.4. No load errors

(Due to magnetizing current in primary producing less secondary output voltage than determined by absolute turns ratio).

No load errors,

$$\Delta + j\delta = 0.1 \times Yc \times Zp.$$

Where:
Δ = Ratio error in %.
δ = Phase error in crad.
Yc = Core admittance measured on primary side in mS.
(Note, Ys is admittance measured from secondary side).
Zp = Primary winding 50Hz impedance in ohms.
(Calculated from Zs and nominal turns ratio, where Zs is the secondary winding 50Hz impedance).

The Model 590G/G-V2 already measures the output of the P.T. with the primary energized at either 150V or 450V (depending on 590G/G-V2 model) and gives an error which is the percentage deviation of the actual output from the output calculated from the P.T. nameplate ratio.

The absolute turns ratio may not be the same as the nameplate ratio, since the turns ratio can be varied to give the desired performance under load. The information from the 590G / G-V2 test can be used to calculate the absolute turns ratio.

2.5. Load effect

(Change in errors due to loading effect of external burden. These are errors which are additional to the no load errors).

Load errors

$$\Delta + j\delta = 0.1 \times Yb \times (Zs + Zp/Kn^2)$$

Where:
Δ = Ratio error in %.
δ = Phase error in centiradians.
Yb = Load admittance (of external burden) in mS.
Zs = Secondary winding 50Hz impedance.
Kn = Nominal primary to secondary winding ratio.
Zp = Primary winding 50Hz impedance.
Calculated from Zs and Kn.

2.6. Primary and Secondary Admittance

The primary is open circuited, and voltage injected into the secondary. This allows the measurement of an impedance, Ys, which is the sum of the primary series impedance and the core admittance.

This test is performed at or near the rated voltage for the error calculations as the core admittance varies with excitation voltage.

Caution is required in this test since the rated high voltage appears on the primary side.
The voltage will typically be 80%, 100% and 120% of rated voltage or whatever is required by the relevant regulations. At 120% rated voltage the current will typically be from 0.1A to 15A and admittance 0.02mS to 1mS.

From Ys the primary side admittance, Yc, is calculated using nominal turns ratio.

3.0. TEST PROCEDURE & RESULTS

3.1. Typical P.T. test

Isolate the P.T. primary and secondary from the supply and connect as shown in Fig.1.

Test data for the P.T. is keyed in. This includes Serial no, Primary and Secondary voltages/ nominal ratio, Phase to Phase or Phase to Neutral primary connection and VA rating.

Start the test

Prompt for primary winding connection:
Primary winding resistance Rp is measured.

```
PRIMARY RESISTANCE TEST                    #88
Rp = 966 ohms                               t
```

Prompt for secondary winding connection:
Secondary winding resistance Rs is measured

```
SECONDARY RESISTANCE TEST                  #89
Rs = 126 mohms                              t
```

The 50Hz secondary winding impedance is also measured.

```
SHORT CIRCUIT TEST                         #90
Zs = 1.982 + 1.364j ohms                    t
```

```
VOLTAGE RATIO TEST                         #91
Ka = 99.743  (ERR=2.57e-3)                  t
```

The no load voltage ratio is measured at 150V. Ka is the open circuit voltage ratio and Ys is the secondary open circuit admittance.
Ys is measured at the secondary voltage corresponding to either 150V or 450V (depending on 590G/G-V2 model) the primary and at 120, 100 and 80% of the rated primary voltage.

The results are then measured & displayed.

```
MEASURING  Ys  Ka                          #92
```

```
120% Ys = 3.72   2.56j mS
100% Ys = 3.62   2.47j mS                   t
```

```
80%V Ys = 3.72   2.56j mS
Ka   Ys = 4.89   -3.22j mS                  t
```

In some instances manufacturers add compensation capacitors and in order to measure the effect of this and the inherent inter-winding capacitance and inductance, the admittance measurement is made at five different frequencies between 40 to 60 Hz, These are denoted as LF (low frequency), MLF (middle low frequency), NOM (nominal frequency I.e. 50Hz), MHF (middle high frequency) and HF (high Frequency).

