External Clock/Trigger Capabilities

The External Clock/Trigger (CKTRIG) hardware installed in your LeCroy digital instrument offers these special capabilities:

- **External Reference:** phase-synchronization to an external 10 MHz reference — either to match the stability of the external source, or to phase-lock the acquired signal. Several instruments can then be synchronized using a single source as reference. *See next page.*
- **Trigger Comparator** pulse generated each time a valid trigger condition* is encountered on the trigger signal — invaluable for event-counting and throughput applications. *See page 7.*
- **External Clock** for externally clocking at a fixed frequency†, enabling full phase control over the acquired signal. As well, the sample rate can be fine-tuned to the exact speed required for the application in hand. *See page 13.*

Thus CKTRIG can provide a uniquely high degree of synchronization between instruments, and between the instrument and the external environment.

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* Edge Trigger only for all models except the ***LC564 AND LC584 SERIES OSCILLOSCOPES, AND DISK DRIVE ANALYZERS (DDAS)***, which offer this feature for SMART Triggers, too.

† 50–500 MHz on all models except those in the ***LC564 AND LC584 SERIES OSCILLOSCOPES, AND DISK DRIVE ANALYZERS (DDAS):*** DC to 500 MHz.

Synchronizing with an External Reference

Instruments can be synchronized with an external, 10 MHz sine-wave or square-signal reference (*Fig. 1*). This reference can even be used when an instrument's channels are combined (*see the instrument Operator's Manual*). The reference's input signal requirements are these:

- **Amplitude:** 800 mV p-p typical; 1.25 V p–p minimum for guaranteed switching
- **Frequency Range:** 10 MHz ± 5 %
- **Offset:** 0 V centered — any DC offset may require a larger input swing
- **Sampling Uncertainty:** ± 100 mV slew-rate signal
- **Input impedance:** 50 Ω ± 5 %
- **Maximum Input Voltage:** ± 2.5 V.

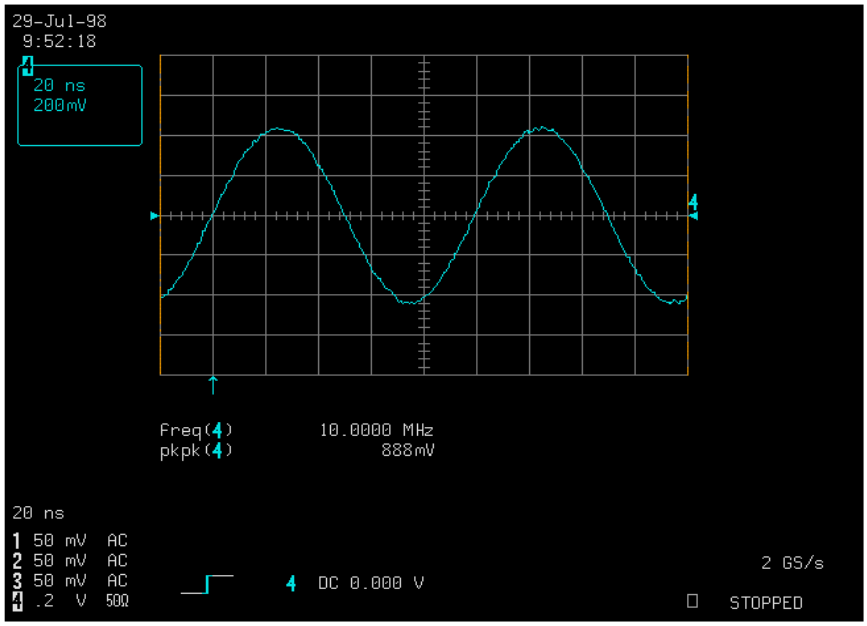


Figure 1: External Reference signal.

Once such a reference signal is displayed, select “External” from the “UTILITIES” “SPECIAL MODES” menus (*Fig.2*). Then, using the “TIMEBASE” menus, display a screen similar to that shown below. To do this by remote control, use the REFERENCE_CLOCK command (*see page 20*).

