AN4941

Option IR for the Microchip 53100A: –175 dBc/Hz and 2E-13 @ τ=1s with One Box

INTRODUCTION

With the Microchip 53100A Phase Noise Analyzer, you can use the power of cross correlation with dual independent reference sources to make phase noise and Allan deviation measurements that would otherwise demand significant investments in equipment and training. Now, with the introduction of Option IR, we’ve packaged two high-performance reference sources inside the box, making dual-reference measurements more accessible than ever without compromising the 53100A’s market-leading flexibility.

Option IR and Option IR plus STD let you make turnkey measurements of clock and signal sources at arbitrary frequencies from 1 MHz to 200 MHz with an instrument you can hold in one hand, at levels that no other standalone instrument can reach. In this application note, we’ll outline some of the enhanced measurement capabilities that are possible with these options, provide some valuable optimization hints, and describe how they can help you make the most of your existing references and frequency standards.

DESCRIPTION

Front Panel Layout

Option IR provides two low-noise 100 MHz reference sources at the INT REF 1 and INT REF 2 SMA jacks on the 53100A’s front panel (Figure 1). Test sets equipped with Option IR are delivered with the channel-1 and channel-2 input jacks strapped to the INT REF 1 and INT REF 2 output jacks by default, rather than to the built-in reference splitter outputs.

In this configuration, the N-F front-panel REFERENCE input jack may be driven by an external 10 MHz “house clock” to discipline one or both of the internal references, or simply left unconnected for true standalone operation. The INT REF 1 and INT REF 2 outputs continue to provide reference signals at 100 MHz when disciplined by an external 10 MHz source, thanks to low-noise frequency multipliers in both channels.

FIGURE 1: Front Panel Layout.

Rear Panel Layout

The rear panel on a 53100A equipped with Option IR includes the TTL/5V CMOS level 1 PPS IN jack shown in Figure 2. Like the front-panel REFERENCE jack, an external disciplining source may be connected to the 1 PPS IN jack. More information on selection and connection of external reference sources appears later in this note.

FIGURE 2: Rear Panel Layout.

Optional Internal Atomic Standard (STD)

The Option IR reference module may be equipped with its own board-level atomic frequency standard. Option STD provides a self-contained disciplining source for measurement applications that require long-term frequency stability without access to high quality external standards. Reference frequency stability at intervals longer than approximately 1000 seconds is improved up to 10x in units equipped with the IR/STD options.

Block Diagram

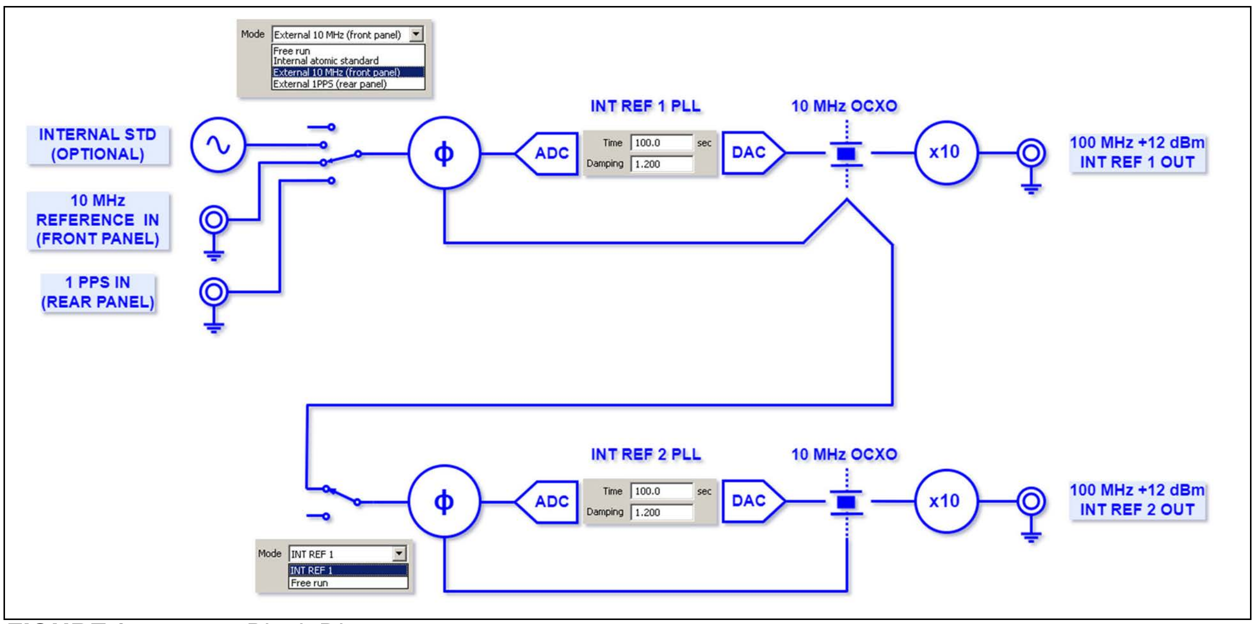


FIGURE 3: Block Diagram.

Figure 3 illustrates the basic architecture of the Option IR internal reference module. Each of the two independent channels has its own 10 MHz oven-controlled crystal oscillator (OCXO) which is followed by a low-noise frequency multiplier that generates the 100 MHz output for that channel.

While capable of free-running operation, the 10 MHz OCXO that drives the INT REF 1 output is most often phase-locked to an external or internal 10 MHz standard to maintain frequency accuracy and long term stability, with its PLL acting as a “cleanup” loop for any short-term noise that may be present. Similarly, the INT REF 2 OCXO can either be phase-locked to the INT REF 1 OCXO or allowed to free-run. By default, INT REF 2 is locked to INT REF 1 with a 100-second time constant, allowing the two channels’ short-term noise to remain uncorrelated while maintaining overall frequency accuracy at longer intervals.

