# OPERATION AND INSTRUCTION MANUAL

# FOR

# MODEL 7520

# PRECISION VOLTAGE DIVIDER

**www.guildline.com**



**OM7520-D4-00**
**20 February 2024**

# WARRANTY AND SERVICE

**CERTIFICATION:** Guildline Instruments Limited certifies that this product was tested and inspected and found to meet its published specifications when it was shipped from the factory.

**WARRANTY:** This product is warranted against defects in materials and workmanship for a period of two years from date of shipment. During the warranty period, Guildline Instruments Limited will, at its option, either repair or replace products that prove to be defective.

**SERVICE:** For warranty service or repair, this product must be returned to the factory. The buyer shall prepay shipping charges to Guildline Instruments Limited and Guildline Instruments Limited shall pay surface shipping to the buyer. Permission must be obtained from the factory for warranty repair returns.

**LIMITATIONS:** The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the buyer, or unauthorized modifications or misuse.

Neither Guildline Instruments Limited nor any of its employees shall be liable for any direct or indirect, special, incidental or consequential damages arising out of the use of this product.

**No other warranty is expressed or implied.**

# SAFETY PRECAUTIONS

This product has been designed and tested in accordance with IEC1010-1/EN61010-1 including amendment 1(1995) for insulation category II use. Use of this equipment in a manner not specified could result in personal injury.

**AC POWER SOURCE:** This product is intended to operate from an ac power source that will apply not more than 264 V ac between either of the supply conductors and ground.

**POWER CORD:** Use only the power cord and connector appropriate for the voltage and plug configuration in your country. The cord must contain a safety ground conductor and be connected to a plug that has a connection to earth ground. Use only a power cord that is in good condition.

**SIGNAL INPUT POWER:** Signals applied to the input or output terminals must be limited to levels deemed safe by the IEC/EN specifications. When applied voltages are above 30 volts, the current source must limit the current to not more than 2 mA.

# TABLE OF CONTENTS

# LIST OF FIGURES

# 1. INTRODUCTION

## 1.1. DESCRIPTION

The Guildline Precision Automated Voltage Divider, with extremely low thermal offsets and built-in temperature controlled chamber, is ideal for voltage ratio measurements to sub-ppm accuracy. Input voltages in the range of 10 mV to 1100 V can be divided by ratios of 1000:1, 100:1, 10:1, 1:1 with uncertainty contributions respectively of 0.5, 0.2, 0.1 and 0.05 depending on the input voltage.

Special care has been taken to minimize thermal offsets and noise. The switches used are high isolation, low thermal relays. The 7520 can be operated from the front panel touch screen or by SCPI commands sent over the USB or IEEE Interfaces.


**Figure 1-1: Guildline Model 7520 Precision Voltage Divider**

The voltage divider is fully controlled by an internal micro-processor through a front panel touch screen, or via a connected computer using SCPI Commands.

## 1.2. WARRANTY

Each Model 7520 Precision Voltage Divider provided includes a two (2) year warranty in which Guildline Instruments warrants that the unit is free from defects in material, workmanship, manufacturing, and design and will perform to or exceed specifications, if operated properly, for the duration of the two (2) year warranty coverage. This warranty only extends to the intended original purchaser.

Guildline will repair or replace any failed unit at no additional cost to the customer. Guildline will be responsible for returning warranty standards to the owner and will bear transportation costs from the repair center back to the user. It will be the customer's responsibility for transportation costs for equipment returned to Guildline for repair or replacement. Warranty repairs will be provided in Canada.

**Guildline does not provide warranty service or file claims due to shipping damage. Customers are responsible for properly packaging instruments and insuring instruments, to account for the possibility of shipping damage.**

These warranties will not, in any way, be voided by any customer performed routine maintenance accomplished in accordance with Guildline's service procedures (e.g. replace fuses, adjust instrument in accordance with calibration instructions, lubrication, cleaning, etc.).

## 1.3. TO OBTAIN WARRANTY SERVICE

Before returning any warranty equipment to Guildline Service Center, a Return Authorization Number (RMA) and shipping instructions from Guildline Instruments is required. Guildline Service Center information is as follows:

The phone number in the USA and Canada to obtain Product Support, Calibration Service or Replacment Parts is (800) 310-8104.

To Contact Guildline Instruments, the following information is provided.

USA and Canada Telephone: (613) 283-3000
USA and Canada Fax: 1-613-283-6082

Outside US and Canada Telephone: + [0] [1] 613 283-3000
Outside US and Canada Fax: + [0] [1] 613 283-6082

You can also contact Guildline Instruments Limted via their Email or Website.

Email is: sales@guildline.com
Website is: www.guildline.com

## 1.4. SPECIFICATIONS

### VOLTAGE DIVIDER RATIO UNCERTANTIES

**7520 SPECIFICATIONS**

| Voltage Divider Ratio | Voltage Divider Ratios Output Uncertainty [1,2] |
|---|---|
| 1:1 | 0.05 |
| 10:1 | 0.1 |
| 100:1 | 0.2 |
| 1000:1 | 0.5 |

| Maximum Voltages | | |
|---|---|---|
| Maximum Voltages | Voltage Input Terminals | 1100 $V_{dc}$ |
| | Reference Standard Terminals | 12.5 $V_{dc}$ |

| Divider Mode | Ratios | Input Impedance[3] | Output Impedance |
|---|---|---|---|
| Divider Mode | 1:1 ratio | 2.303 MΩ | 0 Ω |
| | 10:1 ratio (V≤20) | 43.2 kΩ | 5.8 kΩ |
| | 10:1 ratio (V≤100) | 270 kΩ | 43.2 kΩ |
| | 10:1 ratio (V≤1000) | 2.303 MΩ | 270 kΩ |
| | 100:1 ratio | 2.303 MΩ | 43.2 kΩ |
| | 1000:1 ratio | 2.303 MΩ | 5.8 kΩ |

| Comparator Mode | Mode | Output Impedance |
|---|---|---|
| Comparator Mode | 10 mV (1000:1 ratio) | 5.8 kΩ ± 0.1 % |
| | 100 mV (100:1 ratio) | 43.2 kΩ ± 0.1 % |
| | 1 V (10:1 ratio (V≤100)) | 43.2 kΩ ± 0.1 % |
| | 10 V (1:1 ratio) | 0 Ω ± 0.1 % |
| | 100 V (10:1 ratio (V≤100)) | 43.2 kΩ ± 0.1 % |
| | 1000 V (100:1 ratio) | 43.2 kΩ ± 0.1 % |

| Communication | USB, IEEE 488.2, SCPI Based Language Instructions | |
|---|---|---|
| Environmental | Operating | Storage |
| Temperature | +21 °C to +25 °C (69.8 °F to 77 °F) | -20 °C to +60 °C (-4 °F to 140 °F) |
| Humidity | 20 % to 70 % RH | 15 % to 80 % RH (Non-Condensing) |
| Power Requirements | VAC: 100 V to 240 V ± 10 % / 50 or 60 Hz ± 5 %, 60 VA | |

| Dimensions (Length x Width x Height) | | Weight | |
|---|---|---|---|
| 503 mm x 455 mm x 133 mm | 19.8″ x 17.7″ x 5.2″ | 11 kg | 24 lbs |

1 – Relative to a 10 Vdc Voltage Reference Standard. Maximum input to the 7520 Voltage Reference terminals is 12.5 Volts.
2 – After Self-Alignment or within 140 hours (i.e. 1 week) from last Self-Alignment.
3 – Applies to Both the Divider Chain and Driven Guard.

## VOLTAGE DIVIDER STABILITY

| Ratio | Ratio Stability (parts in $10^{-6}$) | | Input Voltage |
|---|---|---|---|
| | 7 Day | 30 Day | |
| 1:1 ratio | 0.01 | 0.01 | 10 V |
| 10:1 ratio (V≤20) | 0.03 | 0.15 | 10 V |
| 10:1 ratio (V≤100) | 0.03 | 0.15 | 100 V |
| 10:1 ratio (V≤1000) | 0.03 | 0.15 | 1000 V |
| 100:1 ratio | 0.03 | 0.15 | 100 V |
| 1000:1 ratio | 0.05 | 0.25 | 1000 V |

*** Note that the 7520 Self-Calibration does not need external standards or operator intervention, is automated, and can be initiated with a single touch on the 7520 display screen. There is no need for a stability specification beyond 30 days because it is recommended that the self-calibration be done on a weekly or monthly basis.

## VOLTAGE DIVIDER RATIO SELECTIONS

1000:1, 100:1, 10:1, 1:1

## INPUT VOLTAGE RANGE

0.01 volts to 1100 volts

## NOMINAL OUPUT VOLTAGES

0.01, 0.1, 1.0, 10, 100, and 1000 volts

## ENVIRONMENTAL LIMITS

Operating: 21 ºC to 25 ºC and 20 % to 70 % relative humidity
Storage: -20 ºC to 70 ºC and 15 % to 80 % relative humidity

## POWER COEFFICIENT EFFECTS ON RATIO ACCURACY

< 0.015 ppm/V

**ALTITUDE EFFECTS**

Not Applicable if Self-Alignment Process is run at the same altitude as the ratio measurements. Any altitude effects will be compensated for by the Self-Alignment Process.

**DIVIDER RESISTANCE**

| | |
|---|---|
| Divider | 3.0 MΩ ± 0.1 % |
| Driven guard | 10.0 MΩ ± 0.1 % |

**INPUT RESISTANCE (no load on reference or output)**

| | |
|---|---|
| 1:1 ratio | 2.3 MΩ ± 0.1 % |
| 10:1 ratio (V ≤ 20) | 43.2 kΩ ± 0.1 % |
| 10:1 ratio (V ≤ 100) | 270 kΩ ± 0.1 % |
| 10:1 ratio (V ≤ 1000) | 2.3 MΩ ± 0.1 % |
| 100:1 ratio | 2.3 MΩ ± 0.1 % |
| 1000:1 ratio | 2.3 MΩ ± 0.1 % |

**OUTPUT RESISTANCE (no load on reference or input)**

| | |
|---|---|
| 1:1 ratio | 0 Ω ± 0.1 % |
| 10:1 ratio (V ≤ 20) | 5.8 kΩ ± 0.1 % |
| 10:1 ratio (V ≤ 100) | 43.2 kΩ ± 0.1 % |
| 10:1 ratio (V ≤ 1000) | 270 kΩ ± 0.1 % |
| 100:1 ratio | 43.2 kΩ ± 0.1 % |
| 1000:1 ratio | 5.8 kΩ ± 0.1 % |

**COMPARATOR MODE RESISTANCE**

| | |
|---|---|
| 10 mV | 5.8 kΩ ± 0.1 % |
| 100 mV | 43.2 kΩ ± 0.1 % |
| 1 V | 43.2 kΩ ± 0.1 % |
| 10 V | 0 Ω ± 0.1 % |
| 100 V | 43.2 kΩ ± 0.1 % |
| 1000 V | 43.2 kΩ ± 0.1 % |

**SIZE**

L x W x H: 503 mm (19.8 in.) x 450 mm (17.7 in.) x 133 mm (5.2 in.)

**WEIGHT**

11 kg (24 lb.)

**LINE POWER**

100 V – 240 V ± 10 %
45 Hz to 66 Hz
60 VA

# 2. INSTALLATION

## 2.1. INITIAL INSPECTION

This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of marks and scratches and in perfect electrical order upon receipt.

Unpack the instrument and retain the shipping container until the instrument has been inspected for damage in shipment. If in-shipment damage is observed, notify the carrier and obtain authorization for repairs before returning the instrument to the factory.

## 2.2. POWER REQUIREMENTS

The instrument is shipped with a three-wire line cord and must be connected to a grounded 50 to 60 Hz ac power source. This product will operate at between 100 V and 240 V all ± 10 %, install the appropriate fuses for local input voltage as per Section 3.2.