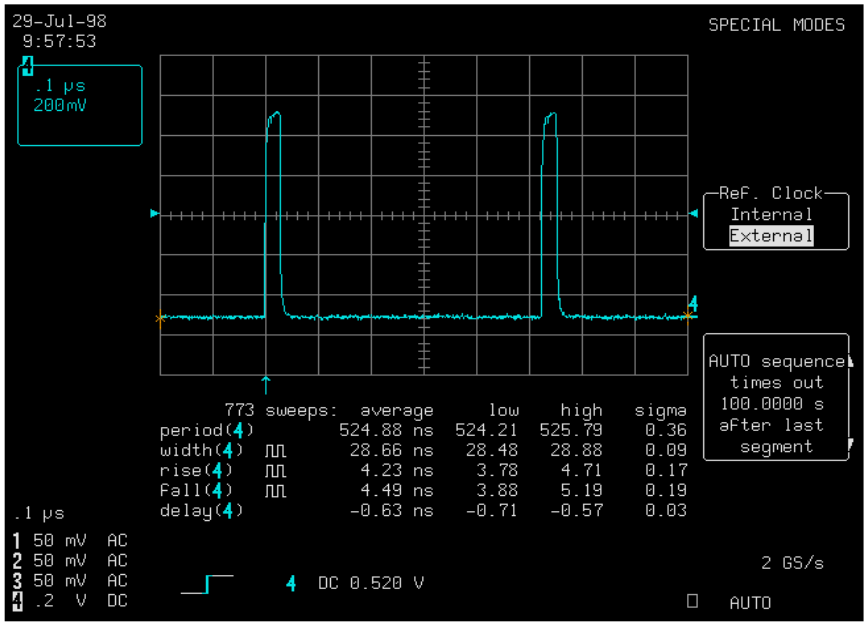
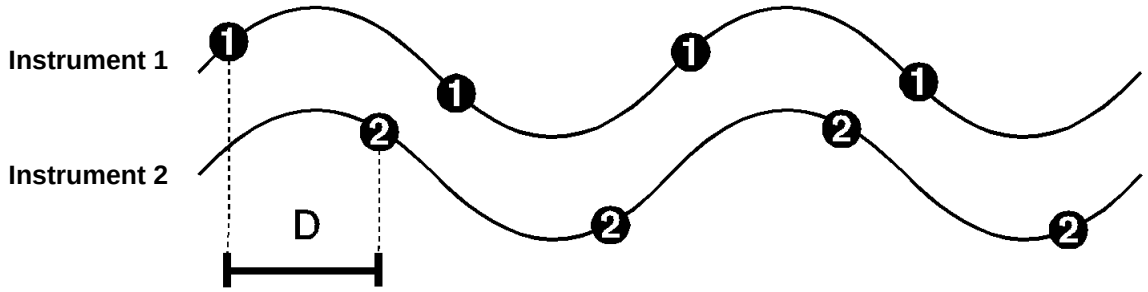


Figure 2: Acquisition with 10 MHz external reference.

Sampling-Time Stability

The histogram graphs on the following pages (*Figs. 3–4*) illustrate the sampling-time stability when using a CKTRIG external reference to synchronize *two* LeCroy digital instruments.

Several acquisitions were made using the instruments, *with* and *without* an external reference. They were placed in the same configuration, and the same input and trigger signals were used by both, *as shown in this diagram*.



First, an acquisition was performed using the same input signal, with the two instruments set up in exactly the same configuration.

Next, the delay in sampling time between them (*D*) in radians was extracted from their data using a PC.

These two steps were then repeated *two hundred times*.

Finally, histograms of *D* were created.

Note: to synchronize the instruments, D must be stable.

In *Figure 3*, *without* an external reference the instruments are unsynchronized. The histogram shows a variation of 4.2 radians in their respective sampling times.

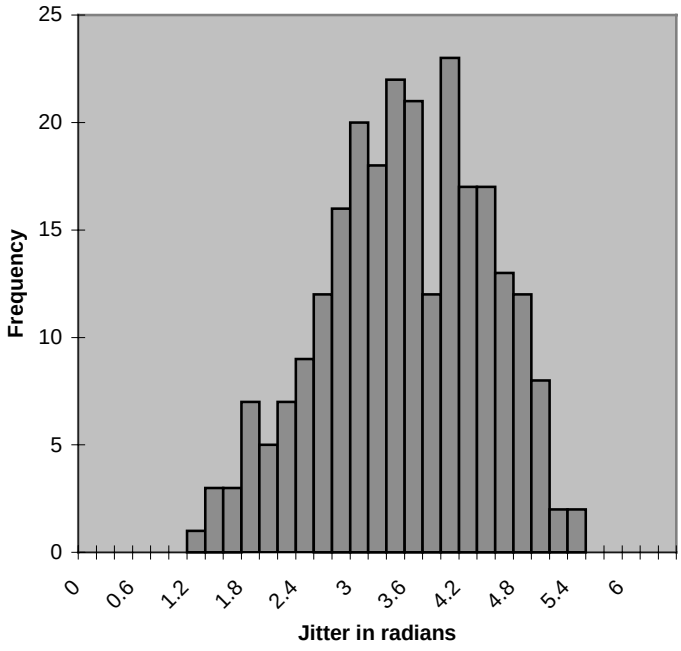


Figure 3: Internal Reference Jitter — distribution of jitter for acquisitions WITHOUT External Reference.

In *Figure 4*, the instruments are synchronized, using a 10 MHz external reference: the difference in sampling time between them is very stable, as both sample at exactly the same time.