With this approach, for example, the 53100A can measure the 1 Hz phase noise of ultrastable 5 MHz OCXOs at levels near –130 dBc/Hz even though the 1 Hz phase noise at the INT REF 1 and INT REF 2 outputs is closer to –120 dBc/Hz. At the same time, Allan deviation measurements near 2E-13 @ t=1s are practical. In areas of the graph where the INT REF 1 and INT REF 2 sources are uncorrelated, the real-world measurement floor for a 53100A equipped with Option IR is often determined more by acquisition time than by the reference sources' own specifications.

Why 100 MHz?

Compared to traditional 5 MHz or 10 MHz references, the use of 100 MHz reference sources offers substantial reductions in PN measurement time when working with high-quality VHF crystal oscillators. Especially at offsets above 1 kHz, lower-frequency references require many more FFT averages to achieve the necessary noise floor improvement. Unfortunately, even the best 100 MHz OCXOs lack the stability to make good reference sources for measurements of high-quality HF oscillators.

Option IR is designed to overcome both limitations. As noted above, the two INT REF output signals originate with independent 10 MHz oven-controlled crystal oscillators (OCXOs) with excellent short-term stability and phase noise characteristics. These oscillators are followed by 100 MHz analog PLLs that are based on JFET frequency multipliers rather than traditional dividers. As a result, the OCXOs' superior phase stability is maintained at offsets below 1 kHz without compromising the broadband noise floor. Integrated jitter at the 100 MHz outputs is typically better than 40 fs in the critical 1 Hz to 1 kHz range and below 10 fs from 1 kHz to 1 MHz. Significant attention has also been paid to RF decoupling between the two reference sources, resulting in well over 100 dB of isolation between the outputs at VHF frequencies.

External Locking

The 53100A's frequency accuracy and stability remain uncompromised when Option IR is enabled. A separate PLL offers the ability to lock INT REF 1 to either a user-provided 10 MHz or 1PPS source or to an optional internal atomic frequency standard (Option STD). Residual performance (measurement floor) near 2E-13/tau is sufficient to allow almost any external 10 MHz source to discipline INT REF 1 (and by extension INT REF 2) without adding significant noise.

Of course, all four of the 53100A's input channels remain user-accessible in both Option IR and standard units, for applications that require direct connection of multichannel sources or external references. The system measurement floor (5E-15 @ τ = 1s) using the cross ADEV feature with dual externally supplied references remains unchanged.

Measurement Floor Considerations

When characterizing high-performance devices, both ADEV and PN measurements benefit from the use of two uncorrelated reference sources as described in AN3526, *Dual Reference Noise and Stability Measurements with the 53100A*. In areas of the graph where the INT REF 1 and INT REF 2 sources are uncorrelated, the real-world measurement floor for a 53100A equipped with Option IR is often determined more by acquisition time than by the reference sources' own specifications.

For example, ADEV measurements near 2E-13 at t=1s can be made in just a few minutes, even when this level of stability exceeds that of the reference sources themselves. Likewise, 1 Hz phase noise figures from ultrastable HF oscillators near –125 dBc/Hz are measurable in minutes with frequency-scaled specifications near –115 dBc/Hz. At higher offset frequencies, phase noise results below –170 dBc/Hz are obtained almost immediately. Examples of all three of these measurement scenarios are presented below.

Software Support

The TimeLab acquisition dialog for the Microchip 53100A includes a separate page of settings and controls for units equipped with Option IR. This page is accessed by pressing the Internal Reference button seen in Figure 4 after selecting Acquire>Microchip 53100A in the TimeLab main menu.

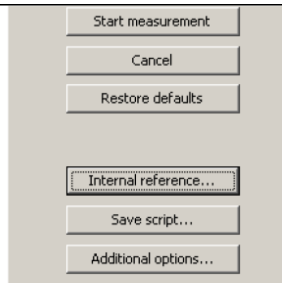


FIGURE 4: Internal Reference Button.

As shown in Figure 5, this dialog page includes controls to adjust PLL properties, configure lock source preferences, and calibrate the two OCXOs and the optional internal atomic standard.

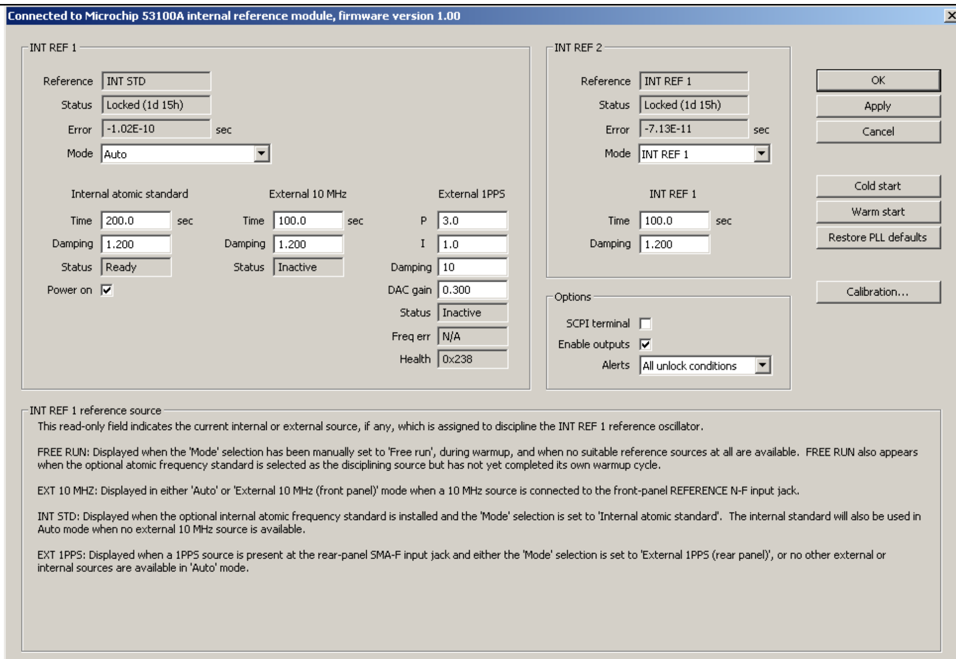


FIGURE 5: Internal Reference Menu.