**WARNING: BEFORE SWITCHING ON THIS INSTRUMENT, THE PROTECTIVE TERMINAL OF THIS INSTRUMENT MUST BE CONNECTED TO A PROTECTIVE EARTH CONTACT. THE POWER LINE CORD SUPPLIED WILL PROVIDE THE PROTECTIVE GROUNDING WHEN INSERTED INTO A SOCKET OUTLET PROVIDED WITH AN EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD OR ADAPTOR WITHOUT A PROTECTIVE GROUNDING CONDUCTOR.**

## 2.3. LOCATION

To ensure optimum performance, the Precision Voltage Divider should be installed in an area having reasonably constant temperature, no strong electrostatic or magnetic fields, and a minimum amount of vibration. The unit should not be located near heating or cooling vents or in direct sunlight. Such locations can cause sudden temperature changes resulting in generation of errors in the measurements due to thermal effects.

**WARNING: NEVER CHANGE OR ENGAGE A VOTAGE DIVIDER MODE OF OPERATION WHILE LIVE VOLTAGE IS PRESENT. DOING SO CAN DAMAGE THE VOLTAGE DIVIDER, OTHER CONNECTED EQUIPMENT AND POSSIBLY RESULT IN INJURY OR DEATH. THE VOLTAGE DIVIDE CAN BE OPERATED UP TO 1100 V AND THEREFORE LEATHAL VOLTAGES MAY BE PRESENT ON INPUT TERMINALS OR EVEN OUTPUT TERMINALS IF USED INCORRECTLY.**

## 2.4. WARM-UP AND SELF ALIGNMENT

When the 7520 is first powered up a red screen will appear during an initialization phase which takes about 20 seconds. Following successful initialization, you will be greeted by the main screen, the heaters will be automatically turned ON and the status bar at the bottom of all screens will show “Warming up”. The warming up process takes about 6 hours and varies slightly depending on the ambient temperature. During this time the internal temperature stabilized chamber is warming up to the default set point of approximately 37 degrees.

You still can use the device and access the functionality of the Voltage Divider by going to the “Setup” menu and selecting “Non-Align”. This will allow going through the various configurations and perform functional measurements. However the 7520 specifications are not guaranteed until the temperature chamber is stabilized.

Once the warming up is complete the screen will indicate “Warmed up”.

At this point you will need to select “Self-Align” found under the “Setup” menu. If you attempt to run this “Self-Align” before the system is warmed up it will not be initiated since this function cannot be done until the unit has reached a stable temperature. The user will be brought to the “Self-Alignment” screen where the user will see the “Warming up” progress bar. After warming up is completed, the Self-Alignment will start automatically. Progress of the Self-Alignment function is shown for each stage of the divider by a progress bar and a “Self-Alignment in process” appears in the status bar of all screens. After successful completion of the “Self-Alignment” the bottom banner of the screens displays” Self-Alignment passed”. The Self Alignment takes about 2 hours to complete.

**WARNING:** If the 7520 has been used in the “Non Align” mode with a voltage higher than 100 V, the “Self Alignment” should not be invoked for 6 hours in order to ensure temperature stability.

If the warm-up fails, the status will show “Warm up failed”. Also note that if this message is displayed any time after continuous use it could be the result of either the 7520 being in an environment that is too warm or the temperature control has failed. Be aware that the proximity of another piece of equipment could cause warm air to blow on the Voltage Divider and cause the triggering of the “Warm up Failed” alarm.

If the warm-up fails, power down the 7520 for an hour and ensure the environment is within the operating limits, and then power it back on. If the temperature chamber still fails to stabilize then the unit must be returned to the factory for repair.

If the Self-Alignment fails, the status bar will display “Self-Alignment failed”. If the Self-Alignment fails, turn off and restart 7520. If the problem persists the unit needs to be returned to the factory.

# 3. MANUAL OPERATION

## 3.1. FRONT PANEL


**Figure 3-1: Front Panel Guildline Model 7520**

1. **TOUCH SCREEN INTERFACE** - Used for front panel operation. Refer to section 3.3 for operation.
2. **VOLTAGE INPUT** - Terminals for connection to the input of the voltage divider resistance chain.
3. **NULL DETECTOR** - Terminals for connection to an external null detector.
4. **VOLTAGE REFERENCE** - Terminals for connection of a reference voltage standard.
5. **VOLTAGE OUTPUT** - Terminals for connection to the outputs of the voltage divider chain.
6. **GUARD -** Terminal for connection of the internal passive guard of the voltage divider chain.
7. **GND** - Terminal for connection to the internal ground tied to the power line ground (i.e. earth).

## 3.2. REAR PANEL

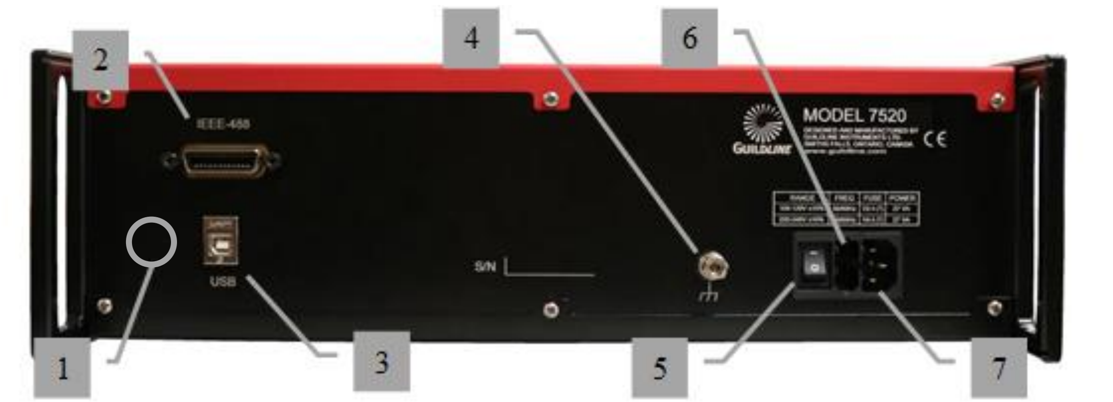



**Figure 3-2: Rear Panel Guildline Model 7520**

1. **BOOTLOADER SWITCH** - Switch to allow firmware upgrade.
2. **IEEE-488** - Access for IEEE-488 interface bus for external control.
3. **USB INTERFACE BUS** - Type B connector used to connect voltage divider to external controller (i.e. computer).
4. **CHASSIS** - Terminal for connection to the chassis tied to power line ground (i.e. earth).
5. **POWER** - Line input voltage on/off switch.
6. **FUSE** – 1.5 A Time Delay for 100 V – 127 V, 0.75 A Time Delay for 220 V– 240 V.
7. **100 V – 240 V AC POWER INPUT** - IEC Line cord to AC mains. 100 V to 240 V ± 10 %; 45 Hz to 66 Hz.

## 3.3. FRONT PANEL OPERATION

The Precision Voltage Divider is operated manually using the touch screen interface. The GUI (Graphical User Interface) navigates through all of the functions and operation of the 7520. The navigation is straightforward and is described in the following diagram of the screen/menu hierarchy.

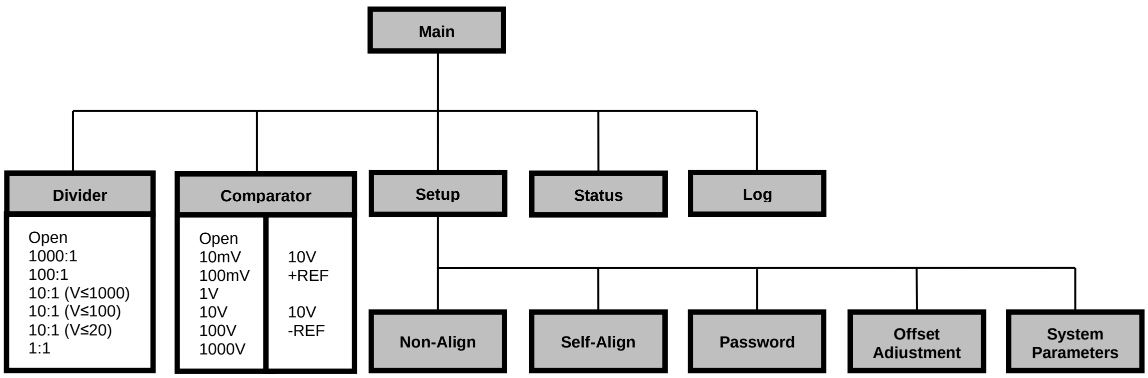



**Figure 3-3: Guildline Model 7520 Menu/Screen Hierarchy**

**Note: The display responds better with the use of touch screen stylus rather than a finger.**

**WARNING: NEVER CHANGE OR ENGAGE A VOTAGE DIVIDER MODE OF OPERATION WHILE LIVE VOLTAGE IS PRESENT. DOING SO CAN DAMAGE THE VOLTAGE DIVIDER, OTHER CONNECTED EQUIPMENT AND POSSIBLY RESULT IN INJURY OR DEATH. THE VOLTAGE DIVIDE CAN BE OPERATED UP TO 1100 V AND THEREFORE LEATHAL VOLTAGES MAY BE PRESENT ON INPUT TERMINALS OR EVEN OUTPUT TERMINALS IF USED INCORRECTLY.**

## 3.4. TOUCH SCREEN DISPLAY FUNCTIONS

### 3.4.1. Opening Banner/Main Display Screen

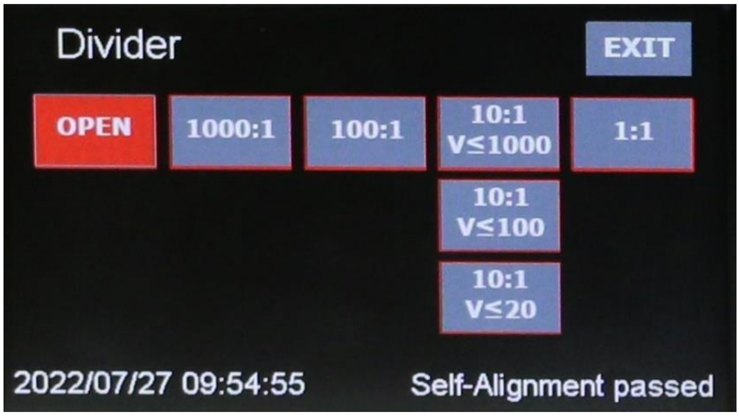

The opening banner appears on start-up of the 7520. The opening banner provides system information of the 7520 such as firmware revision, and system date/time of the 7520. The opening banner is also the root of the menu system. There are 5 main menu areas on the 7520 indicated by “Divider”, “Comparator”, “Setup”, “Status”, and “Log”. Touch either of these grey areas to activate the corresponding menu features. The Status Bar located at the bottom of the screen indicates the status information for the Voltage Divider and is present in all screens of the user interface.

**Note: The first two selections are for the two different operational modes of the 7520. These two modes are the “Divider” mode of operation and the “Comparator” mode of operation.**

The “Divider” selection corresponds to a straightforward voltage divider where the voltage provided on the “Voltage Input” terminals is simply divided by the chosen ratio and this divided voltage is provided on the “Voltage Output” terminals.

The “Comparator” selection corresponds to a comparison voltage divider where the voltage provided on the “Voltage Input” terminals is compared to a reference voltage connected to the “Reference Voltage” terminals. This is accomplished with an external null detector through the “Null Detector” terminals.

### 3.4.2. Divider Menu Screen




The “Divider” menu allows the selection of the available divider voltage ratios and displays the current status of the measurement configuration. On the display you will see the status of the configuration indicated in red, signifying the active measurement configuration.

This “Divider” operation mode is used with a Zener voltage reference to generate lower voltages. The “Divider” mode is also desirable when dividing down a programmable or arbitrary voltage source when not compared to a reference voltage cell. This operation mode offers flexibility and simplicity to work with non-decade values of voltage.