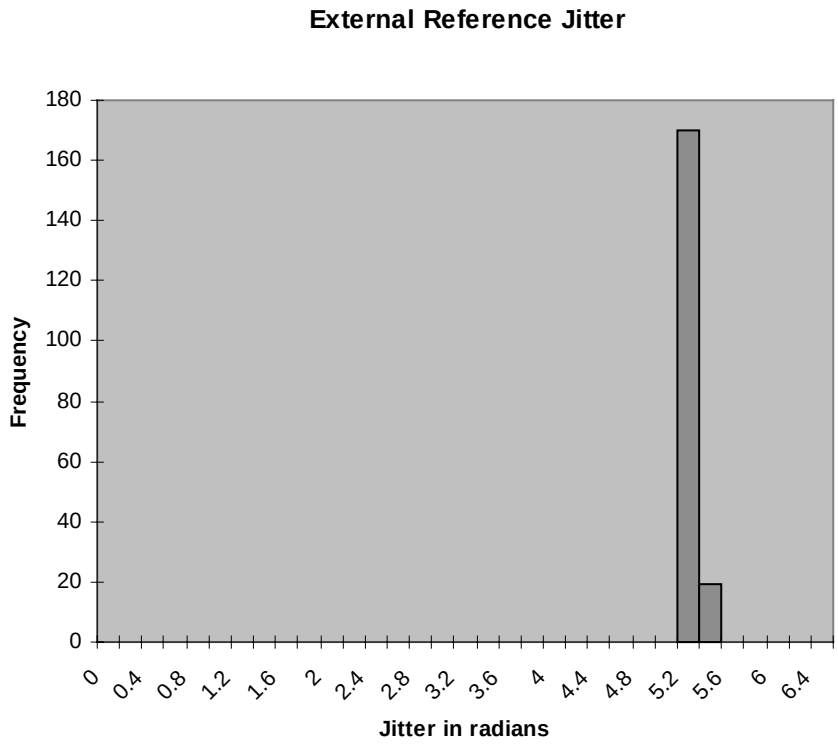


Figure 4: External Reference Jitter — distribution of jitter for acquisitions WITH an External Reference.

At 500 MS/s sample rate, for example, the time between two samples is 2 ns, which is equivalent to a maximum jitter of 2 π. In order to ascertain whether the two instruments are truly synchronized there must be a stable, or fixed, difference in sampling time between them over several acquisitions.

Trigger Output

The Trigger Comparator generates a positive pulse each time a valid trigger condition is met on the trigger signal[‡]. The pulse's duration is constant, independent of trigger signal or condition. The characteristics of this trigger output signal (*Figs. 5–6*):

- **Amplitude:**
  - ECL. 50 Ω, series-terminated (800 mV p-p typical)
  - ***LC564, LC584, DDA SERIES ONLY:*** ECL swing divided by two (400 mV p-p typical) into 50 Ω load to ground
- **Duration of Pulse Width:**
  - Equal to time trigger signal is above/below the trigger level
  - ***LC564, LC584, DDA SERIES ONLY:*** 1 ns typical
- **Maximum Externally-applied Voltage:** + 0 V, −2.5 V.

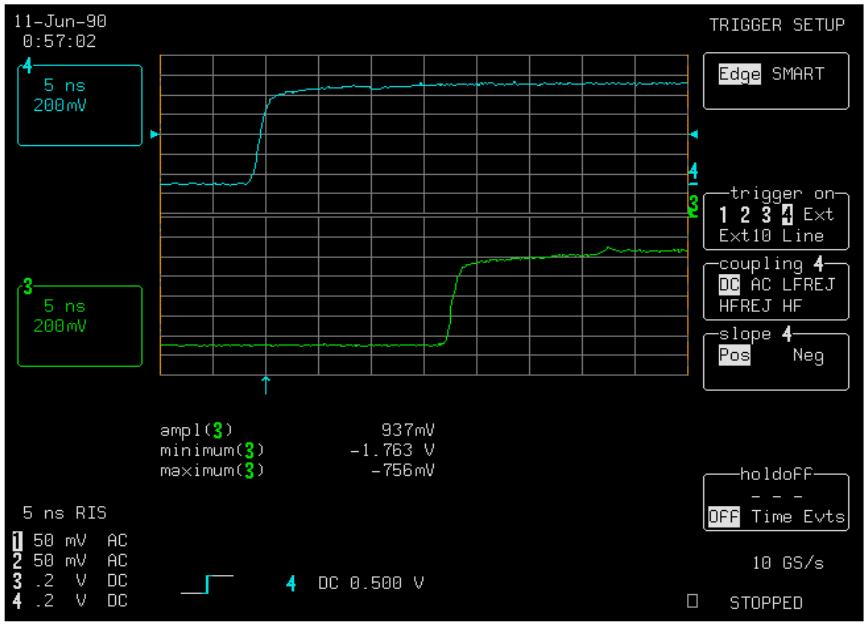


Figure 5: Trigger Output signal (ALL MODELS EXCEPT LC564, LC584, DDA).

[‡] Edge Trigger only for all models except ***LC564 AND LC584 SERIES OSCILLOSCOPES, AND DDAS (DISK DRIVE ANALYZERS)***.

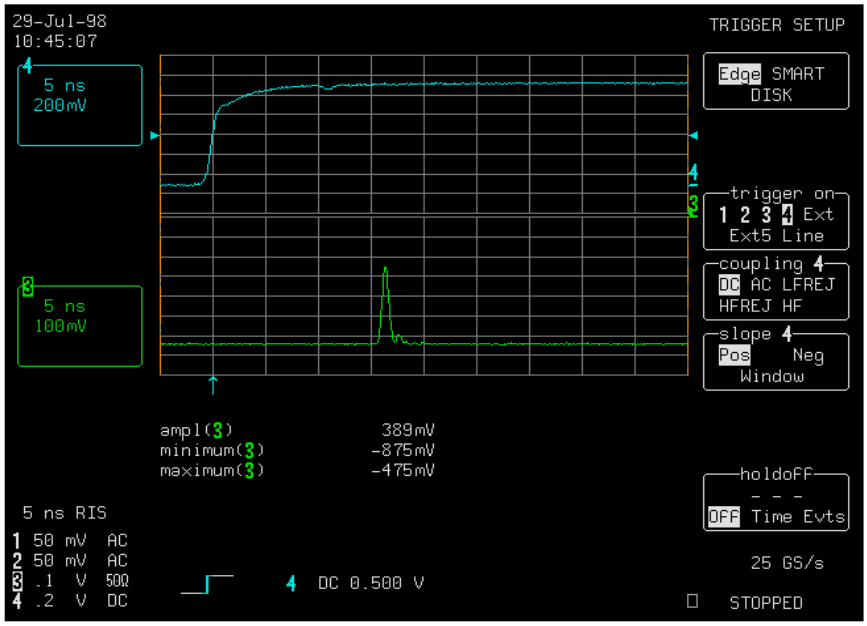


Figure 6: Trigger Output signal (LC564, LC584, DDA SERIES).