The Option IR configuration dialog is divided into two separate sections governing the INT REF 1 and INT 2 references and a third section containing controls common to both. The two INT REF sections are similar, except that INT REF 1 can be locked to the optional internal atomic standard or to an external 10 MHz or 1 PPS source, while INT REF 2 can be disciplined only by INT REF 1. Buttons are also provided at right to reset the internal reference module's onboard CPU (Cold start), force immediate relocking in both channels (Warm start), and restore the values that determine the PLL properties in both channels to their factory default settings (Restore PLL defaults).

User and Factory Calibration

The Calibration button opens an additional dialog page containing user calibration options for the internal OCXO sources and optional atomic standard (Figure 6).

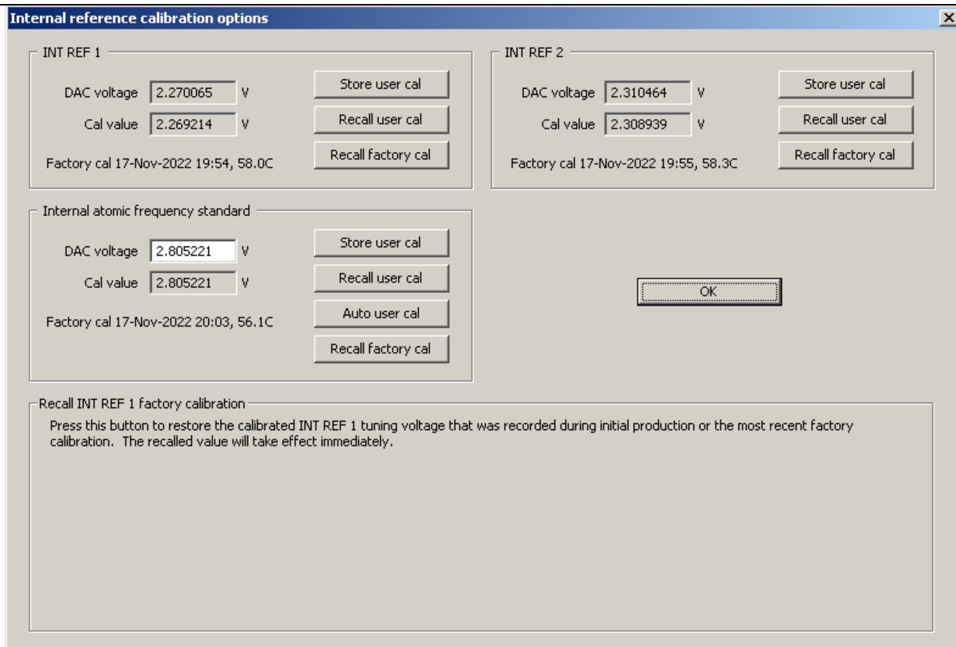


FIGURE 6: *Calibration Menu.*

This dialog box provides access to the calibration constant parameters that apply when a given OCXO is in free-running operation, unlocked to any internal or external source. These calibration constants represent tuning voltages applied via microvolt-resolution DACs to the OCXO frequency-control inputs during unlocked operation. When an OCXO is in free-running (unlocked) operation, its calibration constant can be edited manually, if desired, and updated by pressing Store user cal. The oscillator's tuning range and sensitivity in hertz per volt appears in the mouseover help text for that channel's DAC voltage field. In units equipped with the optional internal atomic frequency standard, a third calibration constant determines its tuning voltage as well.

A key point is that the OCXO calibration constant is not used at all when its corresponding oscillator is locked to an internal or external standard. The OCXO's tuning DAC is driven by its respective software PLL during closed-loop operation, with the DAC voltage displayed as a read-only value. At any time, the tuning DAC voltage for a given channel can be saved to nonvolatile memory with the channel's Store user cal button. This will establish a new "user calibration" value for the channel. Assuming the OCXO was locked to a given calibration source at the time Store user cal was pressed, its frequency during subsequent free-running operation will be very close to that of the source.

It's also important to note that the optional internal atomic frequency standard is not automatically steered by an external source. In fact, an external 10 MHz source connected to the front-panel REFERENCE jack will take precedence over the internal atomic standard in locking the INT REF 1 OCXO when the channel's Mode selection is set to the default Auto value. Instead, the internal standard can be calibrated by connecting an external 10 MHz or 1PPS signal temporarily and pressing the Auto user cal button once the INT REF 1 OCXO has successfully phase-locked to the external source. This will start an autocalibration routine that typically takes 3-5 minutes to match the frequency of the external signal to a fractional accuracy of less than 1E-10. If successful, the resulting DAC voltage will be stored as the internal atomic standard's user calibration constant. The external standard may then be disconnected if desired.

Finally, the most recent factory calibration constant for INT REF 1, INT REF 2, or the internal atomic standard may be recalled at any time by pressing the appropriate Recall factory cal button. The factory calibration constant will replace the user calibration constant (if any) for that channel. It will remain in effect until a new user calibration constant is stored with Store user cal or a previously stored one is recalled with Recall user cal. The factory calibration constants are always available for selection, and cannot be overwritten in normal operation.

Firmware Updates

The latest Option IR firmware accompanies each TimeLab software release alongside the firmware for the 53100A itself. To install new firmware, open the Additional options dialog box from the 53100A acquisition dialog and click the Update firmware button, then select the appropriate Intel .hex file with the file-selection dialog box that appears.

It is not necessary to power-cycle or otherwise reboot the 53100A manually after installing new firmware, although phase lock will be lost during the cold-start cycle that is automatically initiated. As with any other cold-start cycle, please wait at least 30-60 minutes before attempting to make high-performance measurements after updating.

Online Help

As with other acquisition dialog pages in TimeLab, individual controls and features in the Internal reference and Calibration dialogs may vary from one software release to the next. Detailed context-sensitive “mouseover” help text is provided for all dialog fields, and serves as the primary documentation for these controls. Please refer to the help text for the latest user information and operating tips.