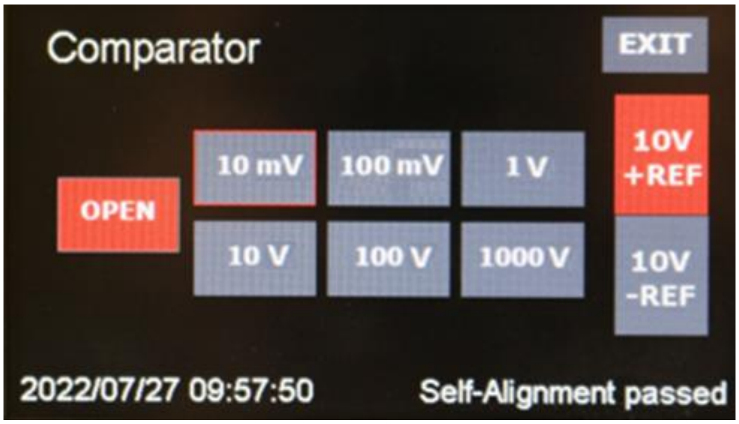
When calibrating working voltage references, Digital Multi-Meters (DMMs), or Volt-Meters the “Divider” mode is used.

You can touch the desired ratio button to engage the configuration. The line will turn red and the “Open” button will turn white. You should always disengage a configuration before engaging a new configuration. Selecting the “Open” button will disengage all measurement configurations and return the active red highlighted range back to white.

If the voltage divider has not been self-aligned (i.e. self-calibrated) the message ‘NON-ALIGNED’ will appear highlighted in yellow. The 7520 can be operated in Non-Aligned mode but the uncertainty of the ratio measurements is not specified.

**WARNING: NEVER CHANGE OR ENGAGE A VOTAGE DIVIDER MODE OF OPERATION, OR RATIO, WHILE LIVE VOLTAGE IS PRESENT. VOLTAGE INPUTS SHOULD BE TURNED OFF BEFORE SWITCHING MEASUREMENT CONFIGURATIONS. CHANGING MEASUREMENT SETUPS WITH LIVE INPUT VOLTAGE CAN DAMAGE THE VOLTAGE DIVIDER, OTHER CONNECTED EQUIPMENT AND POSSIBLY RESULT IN INJURY OR DEATH. THE VOLTAGE DIVIDE CAN BE OPERATED UP TO 1100V AND THEREFORE LEATHAL VOLTAGES MAY BE PRESENT ON INPUT TERMINALS OR EVEN OUTPUT TERMINALS IF USED INCORRECTLY.**

### 3.4.3. Comparator Menu Screen



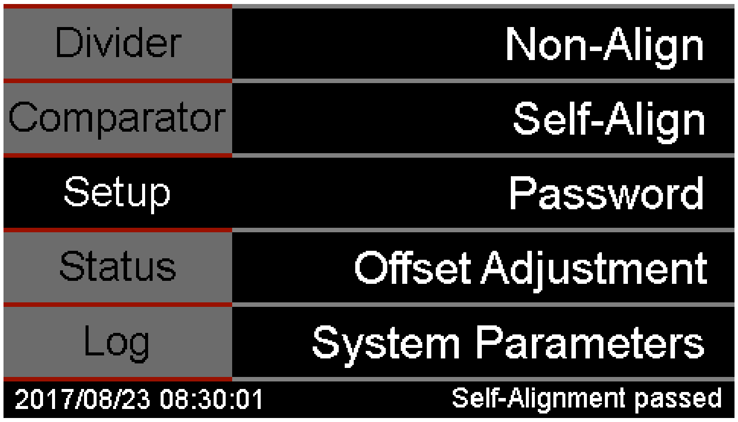

The “Comparator” menu allows the selection of the available divider voltage comparisons to a reference voltage and displays the current status of the measurement configuration. On the display you will see the status of the configuration indicated in red, signifying the active measurement configuration. This operation mode is desirable when using decade values of voltage and comparing them to a 10 V reference standard.

When calibrating voltage sources, such as calibrators, the “Comparator” mode is used. You can touch the desired voltage button to engage the configuration. The line will turn red and the “Open” button will turn white. You should always disengage a configuration before engaging a new configuration. Selecting the “Open” button disengage all measurement configurations and return the active red highlighted range back to white.

You can also reverse the polarity of the reference voltage by selecting the polarity on the right of the screen. The currently active polarity setting is highlighted in red. Note that it is not safe practice to reverse the polarity under live voltage so the divider will return to “Open” when the reverse polarity is activated. You can then ensure your setup is correct and the other input voltage polarity is set accordingly then activate the appropriate comparator operation mode.

**WARNING: NEVER CHANGE OR ENGAGE A VOTAGE COMPARATOR MODE OF OPERATION, OR RATIO, WHILE LIVE VOLTAGE IS PRESENT. VOLTAGE INPUTS SHOULD BE TURNED OFF BEFORE SWITCHING MEASUREMENT CONFIGURATIONS. CHANGING MEASUREMENT SETUPS WITH LIVE INPUT VOLTAGE CAN DAMAGE THE VOLTAGE DIVIDER, OTHER CONNECTED EQUIPMENT AND POSSIBLY RESULT IN INJURY OR DEATH. THE VOLTAGE DIVIDE CAN BE OPERATED UP TO 1100V AND THEREFORE LEATHAL VOLTAGES MAY BE PRESENT ON INPUT TERMINALS OR EVEN OUTPUT TERMINALS IF USED INCORRECTLY.**

### 3.4.4. Setup Menu Screen




The "Setup" menu allows the setup of system functions such as Alignment, Remote Setting and System Password. All of these menu items will direct you to a sub-screen with the pertinent options and details, with the exception of "Non-Align" which is simply a state toggle. The remaining functions outlined below are explained in further detail.

**Note: The "Non-Align" function enables a forced operation override of the 7520 such that the device will allow operation in a "Non-Aligned" therefore uncalibrated state. This is intended for demonstration and training purposes and should never be used for official measurements. If during "Non-Align" mode voltages higher than 100 V have been used, self-alignment should not be invoked for 6 hours to allow the resistor chain to cool to its nominal temperature.**

The "Self-Align" will invoke the Self Alignment process after the system has reached temperature stability of the internal chamber.

The "Password" allows the changing of the system password to protect the calibration integrity of the instruments from possible unintended change.

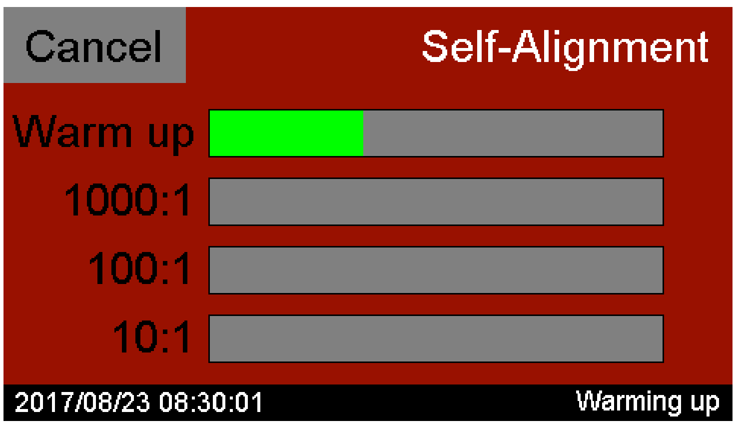
The "Offset Adjustment" allows a direct adjustment and view of voltage ratio adjustments (i.e. calibration coefficients) if utilized by the operator.

The "System Parameters" allows the setting of things such as GPIB address, Date, and Time.

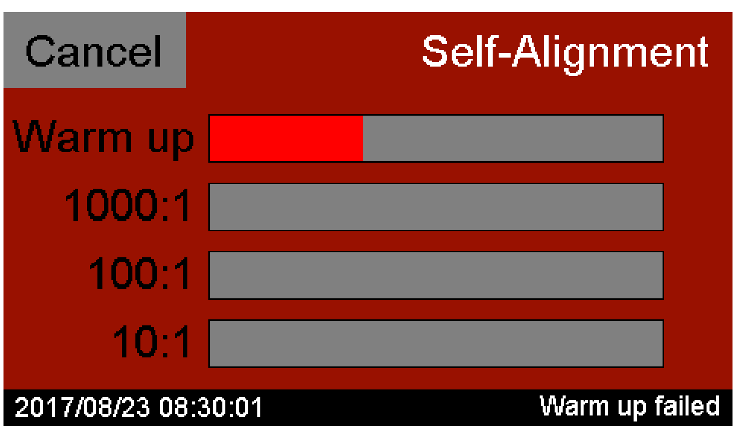
### 3.4.4.1. Self-Alignment Screen

The “Self-Align” menu function initiates the internal ratio alignment / self calibration routine. You will be able to view the status while this routine is executing via the screen with the four status bars. You can cancel the alignment with the “Exit” button to the upper left. The system will remain uncalibrated until such time the alignment process has successfully completed. If the alignment is attempted before the system has finished the 6 hour warm up temperature stability process the 7520 will not initiate self alignment.

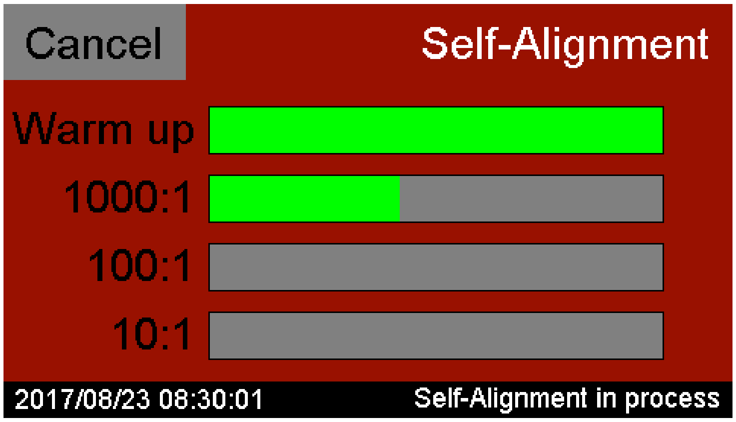
**Note: The “Exit” button will only cancel the alignment process, but the warming up process will still continue in the background.**



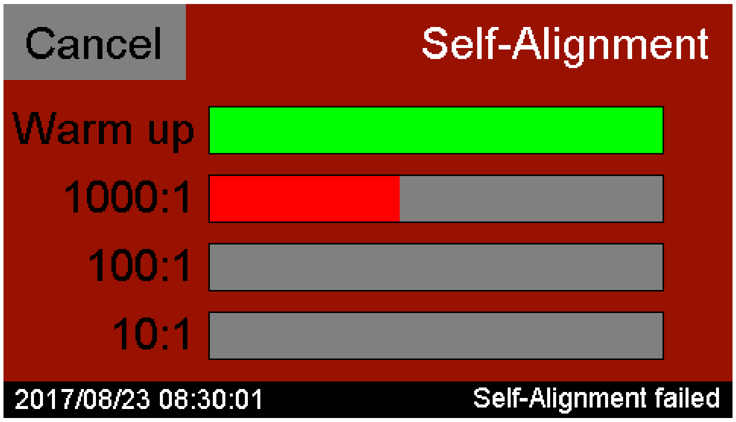

If the warming up process failed, the warm up status bar will turn red and a “Warm up failed” message will appear. The 7520 will then wait for the operator to respond.



When the device is warmed up, the Self-Alignment / Self-Calibration process will start. The bottom bar will show “Self-Alignment in process” as the current state.

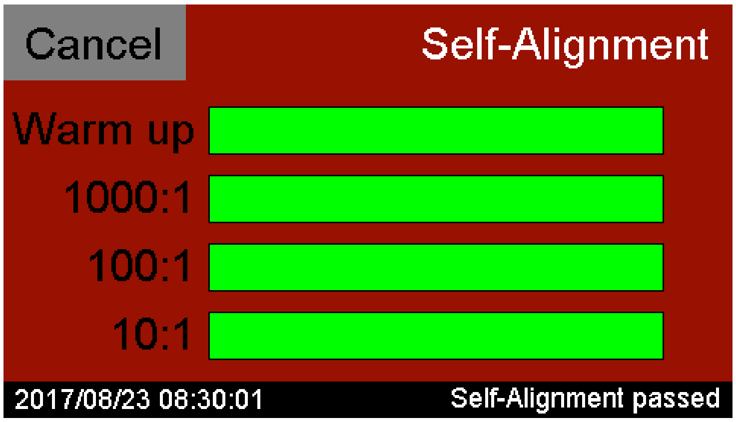



If something during self-alignment does go wrong, the self-alignment process bar will turn red and a “Self-Alignment failed” message will appear. The 7520 will then wait for the operator to respond.