Figures 7–10 show a signal sent to the instrument on Channel 4, and the CKTRIG trigger output on Channel 3:

- ***ALL MODELS EXCEPT LC564, LC584, DDA SERIES:*** At the same time there is a pulse output by the Trigger Comparator on Channel 3 (*Fig. 7*) for each valid trigger condition and each pulse of the trigger signal. This occurs even if no acquisition is performed with these triggers.
- ***LC564, LC584 AND DDA SERIES ONLY:*** At the same time on Channel 3 (*Fig. 8*) a pulse of typically 1 ns is generated each time a valid trigger condition is met on the trigger signal. This occurs even if no acquisition is performed with these triggers.

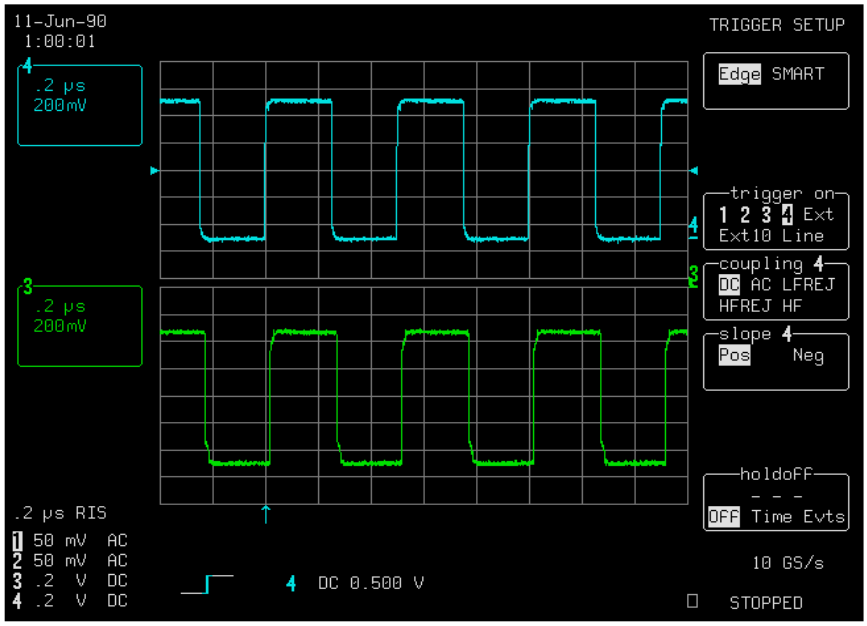


Figure 7: Trigger Output on CH 4 generates a pulse on CH 3 each time a valid (Edge) trigger condition is met — here, on each positive slope (ALL MODELS EXCEPT LC564, LC584, DDA SERIES).

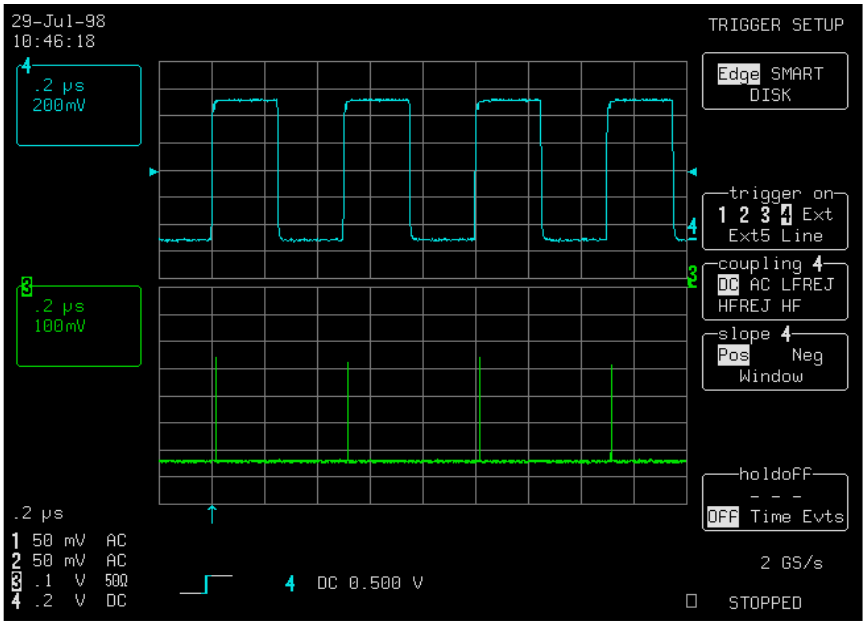


Figure 8: Trigger Output on CH 4 generates a pulse on CH 3 each time a valid Edge or SMART trigger condition is met — here, on each positive slope (LC564, LC584, DDA ONLY).

