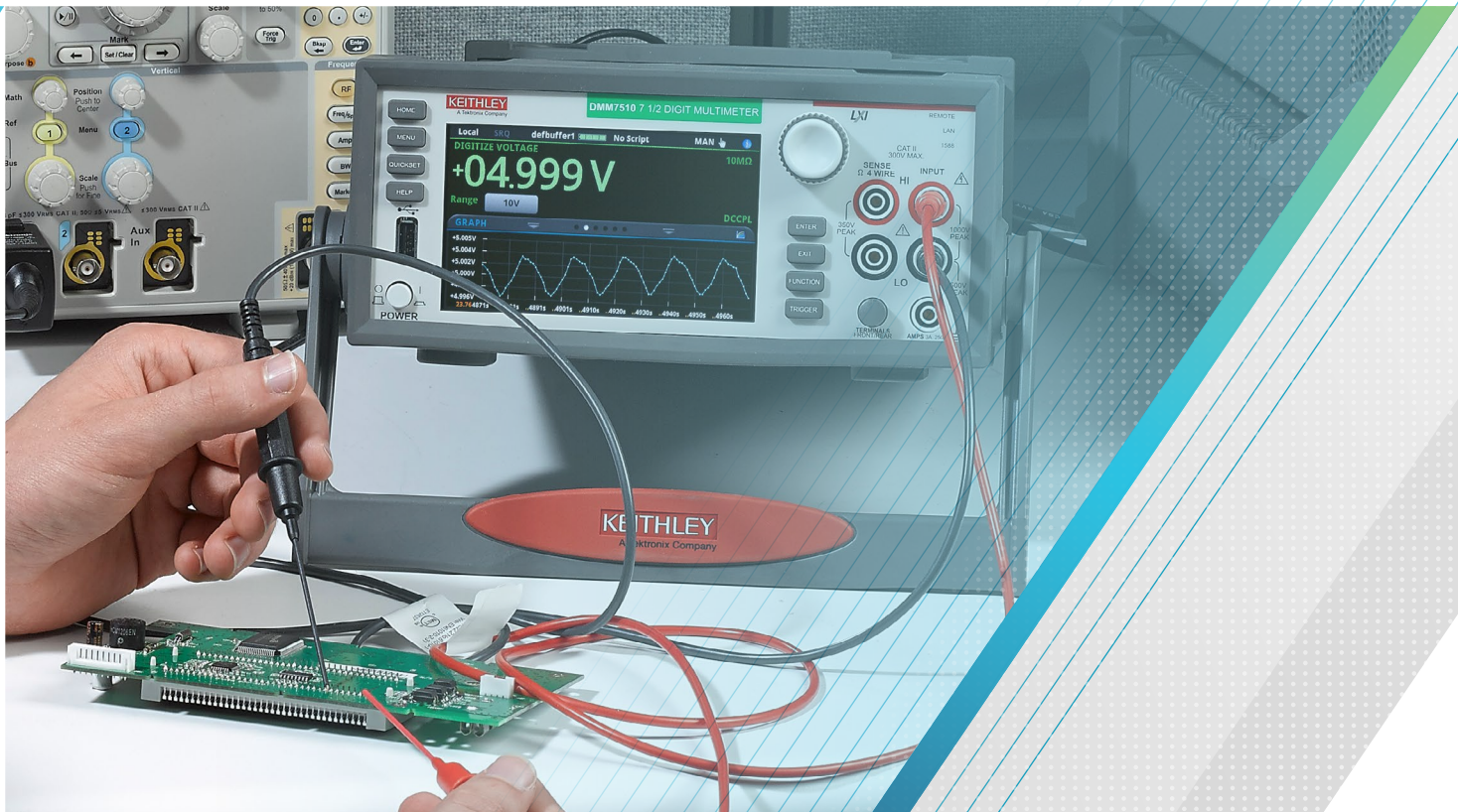


# Implementing Precision Measurement Timing Using the DMM7510 7½-Digit Multimeter

## APPLICATION NOTE



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# Introduction

This application note describes how to use the DMM7510 7½-Digit Multimeter to capture readings for a particular interval of time while also ensuring that said readings are evenly spaced over this interval. The methodology shows how easily this can be done using the front panel menus on the DMM7510 touchscreen display. An example will illustrate how to make use of the available triggering templates and measurement settings to accomplish this goal.