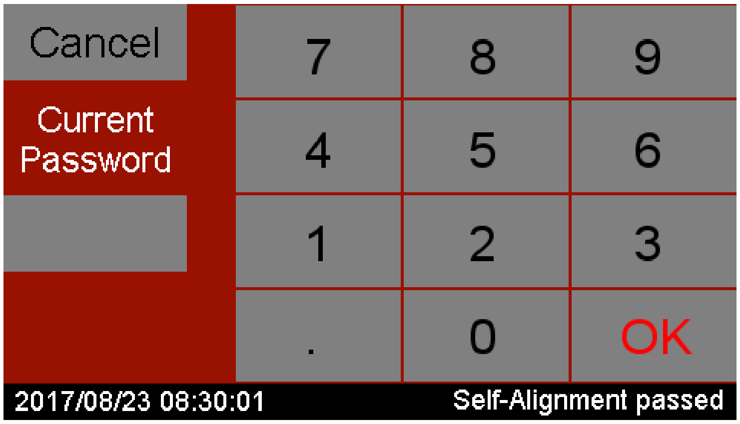



**Note: If a “Self-Alignment failed” error occurs then the 7520 may be too close to a heat source or fluctuating temperature. Power down the 7520 and verify the environmental conditions. Power the 7520 back on, and if the problem persists, the device may need to be returned to the factory for repair.**

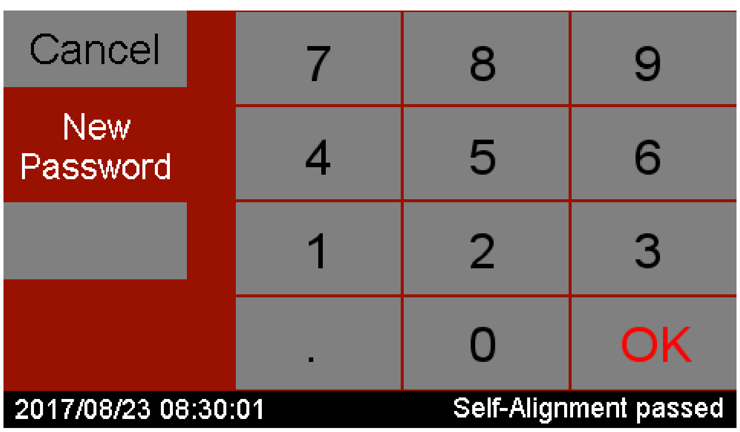
If the Self-Alignment process is successfully passed, all the process bars will remain green and the bottom bar state becomes "Self-Alignment passed".



### 3.4.4.2.Password Screen

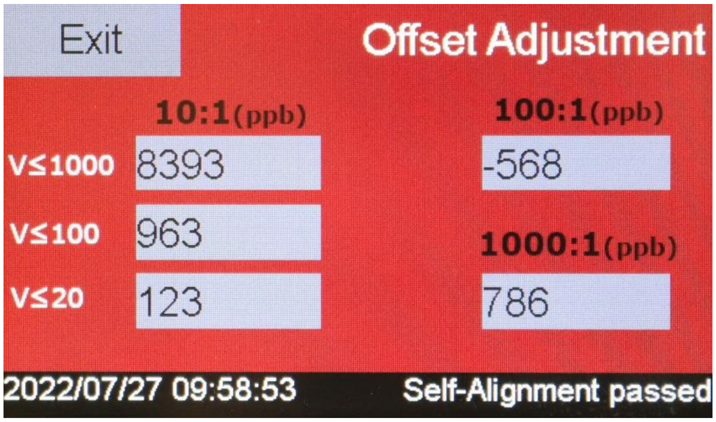



To allow access to the system and calibration functions of the 7520 a system password must be entered. This screen allows an operator to change the system password. When entering the “Password” menu you will be prompted to “Current Password” by this screen then press the “OK” button. If the password is correct then you will be forwarded into the “New Password” screen, otherwise you will be returned to the “Setup” menu. Lastly the “Cancel” button exits the screen back to the “Setup” menu.




**Note: The operator should type in four digits for the password value (0231, 2321, 5633, etc.). The default password is “7520”.**

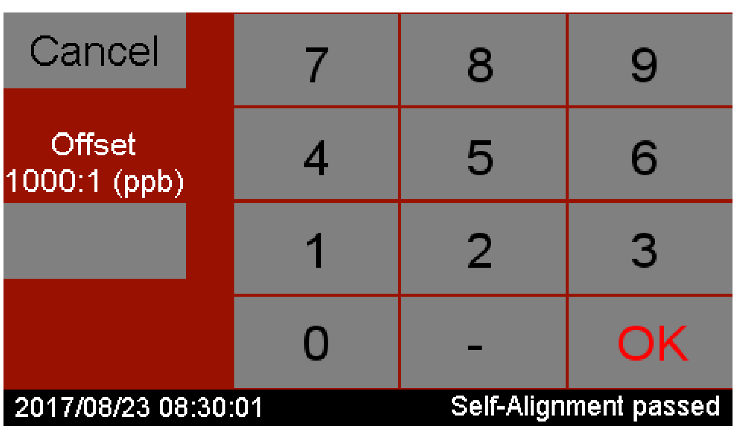
#### 3.4.4.3.Offset Adjustment Screen

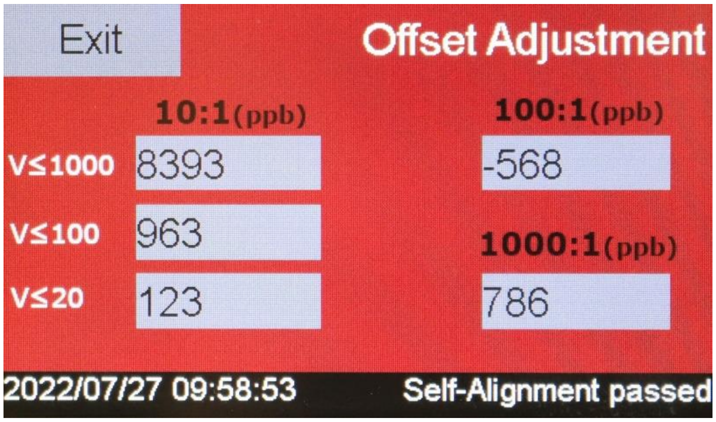



The "Offset Adjustment" screen displays the divider voltage ratios and their respective adjusted/calibrated offsets. You can adjust these values by touching the grey areas respectively. Any calibration parameter entered is used as an "offset" to adjust the voltage ratio that is calculated by the Self-Alignment Process.

**Note: This screen alters the ratio values determined by the Self-Alignment Process and it is recommended that the Calibration Parameters not be changed; and if changed that it be done by qualified personnel. On original shipment these parameters are set to the Guildline calibration settings.**

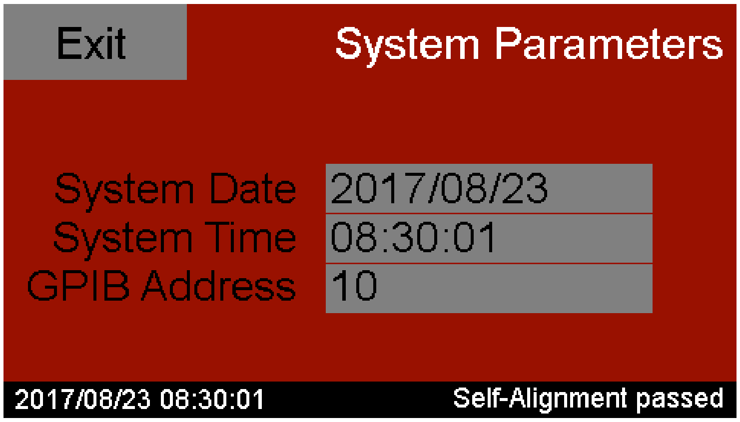
**Note: The screens to change the offset adjustments are password protected. After pressing one of the offset adjustment fields the user will be brought to a password protection screen. After password entry and pressing "OK", the user will be able to enter a new value for the selected offset adjustment ratio.**



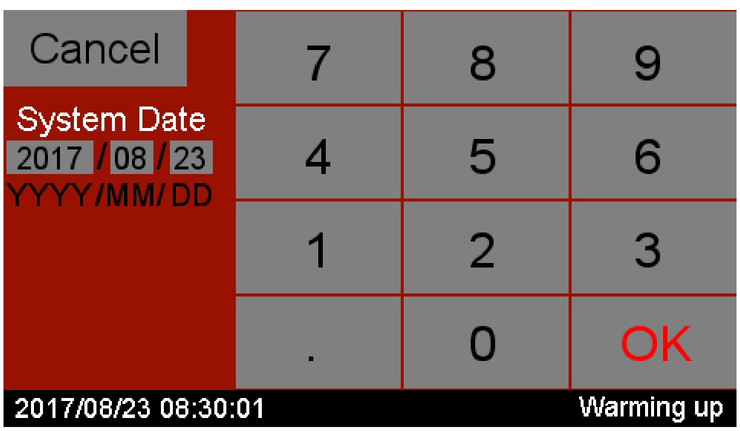



**The user can enter the new value and either press "OK" then "Save & Exit" to save the value in the unit flash, or press "Cancel".**

### 3.4.4.4.System Parameters Screen




The "System Parameters" screen displays and allows changes to be made to the system parameters of the 7520. Touching any of the grey areas will open a corresponding screen to edit and change the parameter displayed in the grey areas. The "Exit" function closes the screen and returns to "System Parameters" menu. These screens are password protected and defined below.



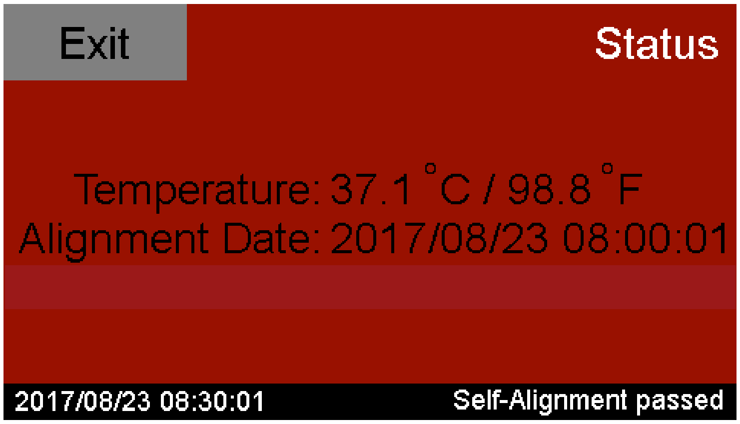

The "System" >> "Date" screen allows changes to be made to the 7520 system date. Touching the grey areas will place a cursor into the field allowing the field to be changed. The "OK" button sets the date to the date displayed and exits the screen. Lastly the "Cancel" exits the screen without applying the change.


The "System" >> "Time" screen allows changes to be made to the 7520 system time. Touching the grey areas will place a cursor into the field allowing the field to be changed. The "OK" button sets the time to the time displayed and exits the screen. Lastly the "Cancel" exits the screen without applying the change.


The "System" >> "GPIB Address" screen allows changes to be made to the 7520 GPIB Address. Touching the grey area will place a cursor into the field allowing the field to be changed. The "OK" button sets the address to the address displayed and exits the screen. Lastly the "Cancel" exits the screen without applying the change. By default the GPIB Address is set to 10.

