



**STANDARD OPERATING PROCEDURE**

<b>Department:</b> Quality Assurance	<b>SOP No.:</b>
<b>Title:</b> Calibration of Scientific Calculator	<b>Effective Date:</b>
<b>Supersedes:</b> Nil	<b>Review Date:</b>
<b>Issue Date:</b>	<b>Page No.:</b>

**1.0 Purpose:**

To calibrated the Scientific Calculator at .....

**2.0 Scope:**

This SOP is applicable for procedure for Calibration of Scientific Calculator, which is used for simple and complex calculation in .....

**3.0 Responsibility:**

**3.1 Officer/Executive QA**

- 3.1.1 Shall be responsible for provide instrument ID as per SOP.
- 3.1.2 Shall be verification for calibration scientific calculator.

**3.2 Officer/Executive QC**

- 3.2.1 Shall be intimated if calibration due.
- 3.2.2 Shell be tacked instrument ID.
- 3.2.3 Shall be performance for calibration at in house.

**3.3 Head -QA/Designee**

- 3.3.1 Shall be responsible for compliance and approval of this SOP

**4.0 Procedure:**

- 4.1 Before starting the calibration check the operation of calculator as per manufacturer's manual.
- 4.2 Calibrate the calculator for Subtraction (-), Addition (+), Multiplication (X), Division ( $\div$ ), Square root ( $\sqrt{\quad}$ ), Logarithmic function (log), Inv (log) or Anti (log), Standard deviation (SD), Memory functions (M, M, M), Percentage (%).
- 4.3 Verify the functions calculated using calculator with manual calculations.
- 4.4 Verify the functions calculated using calculator with manual calculations.
- 4.5 Verify Subtraction using input values as given below and report the result in Annexure-I
  - ❖ 654 – 321.



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**4.6** Verify Addition using the set of values given below and report the result in annexure-I

❖  $123456789 + 987654321$ .

**4.7** Verify Multiplication using the set of values given below and report the result in annexure-I

A)  $12345679 \times 8$                       B)  $12345679 \times 9$ .

**4.8** Verify Division using the input values of 22, 7 and report the displayed value in annexure-I.

**4.9** Press 'p' key and report the displayed value in annexure-I. (This test is significant in verifying the standard values that are stored in calculator's memory).

**4.10** Verify Square root (Ö) function using logarithmic tables and anti-log tables.

The reference equation used for manual calculation is

$\log X = Y$  applying log. on both sides,

$\frac{1}{2} \log X = \log Y$  applying anti – log on both sides  $\text{anti log} (\frac{1}{2} \log X) = \text{antilog} (\log Y)$ .

**4.11** The log. Values for reference are enclosed

**4.12** The complex functions like logarithmic and anti-log functions are counter verified in the square root function itself.

**4.13** For calculation consider  $\sqrt{100}$  and report the values in annexure-I.

**4.14** Verify standard deviation function using the input values as 1, 2,4,4,4.

**4.15** For manual calculation of standard deviation use the following formula

**4.16** Std. deviation =

**4.17** 
$$\frac{\sqrt{n\sum x^2 - (\sum x)^2}}{n(n-1)}$$

**4.18** Where x = individual sample,  $\sum x$  = sum of squares of x, n = sample size,  $(\sum x)$  = square of sum of individual sample.

**4.19** Upon simplifying the equation the result yields  $\sqrt{2} = 1.4142$  (this requires logarithmic application).

**4.20** Press Memory recall (M) to review the result and enter the details in annexure-I.



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- 4.21** Verify the percentage (%) calculations by applying the following values  $1/1 \times \% =$ . Enter the details in annexure-I
- 4.22** Verify all key function as per annexure-I and give observation in annexure –II
- 4.23** Recalibration should be performed in every six month.
- 4.24** Recalibration should be performed if purchase any new calculator.

**5.0 Annexure:**

Annexure No.	Title	Format No.
Annexure I	Follow key of calculator for calibration of scientific calculator.	
Annexure II	Calibration of scientific calculator.	