## Activating and Configuring a Duration Loop Trigger Model Template

Let us say, for instance, that we wish to monitor current drawn by a device for 30 seconds and capture a reading every 20 ms. From the front panel we would select DCI from the **FUNCTIONS** sub screen on the display and (perhaps) set a fixed range, which can be accomplished by touching the **Range** button near the reading middle-left of the display (**Figure 1**).



Figure 1: Set the function and range for the measurement.

To navigate to the feature in question:

- Press the **MENU** key.
- Touch the **Templates** icon under the “Trigger” column on the display.
- Touch the button next to “Templates” within the TRIGGER MODEL TEMPLATES screen.
- Then select **DurationLoop** from the bottom of the of “Templates” dialog (see **Figure 2**).

The user will then be presented with the three main parameters of interest (**Figure 3**):

1. **Duration:** This defines the time interval over which the user wishes to capture measurements.
2. **Delay:** This defines the time between each measurement that occurs over the set duration.
3. **Reading Buffer:** This defines the target buffer where all readings of interest will be stored.

As noted on the display, to initiate the trigger model just created, the user should press the **TRIGGER** key (found to the lower right of the display, also **Figure 3**). Note that, for this example, the duration is set to 30 seconds and the delay between measurements is defined as 20 ms.

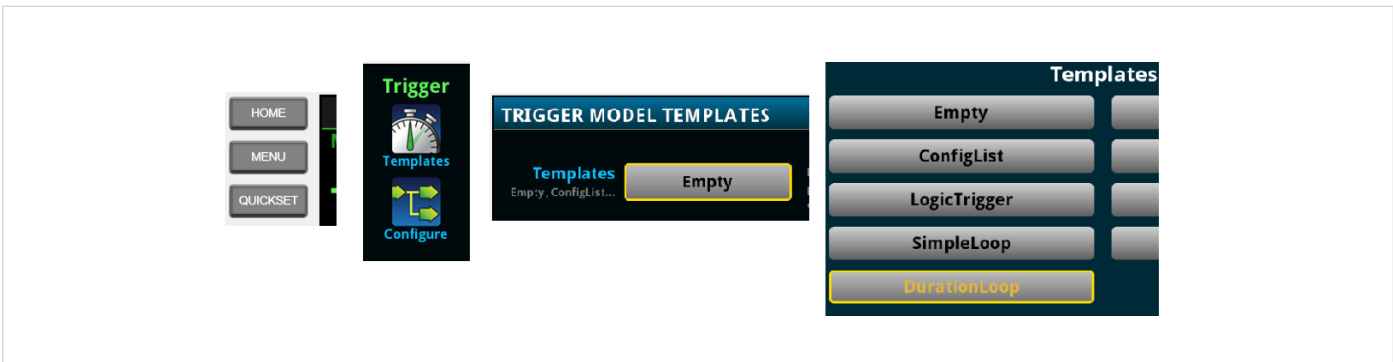


Figure 2: Enabling the “DurationLoop” option from the Front Panel.

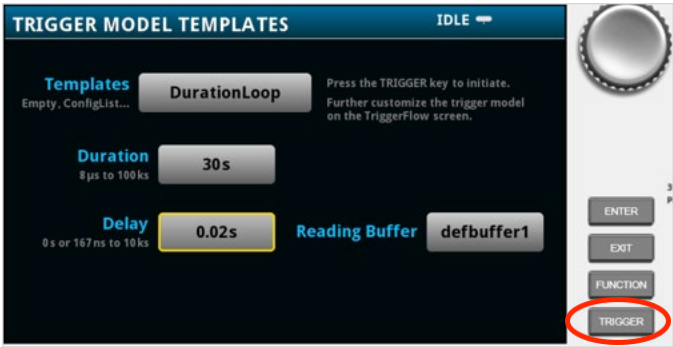


Figure 3: DurationLoop trigger template parameters and location of the trigger key.