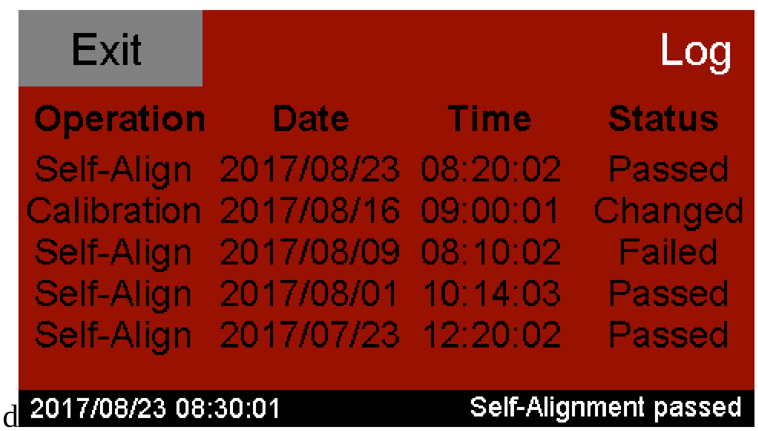
**NOTE: The GPIB address must be entered as 2 digits. For example address '4' must be entered as "04".**

### 3.4.5. Status Screen




The “Status” screen shows the system status such as last alignment date/time, calibration date/time, system date/time, and internal temperature. You may enter this screen at any time without affecting the measurement. The information on this display is updated once a second.

### 3.4.6. Log Screen

d 


The “Log” screen displays up to five system events on each page. These events include dates that the “Self-Alignment” functions were finished, and dates that the “Offset” values were changed. Up to 51 log events are retained. Older events will be deleted automatically to make room for new events as needed.

**Note: Event log details can also be accessed using SCPI commands.**

## 3.5. CONNECTION AND VOLTAGE DIVIDER INSTRUCTIONS

The 7520 Precision Voltage Divider can be configured for voltage ratios from 1:1 up to 1000:1. There are four primary ratio configurations for dividing voltages up to a maximum of 1100 V and down to 1 mV. For the 10:1 ratio there are three options with different input voltages, each with a different output impedance. When using a DMM as a voltage meter connected to the 7520, it is best to use the 10:1 ratio with the lowest output impedance (i.e. 5.8 kΩ) for lower voltages such as 1 Volt and 10 Volt. Most DMMs have a noisier (i.e. higher uncertainty) measurement when connected to a device with higher output impedances. If comparing the 7520 output ratios to a Fluke 752 voltage divider using a DMM it is better to select the 10:1 ratio with the 43.2 kΩ output impedance. A Fluke 752 has about a 40 kΩ output impedance and a connected DMM will give a more consistent measurement if connected to voltage dividers that have similar output impedances.

For best measurement practice if a series of tests are to be conducted over a wide voltage range, it is recommended to start at the lowest voltage outputs working up to the highest voltage. Operators should also be aware that body heat from touching lead and terminals can result in thermals that can introduce errors. Due to the high impedance of most voltage measurement equipment and testing operator proximity can also affect the results. It is best practice to allow all tests to settle for a minimum 3 to 5 minutes and to remain 3 meters (10 feet) away from the test setup, especially if a null detector is being used. For optional results especially if a null detector is used, an EMI cage to shield the system is recommended, though not necessary to meet specifications.


**Figure 3-4: Model 7520 Connections for Operation as a Voltage Divider**

### 3.6. 1:1 RATIO DIVIDER

This configuration is used to directly output the voltage present at the Voltage Input terminals. Connect the measurement components as described in Figure 3-4.

Configure the touch screen for the 1:1 divider ratio and enable the divider. Turn on the input voltage source and the same voltage will be reproduced at the Voltage Output as driven into the Voltage Input. Allow sufficient time for the measurement to stabilize. Once stabilized the output voltage will be a 1:1 ratio value within 0.05 ppm of the certified value.

### 3.7. 10:1 RATIO DIVIDER

This configuration is used to divide by a factor of 10 the voltage that is present at the Voltage Input terminals. Connect as described in Figure 3-4.

Configure the touch screen for one of the three 10:1 divider ratios and enable the divider. The three 10:1 divider ratios have different output impedances and are designed to work with different input voltages as below:

| | |
|---|---|
| 10:1 ratio (V ≤ 20) | 5.8 kΩ ± 0.1 % |
| 10:1 ratio (V ≤ 100) | 43.2 kΩ ± 0.1 % |
| 10:1 ratio (V ≤ 1000) | 270 kΩ ± 0.1 % |

Turn on the input voltage source and a voltage will be produced at the Voltage Output that is the Voltage Input divided by 10. Allow sufficient time for the measurement to stabilize. Once stabilized the Voltage at the 10:1 divided output terminals contributes 0.2 ppm to the total measurement uncertainty. The total measurement uncertainty must also include the uncertainty contribution from the voltage source(s) and the digital volt meter or DMM or null detector which is used to measure the output voltage.

When using a DMM as a voltage meter / null detector the input impedance of the DMM acts as a resistor in parallel with the output impedance of the 7520 and this creates an offset in the measurement. For example, a Fluke 8588A has an input impedance of 10 MΩ +/- 1% for the 100 V range. The 10 MΩ input impedance of the 8588A is in parallel with the 270 kΩ output impedance of the 7520 and results in about 2.63% offset due to a loading effect. Another example is if a DMM has 1 MΩ input impedance it will create a loading effect of 21.3% on the measurements. For an accurate reading, the offset created by the input impedance of the DMM can be mathematically calculated and a manual adjustment can be applied.

The 10:1 ratio (V ≤ 20) with output impedance of 5.8 kΩ can handle up to 100 Volts and the 10:1 ratio (V ≤ 100) with output impedance 43.2 kΩ can handle up to 400 Volts. Any voltage higher than these values might damage the divider chain and cause a “Warmed up Failure” of the unit. In this scenario the unit needs to be returned to the factory for repair.

## 3.8. 100:1 RATIO DIVIDER

This configuration is used to divide by a factor of 100 the voltage that is present at the Voltage Input terminals. Connect as described in Figure 3-4.

Configure the touch screen for the 100:1 divider ratio and enable the divider. Turn on the input voltage source and a voltage will be produced at the Voltage Output that is the Voltage Input divided by 100. Allow sufficient time for the measurement to stabilize. Once stabilized the Voltage at the 100:1 divided output terminals contributes 0.2 ppm to the total measurement uncertainty. The total measurement uncertainty must also include the uncertainty contribution from the voltage source(s) and the digital volt meter or DMM or null detector which is used to measure the output voltage.

1000:1 RATIO DIVIDER

This configuration is used to divide by a factor of 1000 the voltage that is present at the Voltage Input terminals. Connect as described in Figure 3-4.

Configure the touch screen for the 1000:1 divider ratio and enable the divider. Turn on the input voltage source and a voltage will be produced at the Voltage Output that is the Voltage Input divided by 1000. Allow sufficient time for the measurement to stabilize. Once stabilized the Voltage at the 1000:1 divided output terminals contributes 0.5 ppm to the total measurement uncertainty. The total measurement uncertainty must also include the uncertainty contribution from the voltage source(s) and the digital volt meter or DMM or null detector which is used to measure the output voltage.

## 3.9. CONNECTION AND VOLTAGE COMPARISON INSTRUCTIONS

There are six measurement configurations for making comparisons of decade value voltages of 0.01, 0.1, 1, 10, 100 and 1000 volts as described in section 4.5 of this Manual. These comparisons are all with respect to a 10 Volt Reference Standard. In addition to the 10 Volt Reference Standard, a suitable null detector, DMM, or volt meter is required to make the voltage comparisons.

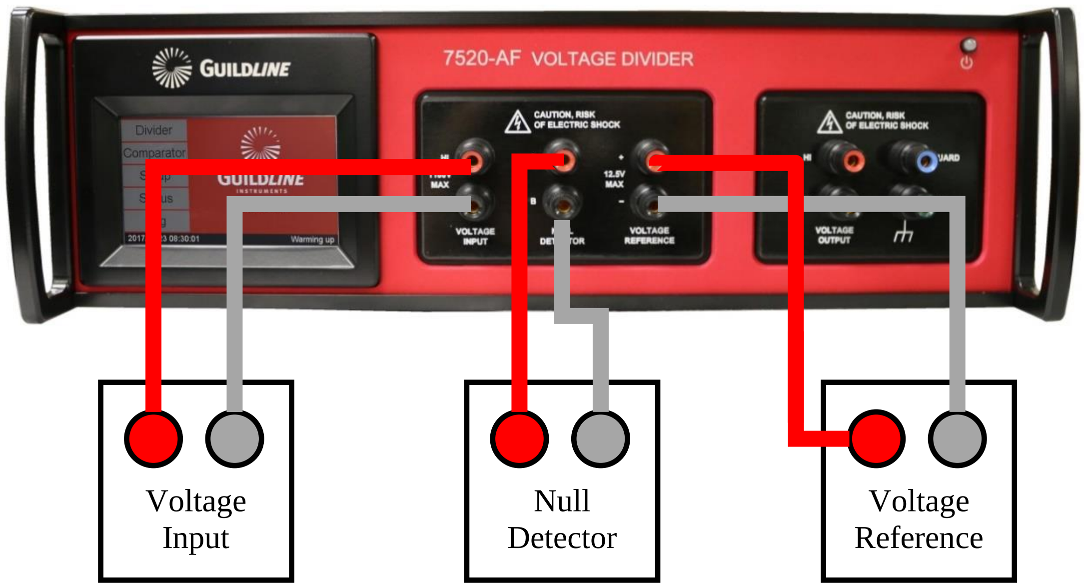



**Figure 3-5: Model 7520 Connections for Comparisons UUT to 10 Volts**

**NOTE: An operator needs to be aware that body heat from touching leads and terminals can result in thermals that can introduce errors. Due to the high impedance of most voltage measurement equipment operator proximity can also affect the measurement results. It is best practice to allow all tests to settle for at least 30 minutes and to remain 3 meters (i.e. 10 feet) away from the test setup; or to use an EMI cage to shield the system to obtain optimal results. Note that the connected Null Detector may be affected by EMI and other sources of noise. The measurements should be performed in both polarities.**

**NOTE: In this configuration the Output Terminal is not used and should be disconnected from any other equipment. Leaving this terminal connected to any other device may result in loading errors.**

**NOTE: all 6 configurations are covered with the above shown connections. (Reference Section 4 Configurations A, B, C, D, E, and F).**

### 3.10. 0.01 VOLT, 1000:1 RATIO COMPARISON

Configuration A is used for the comparison of a 0.01 volt source to a 10 volt reference standard. Connect the measurement components as described in Figure 3-5.

Configure the touch screen in the “Comparator” menu (section 3.4.3) for the 10 mV comparison and enable the divider. Turn on the output from the 10 volt reference connected to the Voltage Reference terminals and the output from the 0.01 volt source connected to the Voltage Input terminals and adjust the 0.01 volt source for a null indication on the null detector. Allow sufficient time for the measurement to stabilize. Once a null is obtained the 0.01 volt source is equal to the 10 volt reference standard certified value divided by the 1000:1 ratio of the 7520.

### 3.11. 0.1 VOLT, 100:1 RATIO COMPARISON

Configuration B is used for the comparison of a 0.1 volt source to a 10 volt reference standard. Connect the measurement components as described in Figure 3-5.

Configure the touch screen in the “Comparator” menu (section 3.4.3) for the 100 mV comparison and enable the divider. Turn on the output from the 10 volt reference connected to the Voltage Reference terminals and the output from the 0.1 volt source connected to the Voltage Input terminals and adjust the 0.1 volt source for a null indication on the null detector. Allow sufficient time for the measurement to stabilize. Once a null is obtained the 0.1 volt source is equal to the 10 volt reference standard certified value divided by the 100:1 ratio of the 7520.

### 3.12. 1 VOLT, 10:1 RATIO COMPARISON

Configuration C is used for the comparison of a 1 volt source to a 10 volt reference standard. Connect the measurement components as described in Figure 3-5.