**6.0 Reference:**

Nil

**7.0 Abbreviation:**

S.No.	Abbreviation	Extended Form
1.	QA	Quality Assurance
2.	QC	Quality Control

**8.0 History of change:**

Revision No.	Effective Date	Change Control No.	Details of reason
00		-	New SOP

**9.0 Distribution List:**

Copy No	Dept/ Distributed to
Master Copy	Quality Assurance – Manager
Control Copy	Manager-Production
Display Copy	Section In-charge



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### Annexure-I



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## FOLLOW KEY OF CALCULATOR FOR CALIBRATION OF SCIENTIFIC CALCULATOR

S.No.	Test Name	Acceptance Criteria
1.	Switch ON	Calculator should be start then press the <b>ON</b> switch
2.	Switch OFF	Calculator should be Shutdown then press the <b>SHIFT &amp; OFF</b>
3.	Subtraction by calculator:654-321	Display value and calculated value should be same (333)
4.	Addition by calculator:123456789+987654321	Display value and calculated value should be same (1111111110)
5.	Multiplication by calculator:123456789x8	Display value and calculated value should be same (98765432)
6.	Division by calculator:123456789/9	Display value and calculated value should be same (13717421)
7.	Square root by calculator: $\sqrt{100}$	Display value and calculated value should be same (10)
8.	Percent	<p><b>%</b> For calculating percentages. Four methods of calculating percentages are presented as follows.</p> <p>1) \$125 increased by 10%...137.5  125 <b>+</b> 10 <b>2ndF</b> <b>%</b> <span style="border: 1px solid black; padding: 2px;">125+10%<sup>DES</sup> 137.5</span></p> <p>2) \$125 reduced by 20%...100  125 <b>-</b> 20 <b>2ndF</b> <b>%</b> <span style="border: 1px solid black; padding: 2px;">125-20%<sup>DES</sup> 100.</span></p> <p>3) 15% of \$125...18.75  125 <b>x</b> 15 <b>2ndF</b> <b>%</b> <span style="border: 1px solid black; padding: 2px;">125x15%<sup>DES</sup> 18.75</span></p> <p>4) W hen \$125 equals 5% of X, X equals...2500  125 <b>÷</b> 5 <b>2ndF</b> <b>%</b> <span style="border: 1px solid black; padding: 2px;">125÷5%<sup>DES</sup> 2500.</span></p>



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<p>9.</p>	<p>Memory Calculation</p>	<p><b>&lt;Example 1&gt; Operation</b></p> <p>0 <b>STO</b> <b>M</b> (Enter 0 for M)</p> <p>25 <b>×</b> 27 <b>M+</b></p> <p>7 <b>×</b> 3 <b>M+</b></p> <p><b>RCL</b> <b>M</b></p> <p><b>Display</b></p> <p>0 → M <b>0.</b></p> <p>25x27M+ <b>675.</b></p> <p>7x3M+ <b>21.</b></p> <p>M= <b>696.</b></p>
<p>10.</p>	<p><b>Exponent Display-</b> The distance from the earth to the sun is approx. 150,000,000 (1.5x10<sup>8</sup>) km. value such as this with many zeros are often used in scientific calculation but entering the zeros one by one is a great deal of work and it's easy to make mistakes. in such a case the numerical values are divided into mantissa and exponent portions displayed and calculated</p>	<p>0.32 <b>÷</b></p> <p>1.6 <b>Exp</b> 19</p> <p><b>=</b></p> <p><b>Display</b></p> <p>0.32 ÷ <b>0.</b></p> <p>0.32 ÷ 1.6 <b>1.6<sup>19</sup></b></p> <p>0.32 ÷ 1.6 <b>2.<sup>20</sup></b></p>
<p>11.</p>	<p><b>Data entry keys</b></p>	<p>0 to 9 Numeric keys for entering data values.</p> <p><b>.</b> Decimal point key. Enters a decimal point.</p> <p><b>+/-</b> Enters minus symbol or sign change key. Changes positive numbers to negative and negative numbers to positive.</p> <p><b>π</b> Pressing π automatically enters the value for π (3.14159...). The constant π, used frequently in function calculations, is the ratio of the circumference of a circle to its diameter.</p> <p><b>Exp</b> Pressing this key switches to scientific notation data entry.</p> <p><b>&lt;Example&gt;</b> Provided the earth is moving around the sun in a circular orbit, how many kilometers will it travel in a year? * The average distance between the earth and the sun being 1.496 x 10<sup>8</sup> km. Circumference equals diameter x π; therefore, 1.496 x 10<sup>8</sup> x 2 x π</p> <p><b>Operation</b></p> <p>1 <b>.</b> 496 <b>Exp</b> 8</p> <p><b>×</b> 2 <b>×</b> <b>π</b> <b>=</b></p> <p><b>Display</b></p> <p>1.496 <b>1.496<sup>08</sup></b></p> <p>1.496E08x2xπ <b>939964522.</b></p>
<p>12.</p>	<p><b>Basic arithmetic keys, parentheses</b></p>	<p><b>+</b> <b>-</b> The four basic operators. Each is used in the same way as a standard calculator:</p> <p><b>×</b> <b>÷</b> + (addition), - (subtraction), x (multiplication), and ÷ (division).</p> <p><b>=</b> Finds the result in the same way as a standard calculator.</p> <p><b>( )</b> Used to specify calculations in which certain operations have precedence. You can make addition and subtraction operations have precedence over multiplication and division by enclosing them in parentheses.</p>