APPLICATION EXAMPLES

These real-world measurement examples share one aspect in common: they were carried out with no external equipment or reference sources other than a Microchip 53100A equipped with Option IR.

Phase Noise of 100 MHz VCXO (1-minute and 30-minute runs)

In the first example, the 53100A was used to evaluate a high-performance VHF crystal oscillator module for compliance with its phase noise specifications. A one-minute test returned the following result (Figure 7):

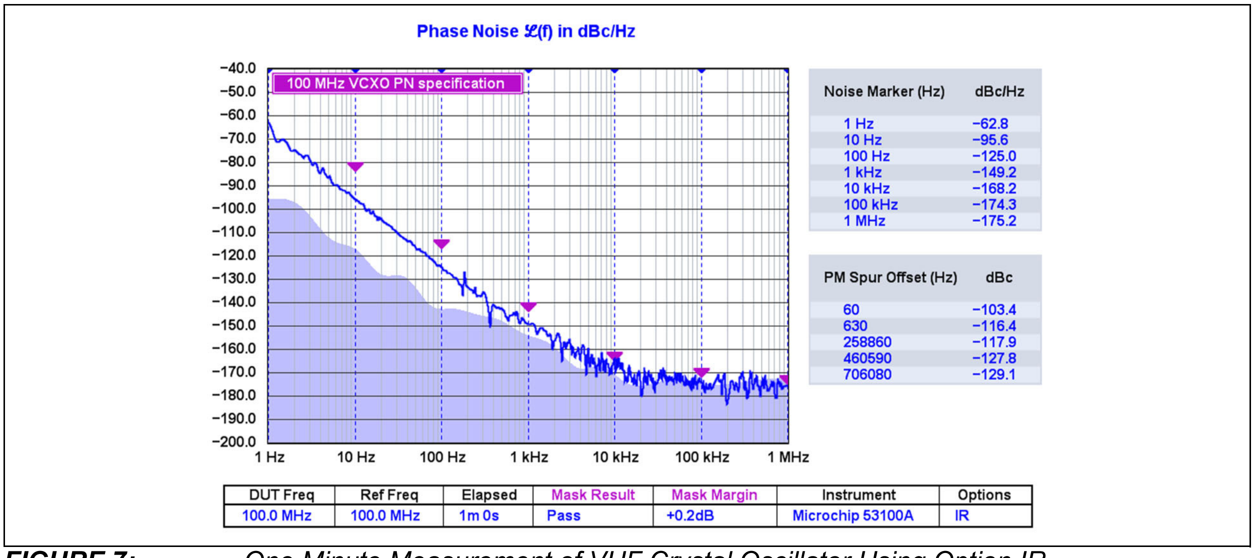


FIGURE 7: One Minute Measurement of VHF Crystal Oscillator Using Option IR.

The observed close-in noise is excellent for this class of device, with substantial headroom available at offsets below 10 kHz. Specifications at the higher-frequency offsets are met as well, but only barely. Along with the high instrument floor estimate, significant trace variance at offsets beyond a few kHz suggests that the cross-correlation measurement hasn’t had enough time to converge fully. Running for 30 minutes instead of only one minute gives us a better clue to the oscillator’s true performance, as well as that of the 53100A:

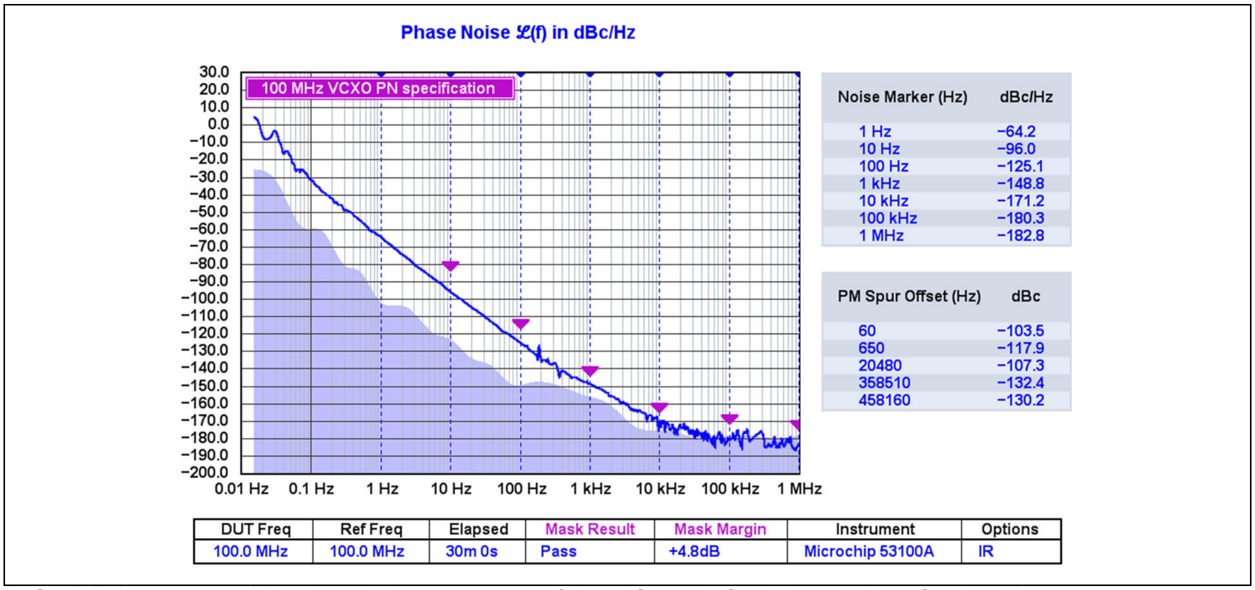


FIGURE 8: 30 Minute Measurement of VHF Crystal Oscillator Using Option IR.