Configure the touch screen in the “Comparator” menu (section 3.4.3) for the 1 V comparison and enable the divider. Turn on the output from the 10 volt reference connected to the Voltage Reference terminals and the output from the 1 volt source connected to the Voltage Input terminals and adjust the 1 volt source for a null indication on the null detector. Allow sufficient time for the measurement to stabilize. Once a null is obtained the 1 volt source is equal to the 10 volt reference standard certified value divided by the 10:1 ratio of the 7520.

### 3.13. 10 VOLT, 1:1 RATIO COMPARISON

Configuration D is used for the comparison of a 10 volt source to a 10 volt reference standard. Connect the measurement components as described in Figure 3-5.

Configure the touch screen in the “Comparator” menu (section 3.4.3) for the 10 V comparison and enable the divider. Turn on the output from the 10 volt reference connected to the Voltage Reference terminals and the output from the 10 volt source connected to the Voltage Input terminals and adjust the 10 volt source for a null indication on the null detector. Allow sufficient time for the measurement to stabilize. Once a null is obtained the 10 volt source is equal to the 10 volt reference standard certified value.

## 3.14. 100 VOLT, 10:1 RATIO COMPARISON

Configuration E is used for the comparison of a 100 volt source to a 10 volt reference standard. Connect the measurement components as described in Figure 3-5.

Configure the touch screen in the "Comparator" menu (section 3.4.3) for the 100 V comparison and enable the divider. Turn on the output from the 10 volt reference connected to the Voltage Reference terminals and the output from the 100 volt source connected to the Voltage Input terminals and adjust the 100 volt source for a null indication on the null detector. Allow sufficient time for the measurement to stabilize. Once a null is obtained the 100 volt source is equal to the 10 volt reference standard certified value multiplied by the 10:1 ratio of the 7520.

Note that the 100 V source should be turned off before choosing this menu selection and should be turned off before choosing another menu selection.

## 3.15. 1000 VOLT, 100:1 RATIO COMPARISON

Configuration F is used for the comparison of a 1000 volt source to a 10 volt reference standard. Connect the measurement components as described in Figure 3-5.

Configure the touch screen in the "Comparator" menu (section 3.4.3) for the 1000 V for the 1000 volt comparison and enable the divider. Turn on the output from the 10 volt reference connected to the Voltage Reference terminals and the output from the 1000 volt source connected to the Voltage Input terminals and adjust the 1000 volt source for a null indication on the null detector. Allow sufficient time for the measurement to stabilize. Once a null is obtained the 1000 volt source is equal to the 10 volt reference standard certified value multiplied by the 100:1 ratio of the 7520.

Note that the 1000 V source should be turned off before choosing this menu selection and should be turned off before choosing another menu selection.

**NOTE:** When using a DMM as a Null Detector in the Comparator Mode it is very important to account for the error created by the input bias current in the measurement. Each individual DMM has an input bias current, where current flows from the amplifier through the input terminals of the DMM. In voltage measurements, there is some source impedance in series with the voltage source.

A small bias current through a small source impedance creates an offset voltage. In configurations where there is a sizeable source resistance from the voltage being measured (in the tens of kOhms), this resulting offset voltage due to the bias current could cause offset errors of several microvolts. This offset can be mathematically determined and manually corrected in the measurement.

# 4. THEORY OF OPERATION

## 4.1. INTRODUCTION

The Guildline Model 7520 Precision Voltage Divider is designed with an extremely stable voltage divider resistor chain with three divider sections (i.e. each with separate resistors that each provide a 10:1 ratio) with low thermal offsets. Each of the 10:1 divider sections can be chosen for the 10:1 ratio based on the voltage selected. The 100:1 ratio is obtained by cascading two of the 10:1 divider sections. The 1000:1 ratio is obtained by cascading all three 10:1 divider sections. The Voltage Divider is contained in a temperature controlled and EMI shielded chamber. Input voltages can be anywhere within the range of 0.01 to 1100 volts. Any voltages between 10 and 1100 Volts can be divided by ratio of 1000:1, 100:1, 10:1, and 1:1 with relative uncertainties (uncertainties are used rather than accuracies as in the table in section 1.4) of 0.5, 0.2, 0.1, and 0.05µV/V respectively to be compared to a 10 V voltage reference when using the Comparator mode. The voltage divider is fully controlled by an internal micro-processor through a front panel touch screen.

Several systems are used to protect the devices connected to the divider and the voltage divider itself from being damaged by operator error or internal failure. The 7520 Voltage Divider can be operated from the front panel touch screen or by commands sent over the USB or GPIB Interface.

## 4.2. LOW THERMAL DESIGN

Special care has been taken to minimize thermal offsets. Very stable resistors are used with a low temperature coefficients and minimal self-heating. The switches used are low thermal relays.

The main voltage divider chain and associated relays are housed in a temperature controlled enclosure. This isothermal enclosure helps to maintain a uniform temperature throughout the divider chain to minimize thermal offsets and maximize stability of the resistance divider components. The stability of the temperature controlled chamber can be monitored from the touch screen display.

### 4.3. INTERNAL CIRCUITS

The 7520 is designed to allow easy operation from both the USB or GPIB interfaces and the front panel. The USB interface is designed to work with a connected computer and installs as a virtual com port and can be used with any terminal program which supports serial interfaces, such as HyperTerminal.

To operate from the front panel, the touch screen interface allows for control of the settings and associated parameters for the two modes of operation and for each of the measurement configurations; as well as to activate the 7520 input and output connections through the divider chain sections.

Both the touch screen and USB/GPIB interfaces are controlled by a microprocessor which is kept isolated from the analogue circuits that are part of the voltage divider chain. This high isolation ensures no noise or offsets will be present in measurements conducted with the 7520 due to heat and noise from the rest of the circuitry inside the 7520.

### 4.4. CIRCUIT PROTECTION

The 7520 has several protection features to help ensure the equipment used with the 7520, as well as the 7520 itself, will be safe from damage. Critical voltages are monitored through the micro-processor which will disconnect inputs and outputs when over voltages are sensed.

The divider chain itself is protected from over voltages on the input as there is only one high impedance input that is used for all divider ratio configurations.

## 4.5. COMPARISON MEASUREMENT CONFIGURATIONS

The Model 7520 Precision Voltage Divider can be configured to allow relative and direct-ratio measurements of signals input to the front panel terminations for each of the voltage configurations shown in the diagrams below. These configurations are for forward and reverse polarity measurements. In all configurations the 10 V reference is connected to the Voltage Reference terminals and the Unit Under Test (i.e. UUT) is connected to the Input Voltage. The VD box refers to the internal divider section.

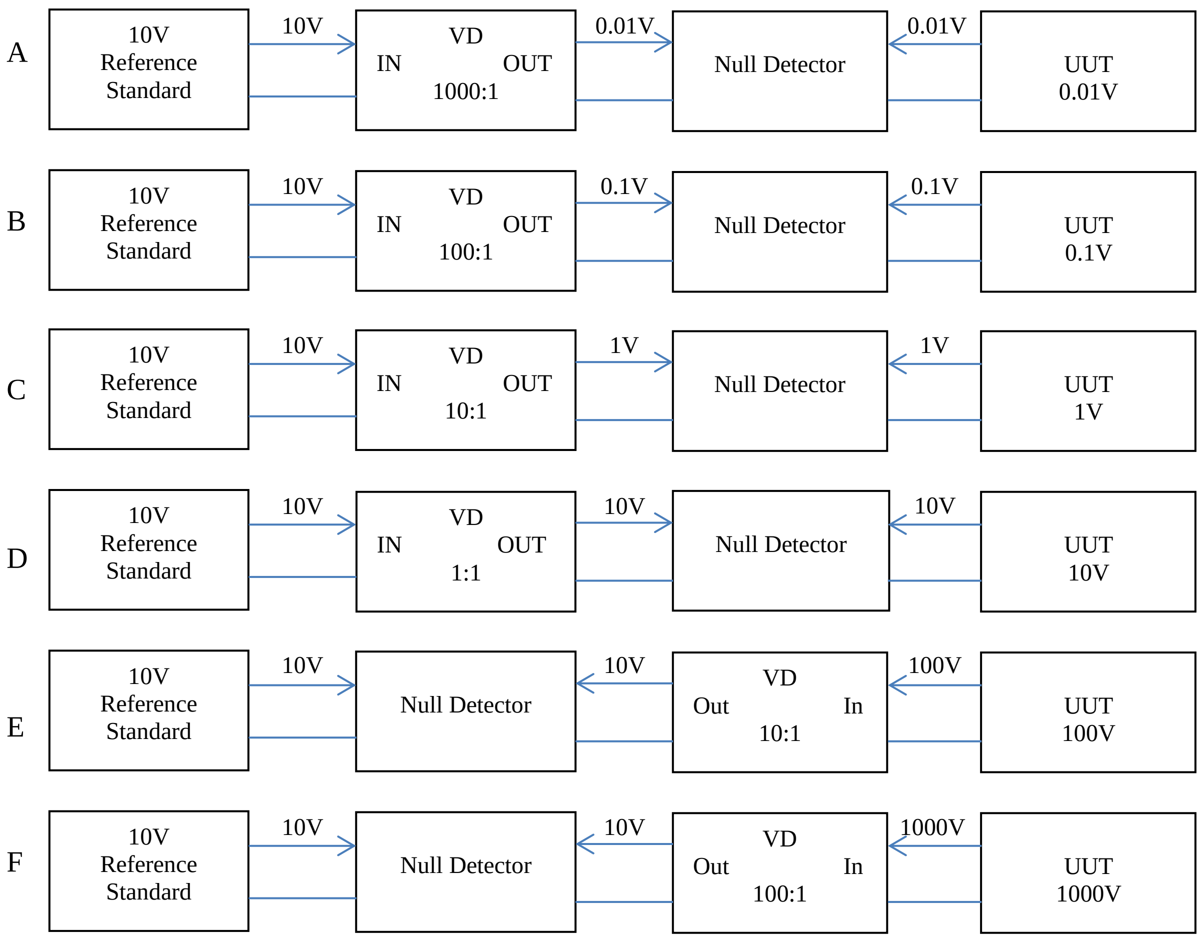



**Figure 4-1: 7520 Comparison Measurement Configurations**

**Note: In all configurations the output of the divider chain is connected to the high side (red terminal) of the null detector.**

## 4.6. MEASUREMENT CONFIGURATION A: 0.01 VOLT COMPARISON

Configuration A is used for comparison of a 0.01 volt source to a 10 volt reference standard through the voltage divider set up for a 1000:1 division. The 10 volt reference connected to the Voltage Reference terminals is connected internally to the high side of the 7520 divider resistance chain input. The low side of the divider chain produces a known 0.01 volt source to be compared to the UUT 0.01 volt source connected to the 7520 Voltage Input terminals. The comparison is done via an external null detector connected to the Null Detector terminals.

## 4.7. MEASUREMENT CONFIGURATION B: 0.1 VOLT COMPARISON

Configuration B is used for comparison of a 0.1 volt source to a 10 volt reference standard through the voltage divider set up for a 100:1 division. The 10 volt reference connected to the Voltage Reference terminals is connected internally to the high side of the 7520 divider resistance chain input. The low side of the divider chain produces a known 0.1 volt source to be compared to the UUT 0.1 volt source connected to the 7520 Voltage Input terminals. The comparison is done via an external null detector connected to the Null Detector terminals.

## 4.8. MEASUREMENT CONFIGURATION C: 1 VOLT COMPARISON

Configuration C is used for comparison of a 1 volt source to a 10 volt reference standard through the voltage divider set up for a 10:1 division. The 10 volt reference connected to the Voltage Reference terminals is connected internally to the high side of the 7520 divider resistance chain input. The low side of the divider chain produces a known 1 volt source to be compared to the UUT 1 volt source connected to the 7520 Voltage Input terminals.

## 4.9. MEASUREMENT CONFIGURATION D: 10 VOLT COMPARISON

Configuration D is used for comparison of a 10 volt source to a 10 volt reference standard through the voltage divider set up for a 1:1 division. The 10 volt reference connected to the Voltage Reference terminals is connected internally directly to one side of the 7520 divider Null Detector terminals. The 10 volt source to be compared is also connected to the other side of the Null Detector terminals. In this case the divider chain is bypassed internally. The comparison is done via an external null detector connected to the Null Detector terminals.