The results are displayed as follows:-

```
 LF   Ys = 2.36    +0.03j mS
MLF   Ys = 2.19    +0.03j mS                ▼
```

```
NOM Ys = 2.19     +0.03j mS
 MHF  Ys = 2.06    +0.02j mS                ▼
```

```
 HF   Ys = 2.07    +0.02j mS
                                            ▼
```

Final ratio and phase errors are calculated and displayed.

```
80%V    I   0.8PF   +0.32%   -5.6'  I      #93
25%VA   I   1.0PF   +0.29%   -6.3'  I       t
```

```
80%V    I   0.8PF   -0.22%   -7.6'  I   s  #93
100%VA  I   1.0PF   -0.24%   -8.3'  I   t
```

```
100%V   I   0.8PF   +0.31%   -5.8'  I   s  #93
25%VA   I   1.0PF   +0.27%   -6.5'  I   t
```

```
100%V   I   0.8PF   -0.25%   -7.9'  I   s  #93
100%VA  I   1.0PF   -0.28%   -8.6'  I   t
```

```
120%V   I   0.8PF   +0.28%   -6.0'  I   s #93
25%VA   I   1.0PF   +0.25%   -6.7'  I   t
```

```
120%V   I   0.8PF   -0.28%   -8.2'  I   s  #93
100%VA  I   1.0PF   -0.31%   -8.8'  I   t
```

3.2. Multiple secondary winding

Testing of Dual secondary windings is also possible by making the appropriate selection.

```
SELECT FULL PT TEST                        #96
1) SINGLE        2) DUAL
```

3.3. Nulll test. *Not performed with 590G-V2*

For improved accuracy, a null test can be done if the PT ratio is available on the 590D-1

```
TURNS RATIO TEST TYPE                      #97
1) RATIO TEST    2) NULL TEST
```

4.0. OPERATING RANGES

Measurable P.T. Types

- Max Primary voltage: 300kV
- Min Primary voltage: 0.24kV
- Selectable secondary voltage for Phase to Phase: 100V or 110V
- Selectable secondary voltage for Phase to Neutral: 63.5V / 57.7V
- VA rating from: 1 to 200VA.
- Burden Selection: 25% & 100%
- Power Factor: 0.8 and 1.0

5.0. HARDWARE

5.1. Power Source

Mains supply via IEC cable.
The Model 590D-1 has a high power 1.2kW switch mode supply.
The source can generate up to 132V at 50Hz or 60Hz, when performing an admittance test.

5.2. Interface

All input and output commands and parameters are handled by the keypad and display on the 590G\G-V2.

5.3. 590D-1 Case

The Model 590D-1 uses the well known "Pelican" brand injection moulded plastic case. The case is robust and hard wearing.
There is an internal aluminium chassis and an aluminium front panel with a reverse screened "Lexan" polycarbonate finish.

5.3.1. Transit Case

A transit case is also provided as standard for transportation. Purpose built from ABS plastic, it is foam lined and offers suitable protection for the 590D-1 during transportation to and from site.
The case has room for test leads and accessories.

5.3.2. Case Sizes (L x W x H)

590D-1 case: 615mm X 230mm x 530mm.
Transit case: 670mm X 290mm X 590mm

5.3.3. Weight

590D-1 ~24kgs
Transit case: ~7kgs
Test leads & accessories: ~3kgs

6.0 PROTECTION FEATURES

Circuit breaker.

Flashing LED when terminals are live.

Buzzer for hazardous voltage warning and to indicate error conditions.

Emergency Stop pushbutton to stop a test.

Over temperature cut-out.

7.0 Serial connection

Connection to a Model 590G/G-V2, using a straight thru RS232 cable with 9 pin “D“ connectors with all pins connected.

Fig. 1. TYPICAL TEST CONNECTION with 590C or G