In Figure 8, the trace still hasn't converged fully beyond 10 kHz after 30 minutes—and likely will not do so regardless of measurement duration, given that it is already well below the –175 dBc/Hz typical performance figures noted in the 53100A's own documentation—but it is safe to conclude that the DUT's broadband noise floor is in the vicinity of –180 dBc/Hz(1).

Most of the 53100A's acquisition parameters, and all of the Option IR loop parameters, were left at their default values for this measurement, apart from specifying the 1-minute and 30-minute measurement durations. Parameter changes made for this demonstration are listed below.

1. Set appropriate spur amplitude and offset thresholds

These options can be found on the Additional options page of the 53100A acquisition dialog (Figure 9). Especially if you use continuous limit-line masks for PN pass/fail evaluation, it's helpful to reduce the Spur threshold from 6 dB to 3 dB to keep small unrecognized spurs from artificially failing the PN test.

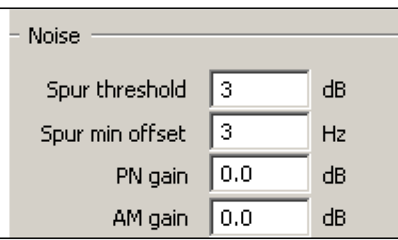


FIGURE 9: Spur Settings.

False spur identification at close-in offsets can be avoided by setting a minimum offset for spur detection. This effect is more likely to occur when testing sources with very low close-in noise, rather than the VCXO in this example.

Note 1: Specifically, the oscillator has a carrier output power of +12 dBm and source impedance near 50Ω. At this power level, a theoretically ideal instrument could measure the PN noise at levels down to –177 dBm/Hz – 12 dBm + 3 dB = –186 dBc/Hz, allowing 3 dB of additional noise for the analyzer's own load impedance. Some caution is warranted as cross-correlating analyzers are subject to artifacts that can underestimate the true noise level when sources are operating near the thermal limit. However, measurement time constraints and very low-level instrument spurs usually determine the 53100A's performance floor before these effects become apparent.

2. Enable overlapped acquisition

This will help low-level phase noise tests pass sooner, often within less than a minute (Figure 10). Try disabling AM noise measurements if USB overruns occur. Also, use the System power option within Windows® to ensure that the high performance power plan is in effect during acquisition.

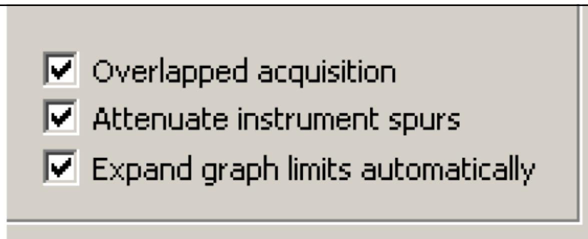


FIGURE 10: Overlapped Acquisition Checkbox.

Both of these fields are on the Additional options page of the main 53100A acquisition dialog.

3. Use the abs(I) cross spectrum estimator

This improves test time in challenging measurements where the DUT noise floor is close to the instrument floor (Figure 11, also on the Additional options page). The trace may appear 'uglier' at first with numerous false spurs that may take a minute or two to resolve. However, the instrument noise contribution will be 3 dB lower, and there will be a corresponding improvement in measurement convergence time.

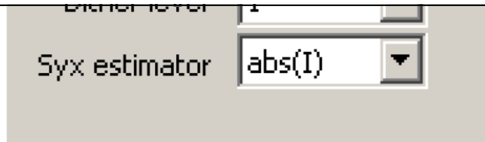


FIGURE 11: Syx Estimator Pull-Down Menu.

Short-Term Stability of Ultrastable 5 MHz DOCXO

In our second scenario, the goal is to verify that a double-oven OCXO meets its short-term Allan deviation specifications of 2E-13 @ t=0.1s, 2E-13 @ t=1s, and 8E-13 @ t=10s. Can the 53100A's internal reference module make this measurement, given that its own absolute ADEV specifications are several times higher? Yes, as Figure 12 reveals, as long as a few prerequisites are understood.

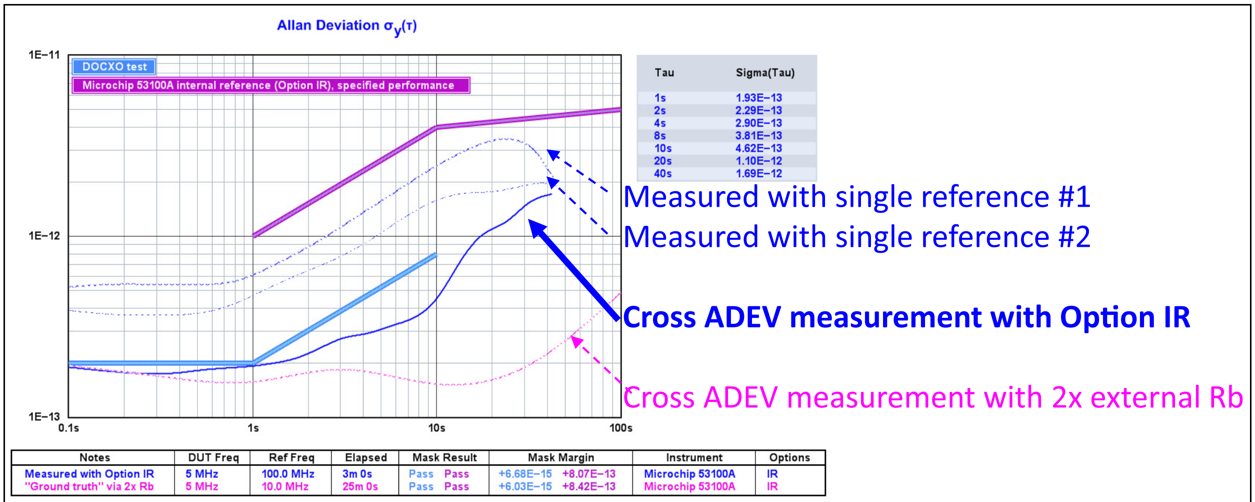


FIGURE 12: ADEV Measurement of Ultrastable 5 MHz DOCXO Using Option IR.