## 4.10. MEASUREMENT CONFIGURATION E: 100 VOLT COMPARISON

Configuration E is used for comparison of a 100 volt source to a 10 volt reference standard through the voltage divider set up for a 10:1 division. The Input Voltage terminals are connected internally to the high side of the 7520 divider resistance chain input. The low side of the divider chain produces 10:1 ratio of the 100 volt source (i.e. outputs 10 V) to be compared with the 10 V reference voltage that is connected to the Reference Voltage terminals. The comparison is done via an external null detector connected to the Null Detector terminals.

## 4.11. MEASUREMENT CONFIGURATION F: 1000 VOLT COMPARISON

Configuration F is used for comparison of a 1000 volt source to a 10 volt reference standard through the voltage divider set up for a 100:1 division. The Input Voltage terminals are connected internally to the high side of the 7520 divider resistance chain input. The low side of the divider chain produces 100:1 ratio of the 1000 volt source (i.e. outputs 10 V) to be compared with the 10 V reference voltage that is connected to the Reference Voltage terminals. The comparison is done via an external null detector connected to the Null Detector terminals.

## 4.12. INTERNAL RATIO ALIGNMENT

The 7520 Precision Voltage Divider contains an internal calibration subsystem that does not require any external standards to operate. It is designed with a fully automatic Voltage Ratio Alignment function (i.e. Self Calibration) which can be invoked from the front panel touch screen as may be desired by the user. The Voltage Ratio Alignment cannot be performed when the 7520 is powered on until the temperature controlled chamber has a stable temperature. The alignment function is completed within about 2 hours and the touch screen will report the results of the alignment. There are no external components required for the internal ratio alignment as the 7520 has an internal Wheatstone Bridge, a very stable, Zener based Voltage Reference source which is temperature controlled, and an internal very low uncertainty optical based Null Detector which is self calibrating.

During the Ratio Alignment process, the resistors in each of the three 10:1 ratio networks are reconfigured into series and parallel combinations. The dynamic internal Wheatstone bridge configuration is setup using the internal voltage source, resistor ratio network, and internal null detector to automatically self-align each 10:1 ratio.

# 5. MAINTENANCE AND TROUBLE SHOOTING

## 5.1. PERIODIC MAINTENANCE

There are no adjustments or controls in the 7520 Precision Voltage Divider. The automatic Voltage Ratio Self Alignment (i.e. self-calibration) can be invoked at any time. To meet the published specifications for the 7520 Voltage Divider it is recommended that the Ratio Self-Alignment process be run once weekly. Note that once the self alignment process is started, either manually via the front panel or automatically via a SCPI command, no operator intervention is required; and no external standards are required.

## 5.2. UNSTABLE READINGS

The automatic Voltage Ratio Verification (i.e. self-calibration) should be performed if unstable readings are encountered after careful attention to external connections and shielding. All shields should be connected to the 7520 “GUARD” terminal and one guard terminal of the external devices if available. Further to Guard, ensure there is no direct airflow or heat/cooling sources nearby as these can cause thermal EMF’s and affect the measurement process.

Note that in most measurement setups the 7520 “GROUND” should NOT be connected. With sub-ppm measurements a ground loop of a few µV or less can affect the measurements.

If the electrical circuit powering the 7520 is noisy then a UPS should be used.

## 5.3. ALIGNMENT

Alignment consists of an internal ratio alignment. No additional equipment is required to accomplish this. If the voltage divider is already ON, please refer to section. 3.4.4.1. If the voltage divider has been turned OFF, please refer to section 2.4.

## 5.4. SERVICE

There are no user serviceable parts in the 7520 Precision Voltage Divider. Contact Guildline Instruments for instructions should a fault be experienced.

# 6. REMOTE CONTROL

## 6.1. REMOTE OPERATION

The 7520 has a GPIB and USB port located on the rear panel which is used for remote operation. These ports can be used to communicate with the 7520,or accessed programmatically through a PC computer. The communication is bi-directional thus allowing both setting the device and querying the status. The GPIB interface conforms to IEEE-488.2 standard and is by default set to address 10. The USB when connected to a PC computer installs a com port commonly referred to CDC RS-232 emulation mode. Both interfaces use the same commands, which are SCPI based.


**NOTE: When the 7520 receives a command over the remote interface, either USB or GPIB, the 7520 will become under remote control and the above screen will appear. To return the device to local control, press the “Exit” button or use the corresponding command in the remote command list.**

REMOTE COMMANDS

A brief description of each of the possible remote commands and their syntax in BNF (Backus Naur Form) follows:

- words inside angle brackets (i.e. < and > ) are defined items
- :== means "is defined to be"
- | means "or"
- [] means optional
- required letters are shown in upper case but may be upper or lower case.

| | | |
|---|---|---|
| <digit>:== 0\|1\|2\|3\|4\|5\|6\|7\|8\|9600 | | |
| <letter> | :== A\|B\|C\|...\|Z\|a\|b\|c\|...\|z | |
| <string> | :== <letter> \| <letter><string> | |
| <boolean> | :== 0\|1 | |
| <unsigned> | :== <digit> \| <digit><unsigned> | |
| <nr1> | :== [+\|-]<unsigned> | |
| <nr3> | :== <nr1>[.[<unsigned>]][E<nr1>] | |
| <?> | :== <letter> \| <digit> | |
| <*> | :== <?> \| [<*>] | : not to be confused with * |
| <DD> | :== <unsigned> | : limited to range 1...31 |
| <MM> | :== <unsigned> | : limited to range 1...12 |
| <YYYY> | :== <unsigned> | : limited to ranges 1999 and up |

| **COMMAND** | **COMMENT** |
|---|---|
| *IDN? | query, display identity of unit |
| *RST | reset the instrument to a known defined state |
| CONFigure:DIVider <ratio> | set the voltage ratio configuration<br><ratio>:== 0\|1\|2\|3\|4\|5\|6<br>0=open<br>1=1:1<br>2=10:1<20<br>3=10:1<100<br>4=10:1<1000<br>5=100:1<br>6=1000:1<br><br>Note: always go thru “OPEN” when changing ratio |
| CONFigure:DIVider? | query, display the ratio range |

| | |
|---|---|
| CONFigure:COMParator <value> | set the Comparator Value<br><value>:== 0\|1\|2\|3\|4\|5\|6<br>0=open<br>1=0.01V<br>2=0.1V<br>3=1V<br>4=10V<br>5=100V<br>6=1000V |
| CONFigure:COMParator? | query, display the Comparator Value |
| CONFigure:REFerence <polarity> | set the configuration reference polarity<br><polarity>:==0\|1<br>0=negative<br>1=positive |
| CONFigure:REFerence? | query, display the configuration reference polarity |
| CONFigure:NONALign <value> | set the Non-Align mode<br><value>:==0\|1<br>0=false<br>1=true |
| CONFigure:NONALign? | query, display the Non-Align mode |
| ALIGN:START<br>Note, unit needs to be warmed up first | initiate self alignment |
| ALIGN:STOP<br>Note, unit self alignment parameters set to default | cancel self alignment |
| OPERate:OFF | set the operation state to off and disables all inputs and outputs |
| SYSTem:STATE? | query, display the system state<br>return value:== 0\|1\|2\|3\|4\|5\|6\|7<br>0=warming up<br>1=warmed up |

| | |
|---|---|
| | 2=warm up failed<br>3=self alignment passed<br>4=self alignment failed<br>5=self alignment cancelling<br>6=self alignment in process<br>7=logging |
| SYSTem:TERSe | respond to commands with a minimum data set |
| SYSTem:VERBose | respond to commands with a maximum data set |
| SYSTem:VERSion? | query, display the installed software version |
| SYSTem:LOCAL<br>SYSTem:REMOTE | respond to local operation (unlock local)<br>respond to remote operation (lock out local) |
| TEMPerature:TarGet? | query, display the target temperature |
| TEMPerature:CurrenT? | query, display the current temperature |
| TIME? | query, display the system time |

# 7. CALIBRATION

## 7.1. THEORY OF CALIBRATION

At time of manufacture the 7520 Voltage Divider is calibrated against a traceable (i.e. NMI calibrated) 7520 Voltage Divider and Offset Coefficients (i.e. calibration coefficients) are entered and stored. The following procedure (i.e. Section 7.2 of this Operator Manual) describes this calibration process.

The 7520 Voltage Divider has a patented, automatic, built-in self-alignment (i.e. self-calibration) feature that adjusts for the drift of the resistors used in the divider network and returns the 7520 ratios to their original calibration (i.e. auto-alignment). The 7520 contains a very stable multi-Zener based voltage source, Wheatstone bridge, and optical null detector. During the self-alignment process the resistors in each of the three 10:1 divider networks are reconfigured into a parallel / series network; balanced using the internal Wheatstone bridge, internal voltage source and internal null detector; and adjusted via internal digital potentiometers to return to the original calibrated ratio values. This fully automated process does not require any external standards and is activated via the 7520 front panel or a SCPI command. The self-alignment process should be run weekly in order to maintain the 7520 uncertainties.

In theory, if the self-alignment is run on a periodic basis, there is no need to re-calibrate a 7520 Voltage Divider. However some 17025 Accreditation Bodies require that a voltage divider be checked, via traceable standards, on a yearly basis. If a customer’s Accreditation Body requires that manual voltage dividers, such as the Fluke 752A/B, be checked on an annual basis then the 7520 Voltage Divider should also be calibrated or verified on an annual basis.

The 7520 Voltage Divider can be calibrated by comparison to a traceable voltage divider, as described in the following Section 7.2 Calibration procedure; or can be calibrated via various ratiometric buildup procedures.

Note that all measurement and self-alignment circuitry in the 7520 is contained within an internal temperature stabilized chamber. As a result, the 7520 can be calibrated, verified, self-aligned, or operated in a temperature range of 19.5 ºC to 26.1 ºC with no additional uncertainty contributions from temperature affects. However, the voltmeter and null-detector used in the calibration will be affected by temperature. It is recommended that during calibration that all other equipment (i.e. other than the 7520 model) be maintained at a ± 1 °C temperature range, be placed inside an EMI shielded chamber, and connected to a UPS or run off a battery.