Assuming the unit is set for Continuous Measurement (where the display is seen continuously updating with active measurements), the DMM7510 provides a dialog box letting the user know of this state and the need to switch. For this example, accept by selecting **Yes** via the button provided, and touch the **Initiate Trigger Model** option from the subsequent dialog that is presented (see **Figure 4**).

## Viewing Buffered Readings and Verifying the Reading Delay

While the user has the option to access and view timing via the **READING TABLE** user interface (accessible via **MENU > Views > Reading Table**), pulling the buffered data from the instrument and loading it onto a remote PC will be more effective for verifying the results of this measurement. To do so, the user should perform the following:

- Press the **MENU** key (**Figure 5**).
- Touch the **Reading Buffers** icon found at the bottom of the Measure column (**Figure 5**).
- Insert a USB thumb drive into the port provided on the front of the DMM7510 (**Figure 5**).
- Touch the **Save to USB** button in the lower right corner of the display (**Figure 6**).

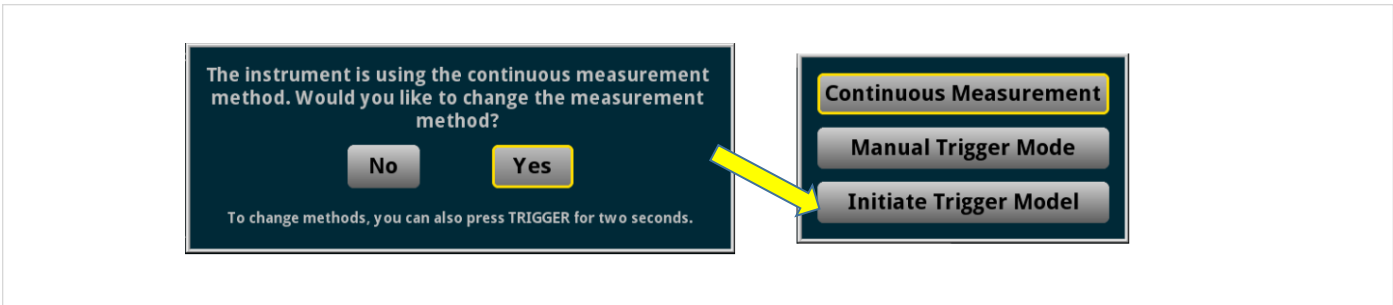


Figure 4: Initiating the Trigger Model.

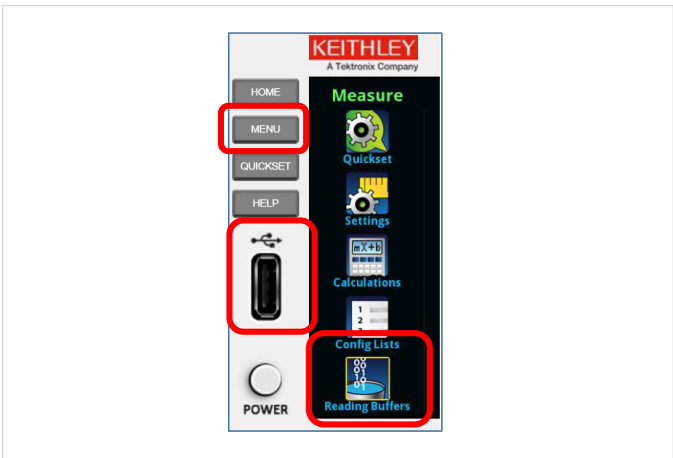


Figure 5: The MENU key; Reading Buffers icon; and USB drive insert.