1. Select a measurement role with cross ADEV support

Cross Allan deviation is not a unique measurement type in itself, but rather a way to perform traditional Allan deviation measurements using multiple channels and/or reference sources in a manner reminiscent of more familiar cross-correlated phase noise measurement techniques. Just as with cross-correlated PN measurements, both reference stability and instrument ADC noise performance undergo progressive improvement over time by averaging the results of two identical measurements carried out simultaneously. While the Microchip 53100A can make cross ADEV measurements using a pair of external or internal references, the technique is an especially good fit for Option IR instruments.

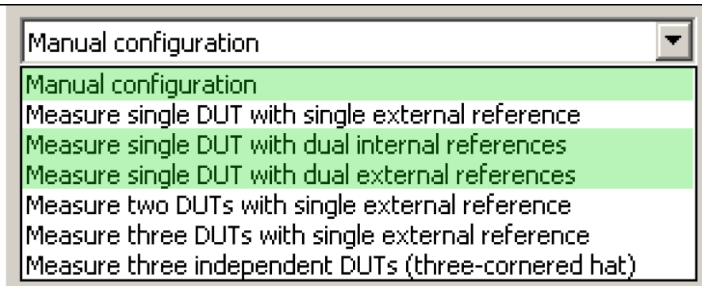


FIGURE 13: *Measurement Role Pull-Down Menu.*

Referring to the main page of the 53100A'a acquisition dialog, any of the predefined measurement role options highlighted in Figure 13 can be used to perform cross ADEV measurements. The required secondary phase data record is automatically created whenever channels 3 and 4 have separate Stability reference channels assigned to them. This will be the case whenever one of the predefined dual-reference roles is chosen, as well as when Manual configuration is used to set up a measurement that meets the same conditions. Note that Always use cross ADEV when possible must also be checked on the Additional options page of the acquisition dialog. This checkbox is selected by default.

In TimeLab itself, make sure that Trace>Show cross ADEV traces when available (Ctrl-j) is enabled. For the screenshot example in Figure 12, we've also selected Trace>Show original traces in computed xDEV displays (F6) to highlight the improvement in the stability measurement floor achieved with cross ADEV. The heavy and light dotted traces in blue represent the measurements that would have been obtained by measuring the DUT against either the INT REF 1 or INT REF 2 reference source by itself. Also for the sake of comparison, the magenta trace shows the actual performance of the DOCXO under test as measured with a pair of lab-grade rubidium frequency standards serving as reference sources.

2. Consider using deferred acquisition if necessary

Given adequate warmup time and an appropriate PLL time constant, drift is negligible when INT REF 1 is locked to an internal or external 10 MHz standard. When one or both OCXOs is allowed to free-run, however, temperature variations associated with the onset of USB data acquisition can induce a small amount of frequency drift in the early part of the measurement. Challenging ADEV measurements such as the one in this example may take longer than expected to settle as a result.

As with other temperature-related effects, initial drift can often be diagnosed by using Edit>Trace properties (e) to set the Trace history parameter to 2 or 3 (Figure 14). Here, the darker ADEV traces correspond to later segments of the measurement's phase record.

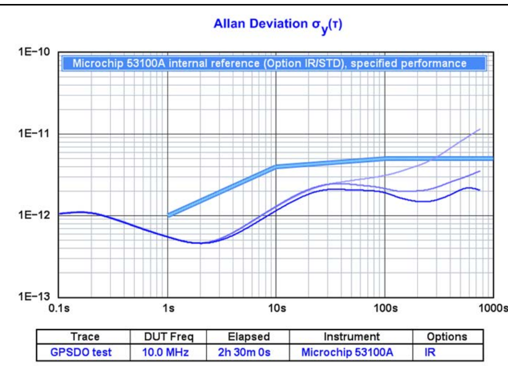


FIGURE 14: *Trace History = 3, Produces Three Sets of Curves.*

One way to avoid this issue is to tell TimeLab to discard the initial subset of measurement data by using Acquire>Acquisition options to specify a delay as shown in Figure 15. Subsequently, select the Acquire>Enable deferred acquisition option to enable the delay. The measurement will begin as usual, but by selecting an appropriate Acquisition delay parameter, no data will actually be recorded until temperature equilibrium, as specified by the user, has been established.

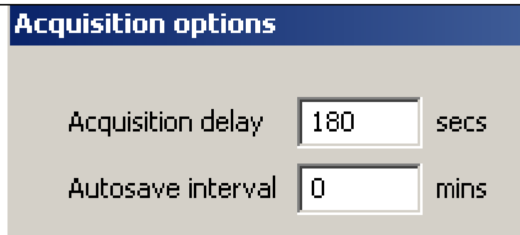


FIGURE 15: Deferred Acquisition Setting.

3. Reduce the measurement bandwidth

The DOCXO that we measured in this example would not have passed its ADEV test at the default 50 Hz (100 points/sec) measurement bandwidth due to the unusually tight performance requirement at t=0.1s. It was necessary to select 5 Hz instead (Figure 16).

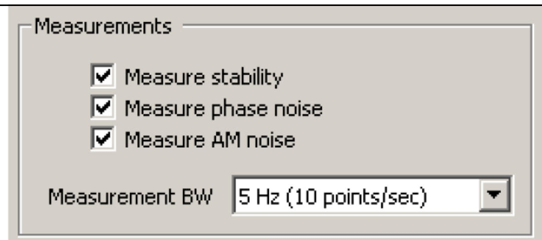


FIGURE 16: Measurement Bandwidth Pull-Down Menu.

Note that the choice of measurement bandwidth does not affect noise measurements, only stability measurements.

4. Ensure references are disciplined appropriately

To achieve the lowest possible ADEV measurement floor near t=1s, it may be tempting to configure INT REF 1 and/or INT REF 2 in free-running mode. Doing so can keep the external or internal reference standard from contributing to short-term reference instability, but the resulting drift may give rise to artifacts that take a very long time to resolve, such as the large divot in Figure 17 that's caused by leaving both references unlocked.