Figures 9–10 show the same trigger signal and pulse, but with the trigger condition set for triggering on a negative slope.

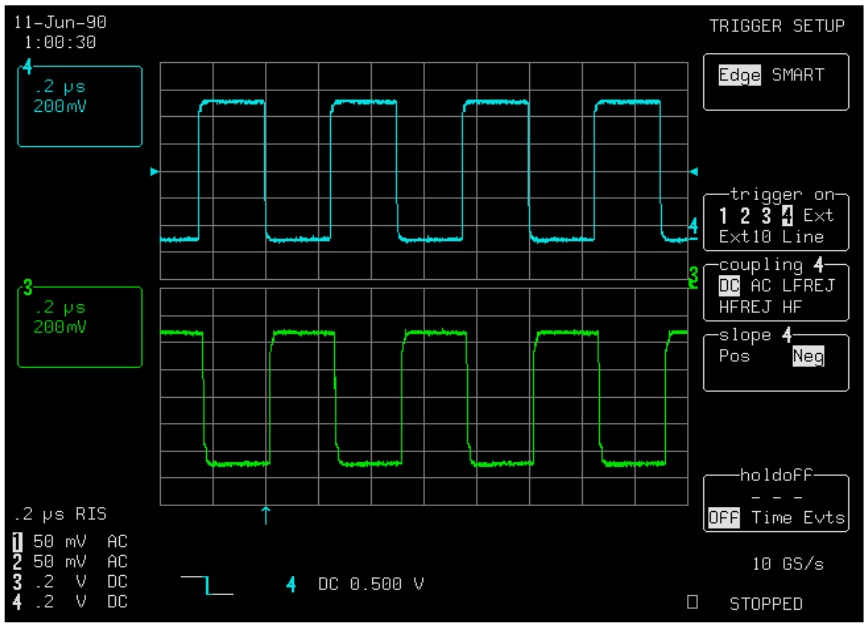


Figure 9: Trigger Output on CH 4 generates a pulse on CH 3 each time a valid (Edge) trigger condition is met — here, on each negative slope (ALL MODELS EXCEPT LC564, LC584, DDA SERIES).

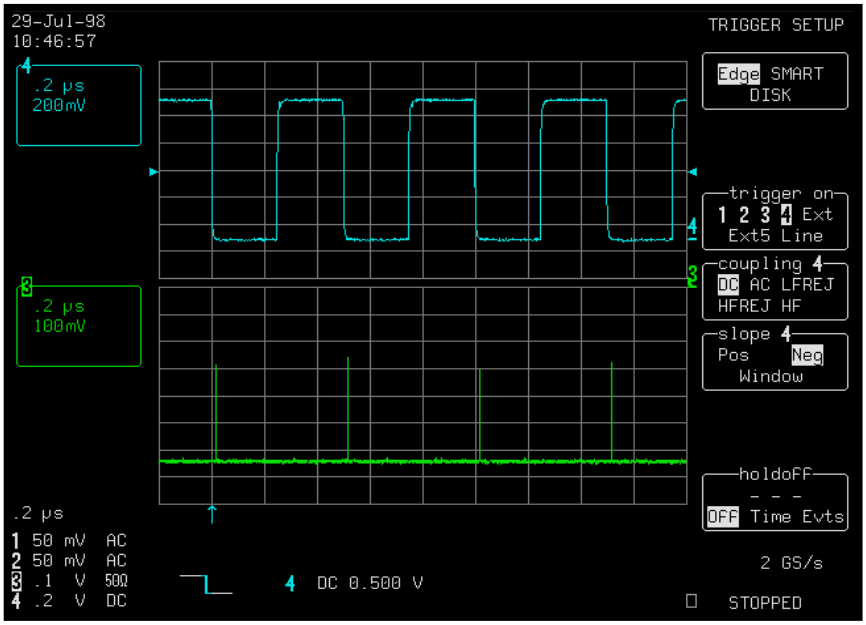


Figure 10: Trigger Output on CH 4 generates a pulse on CH 3 each time a valid Edge or SMART trigger condition is met — here, on each negative slope (LC564, LC584, DDA ONLY).

Full Phase-Control and Sample-Rate Tuning

Externally clocking at a fixed rate gives full phase-control over the acquired signal. The sample rate, too, can be fine-tuned to the exact speed required. Note that for all models other than those in the *LC564, LC584 AND DDA SERIES*, calibration must be initiated for each external clock change. Input signal requirements (*Figs. 11–12*) are:

- **Amplitude:** 800 mV p-p typical; 1.25 V p–p minimum for guaranteed switching
- **Frequency Range:** 50 MHz to 500 MHz
  - ***LC564, LC584 AND DDA SERIES:*** DC to 500 MHz
- **Sampling Uncertainty:** ± 100 mV slew-rate signal
- **Minimum Slew Rate:** < 1.25 ns/V
  - ***LC564, LC584 AND DDA SERIES:*** 20 ns/V
- **Input impedance:** 50 Ω ± 5 %
- **Maximum Input Voltage:** ± 2.5 V