### 7.2. CALIBRATION OF 10:1, 100:1 AND 1000:1 RATIOS USING A REFERENCE CALIBRATED 7520 VOLTAGE DIVIDER

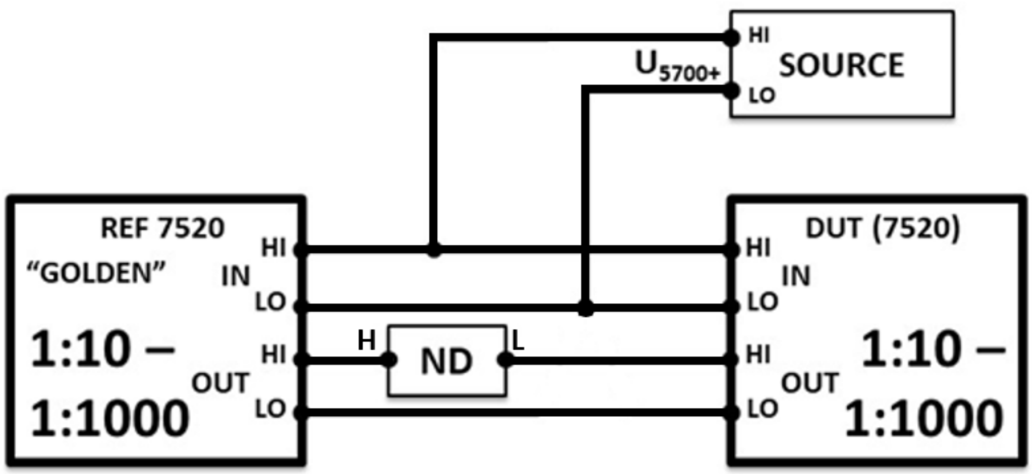



**Figure 7-1: Calibration Setup**

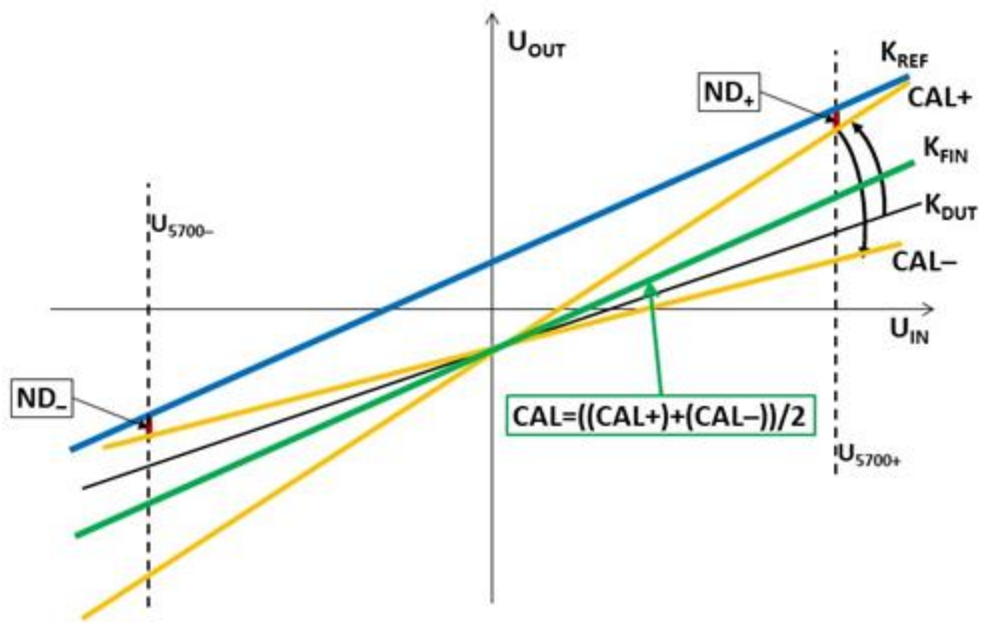



**Figure 7-2: Calibration Graph**

## Symbols on Calibration Graph Fig. 7-2

- $K_{REF}$ – Transfer function of the Reference Divider.
- $K_{DUT}$ – Transfer function of the Uncalibrated Divider.
- **CAL+** – Temporary transfer function during calibration with the positive input voltage.
- **CAL–** – Temporary transfer function during calibration with the negative input voltage.
- $U_{5700+}$ ,$U_{5700-}$ – Positive, negative input voltage used to calibrate the divider.
- **CAL=((CAL+)+(CAL–))/2** – Equation used to calculate the calibration offset required for the range.
- $ND_{+}$, $ND_{-}$ – Zero voltage, as seen on the Null Detector when balancing for the + and – input voltage.
- $K_{FIN}$ – Final (calibrated) transfer function of the divider.

## Equipment List

- REF 7520 “GOLDEN” – Reference Voltage Divider, freshly auto-aligned (i.e. within previous 24 hours) and using internal calibration coefficients as per NMI traceable measurements. Note that an alternative reference voltage divider can be used but typically the uncertainties will be higher than the uncertainties of a 7520 voltage divider
- DUT (7520) – Tested Unit, freshly auto-aligned (i.e. within previous 24 hours).
- SOURCE –DC voltage source with good short-term stability, such as a Guildline 4410 voltage reference, Fluke 732A/B/C voltage reference, or Fluke 57xx model.
- NULL DETECTOR (ND) such as a Fluke 845A/B, or alternately a DMM / DC MICRO VOLTMETER with minimum 1 nV resolution, such as Fluke 8508A/8588A.
- Setup (source, voltmeter) has to be soaked (i.e. warmed up in the lab environment) for at least 12 hours.
- Voltage Dividers have to be warmed up for at least 10 hours and then self aligned (i.e. within previous 24 hours).
- Reference Voltage Divider and Divider Unit Under Test should be connected with the voltage source (e.g. Fluke 5700) in a parallel connection.
- Reference divider (a “Golden unit”), Divider Unit Under Test and voltage source should be connected at the battery side of an Uninterruptible Power Supply (UPS) to remove ground loops and noise from the power grid circuit.
- Due to extremely high precision required, the measurements have to be conducted in a lab environment, preferably in a Faraday cage type setup with a camera to access Null Detector measurements remotely through a computer/laptop. External electric and magnetic fields should be limited. Note that this is not required for the operation of the 7520 voltage dividers but for the equipment used to verify the performance of the 7520. The 7520 has built-in EMI and EMF shielding.

- Null Detector should be fully floating, preferably placed on an isolating Teflon plate, and should work on the internal batteries with the power cord disconnected.
- Adjust the zero on the Null Detector by setting RANGE switch to 1µV range, OR Adjust the zero on the Voltmeter to remove unwanted residual offsets, thermal EMF's etc.
- Test leads, especially from the 7520 voltage dividers to the Null detector, should be twisted with the LO leads, forming a "Y" cord.
  Presence of unessential personnel and equipment should be controlled.
- Measurement of the ratio is done for each of the ranges: 10:1, 100:1 and 1000:1.

**7520 Pre-Calibration Check List**

- Make sure a self-alignment was done not more than 24 hours ago (i.e. check the 7520 Reference Divider log), and if not run the 7520 Reference Divider self-alignment.
- Make sure all Calibration Offsets (i.e. calibration coefficients) are set to zero on the 7520 to be calibrated.

**Note: The output "HIGH" of the Reference Unit is connected to the "HIGH" of the Null Detector and the output "HIGH" of the Divider Unit Under Test is connected to the "LOW" of the Null Detector.**

**Note: A positive delta on the Null Detector will require a positive calibration offset (i.e. calibration coefficient) when using a positive input voltage (10 V or 100 V). The opposite applies when using a negative input voltage (-10 V or -100 V). This applies to all Divider ratios.**

**10:1 (V ≤ 20) Ratio Calibration**

1. Configure Test Setup as per Fig. 7-1.
2. Set both units to Divider mode 10:1 (V ≤ 20). Set Source to +10 V.
3. Balance ND by adjusting the 10:1 (V ≤ 20) Offset Coefficient on the 7520 being calibrated (i.e. DUT).
4. Record the Offset Coefficient **CALH+.**
5. Reverse the source to – 10 V.
6. Balance ND by adjusting the 10:1 (V ≤ 20) Offset Coefficient on the 7520 being calibrated.
7. Record the Offset Coefficient **CALH–**.
8. Calculate and set the final 10:1 (V ≤ 20) Offset Coefficient as

**CALH =((CALH+) + (CALH–)) / 2**

**10:1 (V ≤ 100) Ratio Calibration**

1. Configure Test Setup as per Fig. 7-1.
2. Set both units to Divider mode 10:1 (V ≤ 100). Set Source to +100 V.
3. Balance ND by adjusting the 10:1 (V ≤ 100) Offset Coefficient on the 7520 being calibrated (i.e. DUT).
4. Record the Offset Coefficient **CALH+.**
5. Reverse the source to – 100 V.
6. Balance ND by adjusting the 10:1 (V ≤ 100) Offset Coefficient on the 7520 being calibrated.
7. Record the Offset Coefficient **CALH–**.
8. Calculate and set the final 10:1 (V ≤ 100) Offset Coefficient as

**CALH =((CALH+) + (CALH–)) / 2**

**Note: When using 100 V source for the 10:1 (V ≤ 100) ratio the value read on the null detector needs to be divided by a factor 10 to provide the calibration coefficient.**

**10:1 (V ≤ 1000) Ratio Calibration**

1. Configure Test Setup as per Fig. 7-1.
2. Set both units to Divider mode 10:1 (V ≤ 1000). Set Source to +100 V.
3. Balance ND by adjusting the 10:1 (V ≤ 1000) Offset Coefficient on the 7520 being calibrated (i.e. DUT).
4. Record the Offset Coefficient **CALH+.**
5. Reverse the source to –100V.
6. Balance ND by adjusting the 10:1 (V ≤ 1000) Offset Coefficient on the 7520 being calibrated.
7. Record the Offset Coefficient **CALH–**.
8. Calculate and set the final 10:1 (V ≤ 1000) Offset Coefficient as

**CALH =((CALH+) + (CALH–)) / 2**

**Note: When using 100 V source for the 10:1(V ≤ 1000) ratio the value read on the null detector needs to be divided by a factor of 10 to provide the calibration coefficient.**

**100:1 Ratio Calibration**

1. Use the same Test Setup as per Fig. 7-1.
2. Set both units to Divider mode 100:1. Set Source to +100 V.
3. Balance ND by adjusting the 100:1 Offset Coefficient on the 7520 being calibrated (i.e. DUT).
4. Record the Offset Coefficient **CALM+.**
5. Reverse the source to –100 V.
6. Balance ND by adjusting the 100:1 Offset Coefficient on the 7520 being calibrated.
7. Record the Offset Coefficient **CALM–**.
8. Calculate and set the final 100:1 Offset Coefficient as

**CALM =((CALM+) + (CALM–)) / 2**

**1000:1 Ratio Calibration**

1. Use the same Test Setup, as per Fig. 7-1.
2. Set both units to Divider mode 1000:1. Set Source to +100 V.
3. Balance ND by adjusting the 1000:1 Offset Coefficient on the 7520 being calibrated (i.e. DUT).
4. Record the Offset Coefficient **CALL+.**
5. Reverse the source to –100V.
6. Balance ND by adjusting the 1000:1 Offset Coefficient on the 7520 being calibrated.
7. Record the Offset Coefficient **CALL–**.
8. Calculate and set the final 1000:1 Offset Coefficient as

**CALL =((CALL+) + (CALL–)) / 2**

**Note: When using 100 V source for the 1000:1 ratio the value read on the null detector needs to be multiplied by a factor 10 to provide the calibration coefficient.**

### 7.3. 1:1 Ratio

1. Configure the Test Setup as per Fig.7-3. Twist signal leads in pairs.
2. Set the 7520 unit to Divider mode, 1:1 ratio.
3. Set Source to $U_{\mathbf{SOURCE+}}$ = +10 V. Record the ND reading $\mathbf{U}_{\mathbf{ND+}}$.
4. Reverse Source to $U_{\mathbf{SOURCE-}}$ = –10 V. Record the ND reading $\mathbf{U}_{\mathbf{ND-}}$.
5. Calculate the 1:1 ratio error:

$$K_{1:1+} = \frac{U_{ND+}}{U_{SOURCE+}}\ ;\ K_{1:1-} = \frac{U_{ND-}}{U_{SOURCE-}}\ ;$$

$$\boldsymbol{K_{1:1} = \frac{K_{1:1+} + K_{1:1-}}{2}}$$

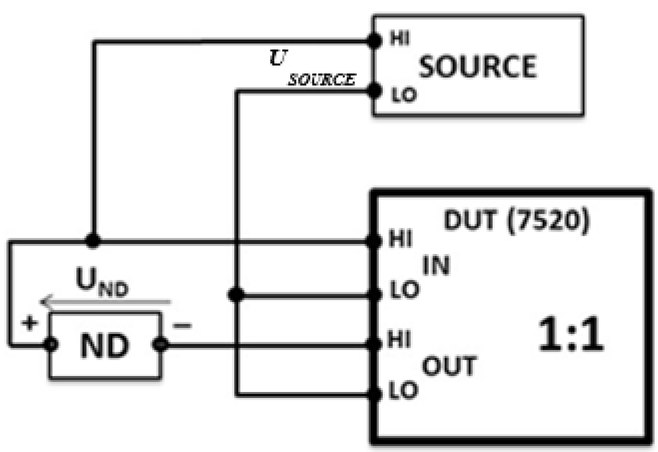



**Figure 7-3: 1:1 Ratio**

# 8. SPARE PARTS

- 0.75 A SLOW BLOW CERAMIC TUBE FUSE, Guildline part # 099-21075
- 1.5 A SLOW BLOW GLASS TUBE FUSE, Guildline part # 099-21501