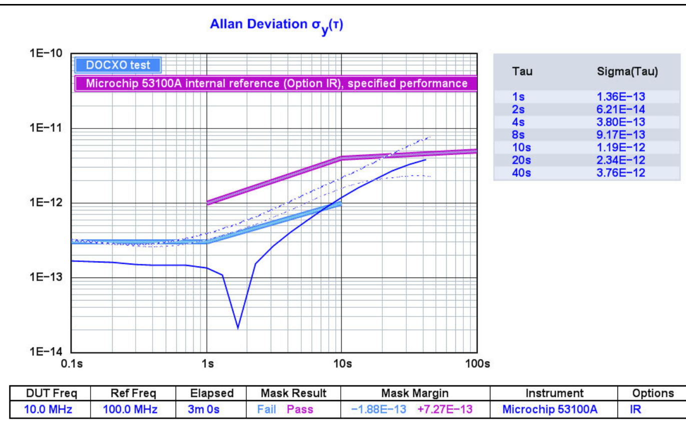


FIGURE 17: Measurement Artifact Due to Unlocked References.

While both cross ADEV and phase noise measurements rely on statistical independence of INT REF 1 and INT REF 2 at the taus and offset frequencies of interest, the choice of lock bandwidth is more likely to be dictated by the maximum ADEV tau of interest than by the minimum PN offset requirement. INT REF 2's lock bandwidth will have a noticeable impact on the cross ADEV measurement floor at taus exceeding 5% to 10% of the lock time constant in seconds.

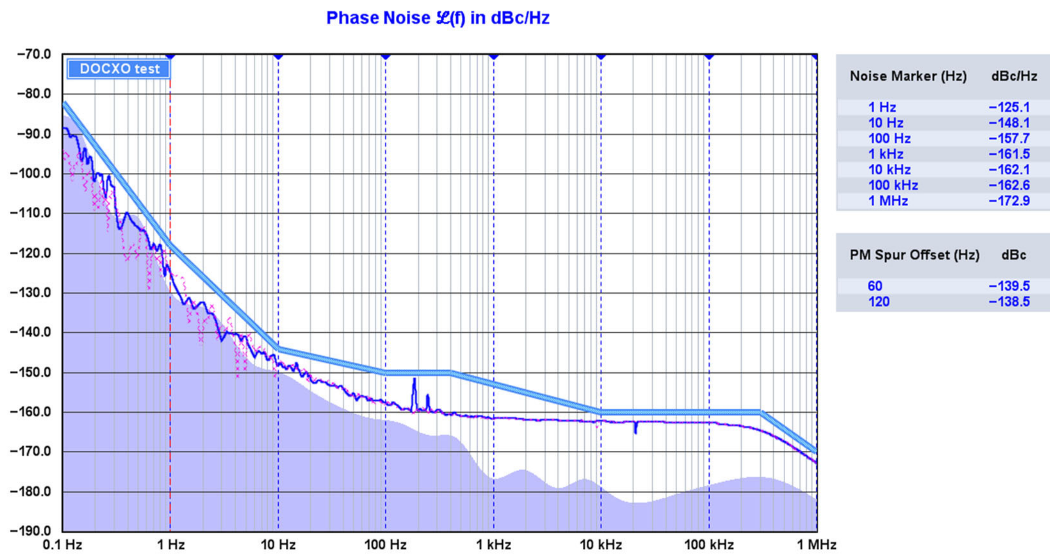
Consequently, in the absence of an external 10 MHz reference with excellent short-term stability that can be used as a disciplining source for INT REF 1, a better strategy for measuring low ADEV levels at taus exceeding a few seconds can be to operate INT REF 1 with a longer-than-usual time constant (e.g., 200 seconds or more, particularly if locking to the internal atomic standard) while locking INT REF 2 to INT REF 1 with a similar time constant. INT REF 1 can also be allowed to free-run while INT REF 2 is locked to it. All of that being said, the result in Figure 12 was obtained with the default lock parameters shown in Figure 5.

On the other hand, when a high-quality 10 MHz reference such as a maser or ultrastable OCXO is available, consider using very short time constants on the order of 1 second for both INT REF 1 and INT REF 2. Stability measurements will inherit both the short-term and long-term characteristics of your external reference in this case, while phase noise measurements at offsets beyond a few hertz will benefit from the independent low-noise internal OCXOs as usual.

As a further note, external 1PPS references should be avoided in demanding applications such as this example. Residual ADEV from the 1PPS source is approximately 1E-11 at t=30s with the default 1PPS disciplining parameters. The 10 MHz loops have significantly better residual performance, are much easier to tune, and lock much more rapidly.

Close-In Phase Noise of Ultrastable 5 MHz DOCXO

The phase noise of the DOCXO was also measured during the previous test and is now evaluated for compliance with specified limits (Figure 18):



Notes	DUT Freq	Ref Freq	dBc/Hz at 1 Hz	Elapsed	Mask Result	Mask Margin	Instrument	Options
Measured with Option IR	5 MHz	100.0 MHz	−125.1	3m 0s	Pass	+1.5dB	Microchip 53100A	IR
"Ground truth" via 2x Rb	5 MHz	10.0 MHz	−125.0	25m 0s	Pass	+2.1dB	Microchip 53100A	IR

FIGURE 18: *Phase Noise Measurement of Ultrastable 5 MHz DOCXO Using Option IR.*

As before, the blue trace represents the measurement made by the standalone 53100A equipped with Option IR in 3 minutes, while the magenta trace represents the same DUT measured against a pair of high performance rubidium standards over 25 minutes. Both measurements are sufficient to confer a passing grade on the DUT. In particular, the self-contained Option IR references were able to measure the oscillator’s 1 Hz phase noise at –125 dBc/Hz (a figure achieved by a relatively small fraction of devices on the market) while additionally confirming performance below –170 dBc/Hz at 1 MHz.