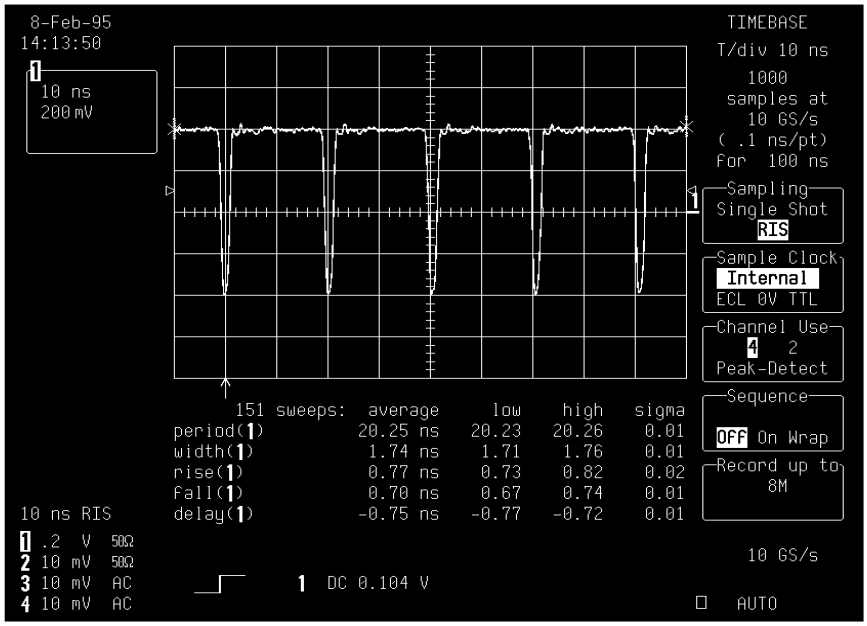


Figure 11: 50 MHz External Clock signal (ALL EXCEPT LC564, LC584, DDA).

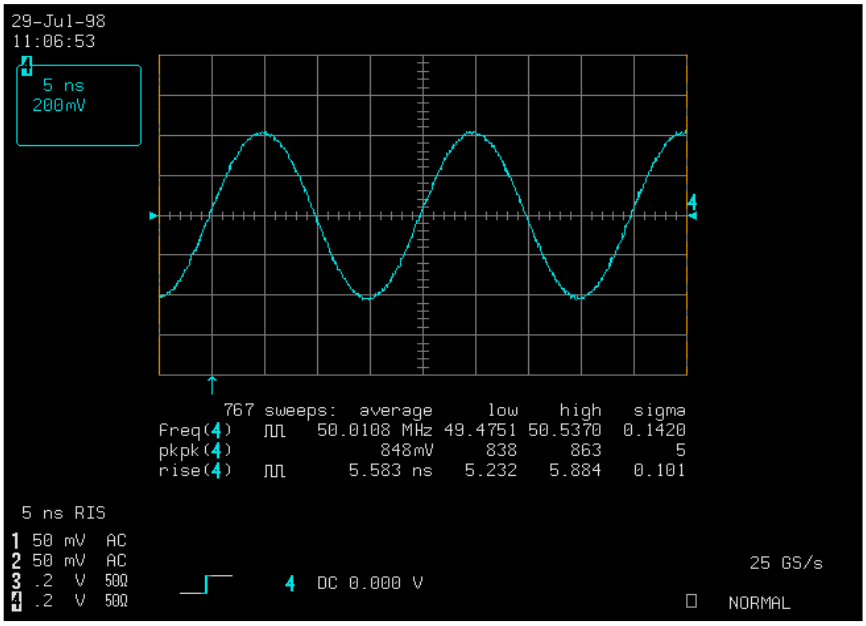


Figure 12: 50 MHz External Clock signal (LC564, LC584, DDA ONLY)

- **Swept Clock:** only a fixed-frequency clock can be supported; swept clock may cause offset errors of up to 10 % in the worst case.

Figures 13–14 show acquisitions using a 50 MHz external clock.

To enable the external clock, according to model and the menus available for that model, select either "**RP**" (*Fig. 13*), or "**External**" (*Fig. 14*), from the "TIMEBASE EXTERNAL" "Sample Clock" menu. Or, by remote control, use the SAMPLE_CLOCK command (*see page 21*).

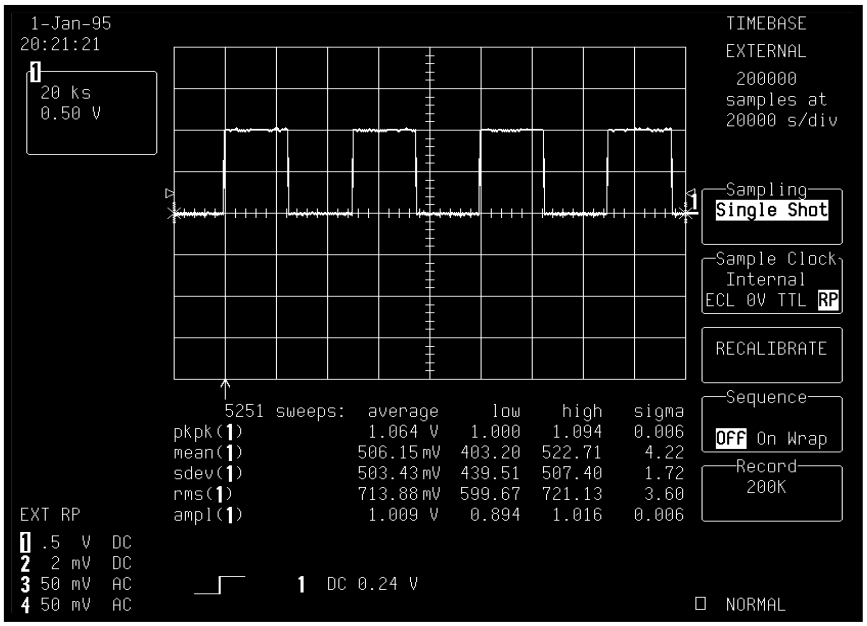


Figure 13: Acquisition of an external square signal using External Clock (ALL MODELS EXCEPT LC564, LC584, DDA).