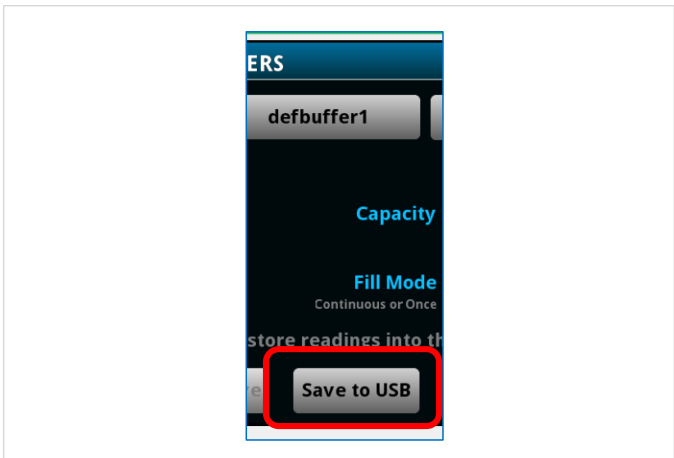


Figure 6: Save to USB.

Once on the user's computer, the \*.csv file that was created can be opened in Microsoft Excel (or another spreadsheet application) where the output of the buffer can be viewed in its entirety. The last two columns provide the timing elements of interest at this point: Time and Fractional Seconds. The former provides the general system time (hour, minute, second) and the latter provides the additional time separation between seconds. If a simple difference calculation is performed on the Fractional Seconds, then the actual time between measurements taken is revealed (**Figure 7**). What the user may find is that what is presented is not what they would be expecting from the calculation, which is the 20 ms interval defined in the Trigger Template.

Time	Fractional Seconds		
8:27:15	0.214673		Time Delta ?
8:27:15	0.256807		0.042133
8:27:15	0.298925		0.042119
8:27:15	0.341044		0.042119
8:27:15	0.383179		0.042134
8:27:15	0.425314		0.042135
8:27:15	0.467448		0.042134
8:27:15	0.509583		0.042135
8:27:15	0.551718		0.042135
8:27:15	0.593855		0.042136
8:27:15	0.635989		0.042134
8:27:15	0.678121		0.042132
8:27:15	0.720257		0.042136
8:27:15	0.762392		0.042134
8:27:15	0.804526		0.042134

Figure 7: Evaluating the delay time.... and finding that it does not (initially) meet expectations.

The reason for this is as follows:

- The default NPLC setting (used from the beginning of this example) is set to 1 (1PLC = 16.67 ms)
- The default setting for the Auto Delay feature (which provides added delay to optimize the measurement per selected range) is set to On and adding to the delay.

- The default setting for the Auto Zero feature (which takes an additional pre-measurement – along with the time to make it – to remove potential offset at the inputs of the meter) is set to On and adding to the delay.

The first item alone is contributing substantially to the error of the timing expectation. While this setting helps to provide better accuracy for the actual measurements, this does not contribute to the success of the initial goal for controlling the timing of the measurement. In this case, it is in the best interest of the user to optimize timing, and, therefore, a first-step solution for this is to compromise the reading accuracy by lowering the NPLC setting such that it has minimal contribution to the interval between the measurements.

To modify the NPLC setting (illustrated in **Figure 7**):

1. Press the **MENU** key on the front panel.
2. Touch the **Settings** icon found under the Measure column in the display.
3. Locate and touch the button associated with **Integration Rate** found in the MEASURE SETTINGS screen.
4. Change the integration rate to 0.001 PLC (reducing the timing contribution to only 16.67  $\mu$ s), then touch the OK button.

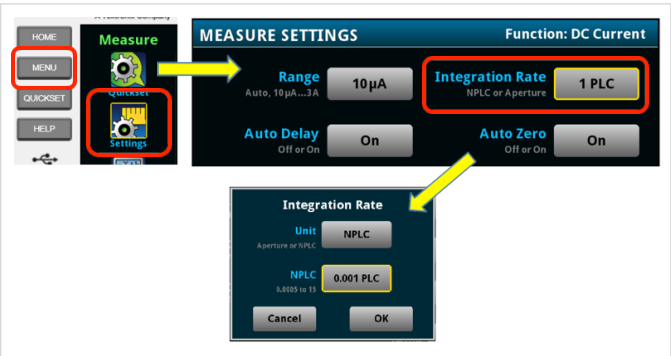


Figure 7: Modifying the Integration Rate to adjust for timing offsets.