TIPS FOR HIGH-PERFORMANCE MEASUREMENTS WITH OPTION IR

Allow sufficient stabilization time after applying power or changing loop parameters

The Option IR module is active whenever the 53100A is connected to its power supply, regardless of the power switch setting. The firmware enforces a 3-minute warmup period after power application before any lock attempts are made. This represents a minimum requirement. It is strongly recommended that the reference module be allowed to warm up for at least 30-60 minutes before making measurements with a 53100A that has just been connected to its power supply. When freshly powered up, the INT REF 1 OCXO may require multiple attempts to lock to an external 10 MHz source or to the optional internal atomic standard and if INT REF 2 is locked to INT REF 1, it may need some extra time as well.

Observe lock status before and during the measurement

Prior to starting a measurement, you can monitor the lock status for both INT REF 1 and INT REF 2 by clicking on the Internal reference button in the 53100A acquisition dialog to bring up the Option IR configuration dialog box shown in Figure 5. The read-only Reference, Status, and Error fields in the configuration dialog will be updated periodically to reflect the current INT REF 1 and INT REF 2 lock states. Lock status messages may be observed in the SCPI terminal, which can be toggled on and off with the corresponding checkbox in the Options area.

Additionally, the tuning voltages for any OCXOs undergoing phase locking are also updated in real time on the Calibration page. Stable lock conditions exist when the least significant digits of the tuning voltages are no longer changing rapidly.

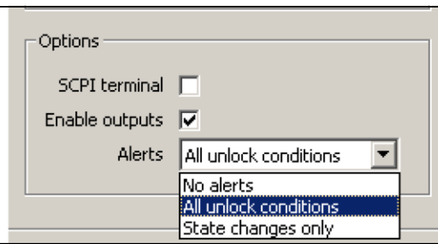


FIGURE 19: *Lock Notification Options.*

During the measurement itself, there are two ways to keep an eye on the reference's lock status. First, whenever operating conditions such as loss-of-lock, OCXO and atomic standard warmup, and 1PPS holdover are detected by the reference module's onboard controller, they will be reported by default in the status line at the bottom of the main TimeLab window. Refer to the help text for the Alerts control in the Options area of the Option IR configuration dialog box (Figure 19) for more information about the conditions that generate these messages. The most common alerts from the internal reference module will resemble Figure 20, indicating that the reference module is attempting to return to a phase-locked condition after excessive drift, external signal loss, or other hardware or environmental issue has interrupted the disciplining process. Timestamps help determine when the most recent interruption or other event occurred in the course of a long (and possibly unattended) measurement.

FIGURE 20: *Common Alerts from the Internal Reference Module.*

For more specific information about the operating status of the Option IR module while a measurement is in progress, you can access the Internal reference and Calibration dialogs in much the same way as you would when the 53100A is idle. Select Acquire>Microchip 53100A in TimeLab, just as if you were preparing to initiate a new measurement. The device selection menu entry for the 53100A that's currently performing the measurement will be marked (In use), with all of the other controls in the acquisition dialog box except for the Cancel and Internal reference buttons disabled. Selecting Internal reference will close the acquisition dialog and bring up the Option IR configuration dialog in its place. All options and controls in this dialog box, as well as those on the Calibration page, are available for use while the 53100A is collecting data. Note, however, that any Option IR dialog boxes will automatically be closed when the measurement ends, canceling any operations such as user calibration of the optional atomic frequency standard that may be in progress at the time.

Access to the Option IR dialog boxes at measurement time can be invaluable for monitoring and diagnostic purposes. Of course, any attempt to change disciplining sources, make significant adjustments to the PLL parameters, or select different calibration states may have adverse effects on the measurement in progress. These operations are best performed before initiating the measurement.

Use high-grade cables to connect the DUT

The use of cables with low shield resistance, as measured with an ohmmeter from shell to shell, is especially important for PN measurements that are expected to reach –170 dBc/Hz and below.

Shield DUT from environmental effects

Devices that are exposed to the open air on a PCB or breadboard will be vulnerable to effects such as HVAC circulation and local convection currents that make it difficult to pass demanding ADEV tests. They can also exhibit higher-than-necessary levels of close-in phase noise. Both environmental and RF isolation can be improved by enclosing the DUT in an insulated housing for test purposes (Figure 21). This was necessary in order to achieve the results obtained here for both the 10 MHz DOCXO and the 100 MHz VCXO.

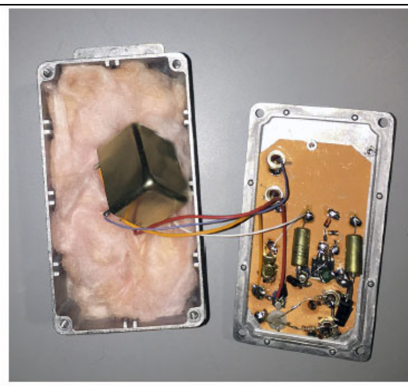


FIGURE 21: *DUT Enclosures for Reducing Unwanted Environmental Effects.*

Disconnect unused signals from the front-panel REFERENCE jack

While Option IR is ideal for installations where an outside reference source is unavailable, the internal reference module may be disciplined by an external source at 10 MHz ±1 Hz simply by connecting it to the front-panel REFERENCE input as described earlier. Amplitude of the external 10 MHz reference source should range from +5 dBm to +15 dBm. Signals at other frequencies and power levels may cause undesired behavior such as intermittent locking and spurious responses, so it's best to disconnect any external sources other than those participating in the measurement.

CONCLUSION

Option IR adds more than just operating convenience to the 53100A—it enhances measurement performance in ways that would otherwise require multiple external frequency standards with a substantial impact on test bench footprint and cost. With its unique combination of single-box integration and flexible configuration possibilities, the Microchip 53100A/IR offers a genuinely future-proof solution to stability and phase noise measurement requirements in both production test and R&D applications.

NOTES:

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