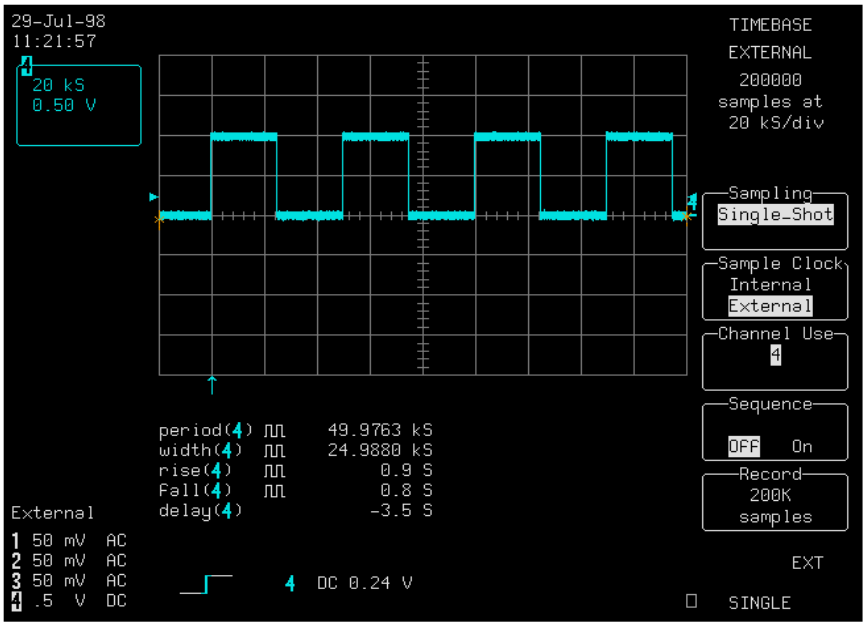


Figure 14: External Clock acquisition of a 1 kHz signal using 200 000 points at 50 MHz. The displayed parameter units are in samples. (LC564, LC584, DDA ONLY).

The following figure (*Fig. 15*) shows a similar acquisition and illustrates the recalibration menu. Calibration must be initiated for each external clock change ***(ALL MODELS EXCEPT LC564, LC584 AND DDA)***.

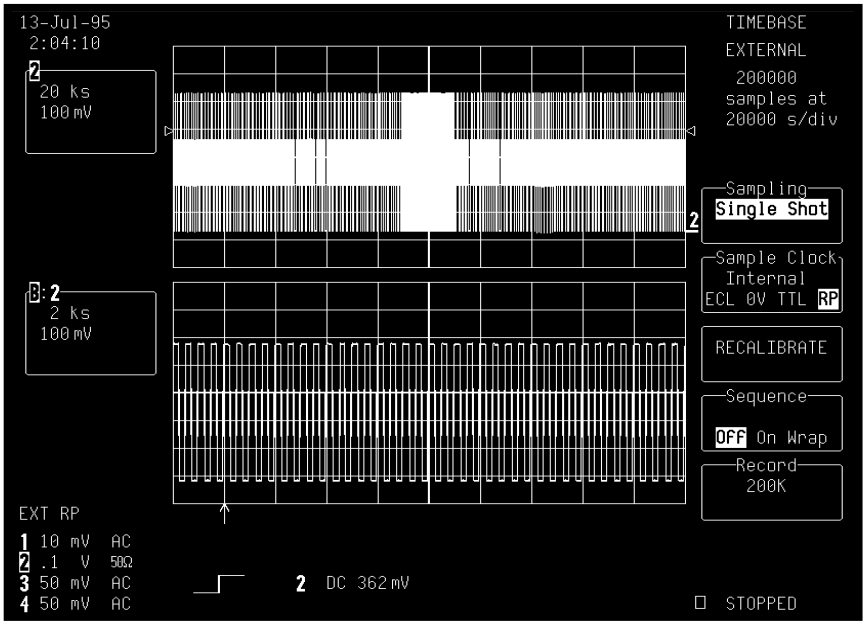


Figure 15: Acquisition of a 100 kHz signal using 200k points with external clock (ALL MODELS EXCEPT LC564, LC584, DDA).

NOT FOR LC564, LC584, DDA

This table shows a measurement on the same 1 V square signal at 100 kHz with different external clock rates using 10 000 points. For each change of clock rate, at least one manual recalibration has been performed. Gain and offset are extremely stable.