**Figure 8a** shows the timing offset significantly reduced and the user is much closer to the desired timing defined in the Trigger Template. **Figure 8b** shows the timing improvement when the user also disables the Auto Delay and Auto Zero features (seen above in **Figure 7**).

Time	Fractional Seconds		
2:18:00	0.747985		Time Delta
2:18:00	0.768967		0.020982 ←
2:18:00	0.789947		0.02098
2:18:00	0.810927		0.02098
2:18:00	0.831906		0.020979
2:18:00	0.852886		0.02098

Figure 8a: Improvement at 0.001PLC.

Time	Fractional Seconds		
9:39:27	0.009311		Time Delta
9:39:27	0.029355		0.020043 ←
9:39:27	0.0494		0.020045
9:39:27	0.069444		0.020044
9:39:27	0.089488		0.020044

Figure 8b: Improvement w/ no Auto Zero or Auto Delay.

## Speed Limitations with Standard Measurement Functions

While programming specific settings gets the user the fastest, most accurately-timed measurement acquisition possible, it is important to understand the limitation using the standard measurement functions (i.e., not using the digitizer features). For the example shown above, measurements were spaced 20 ms apart with the delay feature then optimized by lowering the aperture time. To push the instrument to its maximum measurement rate, consider a setup where the PLC setting is adjusted to its absolute minimum (0.0005 NPLC) for the integrating A/D converter and completely eliminating the programmed duration (set to 0). Additionally, reducing the number of digits to be updated on the LCD display (**Figure 9**) will help eliminate timing overhead without compromising the data actually stored in the buffer.

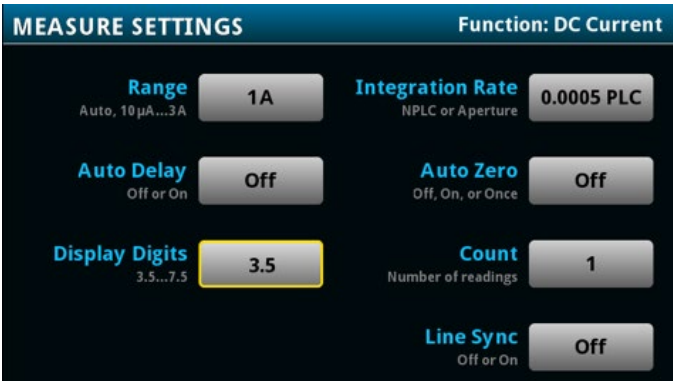


Figure 9: Additional speed/timing optimization per removal of Auto Delay, Auto Zero, and reducing the NPLC value to 0.0005.

After the user executes the DurationLoop Trigger Model Template and reviews the timing information found in the reading buffer (as evaluated before and illustrated by **Figure 10**), one can expect to achieve evenly spaced readings with as little as approximately 37  $\mu$ s between each (a rate of about 27 kHz).

Time	Fractional Seconds		
14:20:14	0.714459		Time Delta
14:20:14	0.714496		3.6859E-05 ←
14:20:14	0.714533		3.6879E-05
14:20:14	0.71457		3.6899E-05
14:20:14	0.714607		3.6839E-05
14:20:14	0.714644		3.6899E-05

Figure 10: Timing after fastest settings are applied.

While the suggested modifications help achieve the timing goals, one must also consider the possible tradeoff with respect to measurement accuracy. Though limiting the number of displayed digits does not influence the actual readings stored in the buffer, disabling Auto Delay and Auto Zero may affect the readings such that they could be unacceptable to the user. We recommend that the user experiment to determine an optimal group of settings that will provide acceptable results.

## Summary

The Trigger Model Templates provide a more direct and intuitive way for a user to manage the DMM7510 measurement behavior for a specific application and, as shown here, modify other time-dependent features to achieve tighter control of timing for captured readings. The DurationLoop model will allow for measuring periods as short as eight microseconds all the way up to 100 kiloseconds (well over 24 hours).

While the digitizing functions certainly promote a higher sampling rate, a user can still use standard measurement functions to achieve accurately timed readings with less than 37  $\mu$ s of separation. All of this is done using the front panel controls, eliminating the need to generate code to perform the exact same task.

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