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<b>13.</b>	<p><b>Inverse, Square cube, xth power of y, square root, cube root, xth root of y-</b></p> <p><math>x^{-1}</math> Calculates the inverse of the value on the display.</p> <p><math>x^2</math> Squares the value on the display.</p> <p><math>x^3</math> Cubes the value on the display.</p> <p><math>y^x</math> Calculates exponential values.</p> <p><math>\sqrt{\quad}</math> Calculates the square root of the value on the display.</p> <p><math>\sqrt[3]{\quad}</math> Calculates the cube root of the value on the display.</p> <p><math>\sqrt[x]{\quad}</math> Calculates the <math>x^{\text{th}}</math> root of y.</p>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <math>2 \times 2 \times 2 \times 2 =</math> </div> <div style="text-align: center;"> <math>2^{y^x} 4 =</math> </div> </div> <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 10px;"> <div style="text-align: center;"> <math>4 \sqrt[2]{16} =</math> </div> </div>
<b>14.</b>	<p><b>10 to the power of X, common logarithm</b></p> <p><math>10^x</math> Calculates the value of 10 raised to the <math>x^{\text{th}}</math> power.</p> <p><math>\log</math> Calculates logarithm, the exponent of the power to which 10 must be raised to equal the given value.</p>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <math>\sqrt[2]{10^x} 3 =</math> </div> <div style="text-align: center;"> <math>\log 1000 =</math> </div> </div>
<b>15.</b>	<p><b>E to the power of X natural logarithm</b></p> <p><math>e^x</math> Calculates powers based on the constant e (2.718281828).</p> <p><math>\ln</math> Computes the value of the natural logarithm, the exponent of the power to which e must be raised to equal the given value.</p>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <math>\sqrt[2]{e^x} 5 =</math> </div> <div style="text-align: center;"> <math>\ln 10 =</math> </div> </div>
<b>16.</b>	<p><b>Permutations, combinations</b></p> <p><math>nPr</math> This function finds the number of different possible orderings in selecting r objects from a set of n objects. For example, there are six different ways of ordering the letters ABC in groups of three letters—ABC, ACB, BAC, BCA, CAB, and CBA. The calculation equation is <math>{}_3P_3 = 3 \times 2 \times 1 = 6</math> (ways).</p> <p><math>nCr</math> This function finds the number of ways of selecting r objects from a set of n objects. For example, from the three letters ABC, there are three ways we can extract groups of two different letters—AB, AC, and CB. The calculation equation is <math>{}_3C_2</math>.</p>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <math>6 \sqrt[2]{nPr} 4 =</math> </div> <div style="text-align: center;"> <math>6 \sqrt[2]{nCr} 4 =</math> </div> </div>