Clock rate MHz	Amplitude mV	Mean mV	rms mV
50	998	7.5	500
100	999	9.1	500
150	1000	5.7	501
200	1000	7.5	501
300	998	7.9	501
400	997	7.5	499
500	1002	8.1	501

Notes for Using External Clock

- ***NOT APPLICABLE FOR LC564, LC584 OR DDA SERIES:*** *When the external clock characteristics are changed, a manually performed calibration is required. This is done either by altering sensitivity or, depending on the model, pressing the button corresponding to the "RECALIBRATE" menu (see previous page).*
- ***ALL MODELS:*** *In the "TIMEBASE" menu, the clock-source change can be slow. However, each press of a menu button is detected by the instrument during the waiting time.*
- ***ALL MODELS:*** *Any action that changes the timebase value WILL CAUSE THE INSTRUMENT TO REVERT TO THE INTERNAL CLOCK. Autosetup and timebase changes, for example, CANNOT be used with external clock.*
- ***ALL MODELS:*** *The minimum number of external clock cycles needed to perform an acquisition is NOT fixed. The instrument will require a number of cycles (typically 50) before it recognizes the external clock signal. The acquisition is halted only when the trigger conditions have been satisfied.*
- ***NOT APPLICABLE FOR LC564, LC584 OR DDA SERIES:*** *For calibration by Remote Control, the *CAL? query is recommended.*

  Calibration cannot be performed with an external gated clock (Fig. 16). In order to use such a clock, the calibration must be done as follows:

  1. *Turn OFF autocalibration*
  2. *Turn the external clock to a NON-GATED clock*
  3. *Perform a calibration*
  4. *Turn the external clock to a GATED clock and acquire data.*

See, too the section on External Clock in the "Timebase Modes and Setup" chapter of the instrument Operator's Manual.

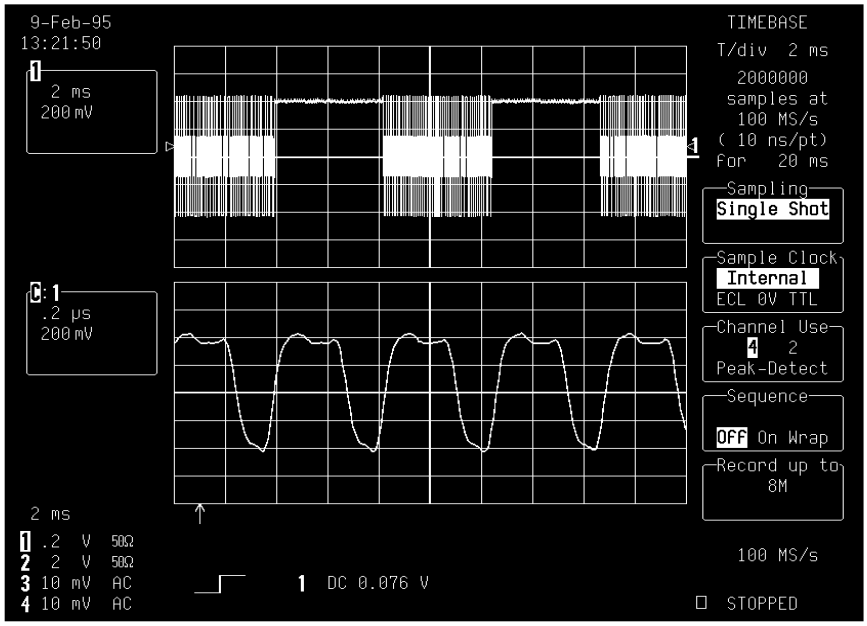


Figure 16: Calibration CANNOT be performed with an external gated clock (ALL MODELS EXCEPT LC564, LC584, DDA). See final note, previous page.

Remote Commands Specific to CKTRIG

These remote control commands and queries are available only on instruments fitted with CKTRIG. ***For your instrument's many other commands and queries, and an explanation of its remote control, refer to the*** **Remote Control Manual.**

ACQUISITION — REFERENCE_CLOCK, RCLK

Command/Query

DESCRIPTION

REFERENCE_CLOCK selects the system clock source, allowing the instrument to be phase-synchronized to an external reference clock input.

COMMAND SYNTAX

`Reference_CLocK` <state>

<state> : = {**`INT`**, **`EXT`**}

QUERY SYNTAX

`Reference_CLocK?`

RESPONSE FORMAT

`Reference_CLocK` <state>

SAMPLE_CLOCK, SCLK☝

Command/Query

DESCRIPTION

The SAMPLE_CLOCK command allows the user to control an external timebase. The user sets the number of data points that will be acquired when the instrument is using the external clock. When the optional suffix NUM is used with the query, the response will be returned in standard numeric format.

COMMAND SYNTAX

Sample_CLocK <state>[**,**<recordlength>][**,**<coupling>]

<state> : = {**INT**, **ECL**, **LV0**, **TTL**, **RP**☝}

<recordlength> : = {**50**, **100**, **200**, **500**, **1K**, **2K**, **5K**, **10K**, **20K**, **50K**, **100K**, **200K**, **500K**, **1M**, **2M**}

Or, alternatively, in standard numeric format:

= {**10e+3**, **10.0e+3**, **11e+3**…}, for example.

<coupling> : = {**D1M** or **D50**☝}

Note: The record length cannot be larger than the maximum available memory of the model being used. The instrument will adapt to the closest valid <recordlength>. See Appendix A of the instrument Operator's Manual for maximums.

QUERY SYNTAX

Sample_CLocK? [**NUM**]

☝ **AVAILABILITY**

Not available on 9361C or 9362C Series oscilloscopes.

RESPONSE FORMAT

Sample_CLocK <state>**,**<recordlength>