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<p>17.</p>	<p><b>Fractional calculation-</b></p> <p><b>ab%</b> Inputs fractions and converts mutually between fractions and decimals.</p> <p><b>d/c</b> Converts between mixed numbers and improper fractions.</p>	<p>3 <b>ab%</b> 1 <b>ab%</b> 2 <b>+</b> <b>3-1r2+5r7=</b>            5 <b>ab%</b> 7 <b>=</b> <b>4r3r14.</b></p> <p><b>ab%</b> <b>3-1r2+5r7=</b>  <b>4.214285714</b></p> <p>Convert to decimal notation            Press once to return to the previous display</p> <p><b>2ndF</b> <b>d/c</b> <b>3-1r2+5r7=</b>  <b>59r14.</b></p> <p>Convert to an improper fraction            Press once to return to the previous display</p> <p><b>2ndF</b> <b>d/c</b> <b>3-1r2+5r7=</b>  <b>4r3r14.</b></p>
<p>18.</p>	<p><b>Memory calculation-</b></p> <p><b>STO</b> Stores displayed values in memories A-F, X, Y, M.</p> <p><b>RCL</b> Recalls values stored in A-F, X, Y, M.</p> <p><b>M+</b> Adds the displayed value to the value in the independent memory M.</p> <p><b>M-</b> Subtracts the displayed value from the value in the independent memory M.</p> <p><b>A</b> ~ <b>F</b> <b>X</b> <b>Y</b> Temporary memories</p> <p><b>M</b> Independent memory</p>	<p>0 <b>STO</b> <b>M</b> <b>0 → M</b>            (Enter 0 for M)</p> <p>25 <b>×</b> 27 <b>M+</b> <b>25x27M+</b>  <b>675.</b></p> <p>7 <b>×</b> 3 <b>M+</b> <b>7x3M+</b>  <b>21.</b></p> <p><b>RCL</b> <b>M</b> <b>M=</b>  <b>696.</b></p>
<p>19.</p>	<p><b>Last answer memory-</b></p> <p><b>ANS</b> Automatically recalls the last answer calculated by pressing <b>=</b></p>	<p><math>x = \sqrt{2} + 3</math> and <math>y = 4 \div x</math></p> <p>Operation Display</p> <p><b>√</b> 2 <b>+</b> 3 <b>=</b> <b>√2+3=</b>  <b>4.414213562</b></p> <p>4 <b>÷</b> <b>ALPHA</b> <b>ANS</b> <b>=</b> <b>4+ANS=</b>  <b>0.906163678</b></p>
<p>20.</p>	<p><b>Trigonometric function-</b></p> <p><b>sin</b> Calculates the sine of an angle. <math>\sin\theta = \frac{b}{a}</math></p> <p><b>cos</b> Calculates the cosine of an angle. <math>\cos\theta = \frac{c}{a}</math></p> <p><b>tan</b> Calculates the tangent of an angle. <math>\tan\theta = \frac{b}{c}</math></p>	<p>[DEG mode]</p> <p>Operation Display</p> <p><b>tan</b> 45 <b>×</b> 15 <b>tan45x15+1.5</b>  <b>+</b> 1 <b>•</b> 5 <b>=</b> <b>16.5</b></p> <p>View point</p>



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### Arc Trigonometric function-

**sin<sup>-1</sup>** (arc sine) Determines an angle based on the ratio  $\theta = \sin^{-1} \frac{b}{a}$   
b/a of two sides of a right triangle.

**cos<sup>-1</sup>** (arc cosine) Determines an angle based on the ratio  $\theta = \cos^{-1} \frac{c}{a}$   
c/a for two sides of a right triangle.

**tan<sup>-1</sup>** (arc tangent) Determines an angle based on the ratio  $\theta = \tan^{-1} \frac{b}{c}$   
a/b for two sides of a right triangle.

[DEG mode]

Operation

Display

2ndF tan<sup>-1</sup> ( 80 ÷  
100 ) =

tan<sup>-1</sup>(80÷100)  
38.65980825

21.

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**Annexure-II**



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**CALIBRATION OF SCIENTIFIC CALCULATOR**

S.No.	Test Name	Observation
1.	Switch ON	
2.	Switch OFF	
3.	Subtraction by calculator: 654-321	
4.	Addition by calculator: 123456789+987654321	
5.	Multiplication by calculator: 123456789x8	
6.	Division by calculator: 123456789/9	
7.	Square root by calculator: $\sqrt{100}$	
8.	<b>Percent</b>	
9.	Memory Calculation	
10.	<b>Exponent Display-</b> The distance from the earth to the sun is approx. 150,000,000( $1.5 \times 10^8$ ) km. value such as this with many zeros are often used in scientific calculation but entering the zeros one by one is a great deal of work and it's easy to make mistakes. in such a case the numerical values are divided into mantissa and exponent portions displayed and calculated	
11.	<b>Data entry keys</b>	
12.	<b>Basic arithmetic keys, parentheses</b>	
13.	<b>Inverse, Square cube, <math>x^{\text{th}}</math> power of y, square root, cube root, <math>x^{\text{th}}</math> root of</b>	



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











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	<p><b>y-</b></p> <p> Calculates the inverse of the value on the display.</p> <p> Squares the value on the display.</p> <p> Cubes the value on the display.</p> <p> Calculates exponential values.</p> <p> Calculates the square root of the value on the display.</p> <p> Calculates the cube root of the value on the display.</p> <p> Calculates the x<sup>th</sup> root of y.</p>	
<p><b>14.</b></p>	<p><b>10 to the power of X, common logarithm</b></p> <p> Calculates the value of 10 raised to the x<sup>th</sup> power.</p> <p> Calculates logarithm, the exponent of the power to which 10 must be raised to equal the given value.</p>	
<p><b>15.</b></p>	<p><b>E to the power of X natural logarithm</b></p> <p> Calculates powers based on the constant e (2.718281828).</p> <p> Computes the value of the natural logarithm, the exponent of the power to which e must be raised to equal the given value.</p>	
<p><b>16.</b></p>	<p><b>Permutations, combinations</b></p> <p> This function finds the number of different possible orderings in selecting r objects from a set of n objects. For example, there are six different ways of ordering the letters ABC in groups of three letters—ABC, ACB, BAC, BCA, CAB, and CBA. The calculation equation is <math>{}_3P_3 = 3 \times 2 \times 1 = 6</math> (ways).</p> <p> This function finds the number of ways of selecting r objects from a set of n objects. For example, from the three letters ABC, there are three ways we can extract groups of two different letters—AB, AC, and CB. The calculation equation is <math>{}_3C_2</math>.</p>	
<p><b>17.</b></p>	<p><b>Fractional calculation-</b></p>	



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

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	<p> Inputs fractions and converts mutually between fractions and decimals.</p> <p> Converts between mixed numbers and improper fractions.</p>	
<p>18.</p>	<p><b>Memory calculation-</b></p> <p> Stores displayed values in memories A-F, X, Y, M.</p> <p> Recalls values stored in A-F, X, Y, M.</p> <p> Adds the displayed value to the value in the independent memory M.</p> <p> Subtracts the displayed value from the value in the independent memory M.</p> <p> Temporary memories</p> <p> Independent memory</p>	
<p>19.</p>	<p><b>Last answer memory-</b></p> <p> Automatically recalls the last answer calculated by pressing </p>	
<p>20.</p>	<p><b>Trigonometric function-</b></p> <p> Calculates the sine of an angle. <math>\sin\theta = \frac{b}{a}</math></p> <p> Calculates the cosine of an angle. <math>\cos\theta = \frac{c}{a}</math></p> <p> Calculates the tangent of an angle. <math>\tan\theta = \frac{b}{c}</math></p>	
<p>21.</p>	<p><b>Arc Trigonometric function-</b></p> <p> (arc sine) Determines an angle based on the ratio b/a of two sides of a right triangle. <math>\theta = \sin^{-1} \frac{b}{a}</math></p> <p> (arc cosine) Determines an angle based on the ratio c/a for two sides of a right triangle. <math>\theta = \cos^{-1} \frac{c}{a}</math></p> <p> (arc tangent) Determines an angle based on the ratio a/b for two sides of a right triangle. <math>\theta = \tan^{-1} \frac{b}{c}</math></p>	



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