

Reverse Sweep and Balance

Application Note 2



**Cable Networks
Application:**
Using Acterna's
family of SDA
Sweep for
reverse sweep
and balance.

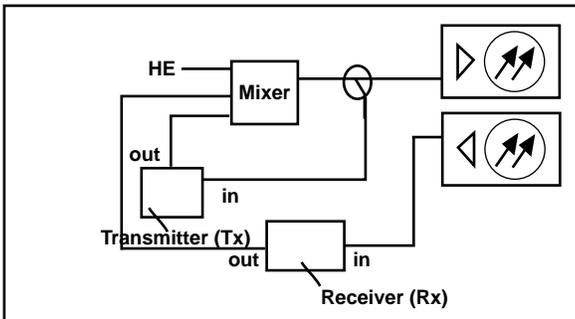
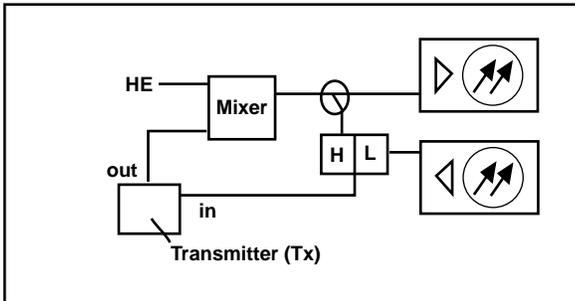


Step-by-Step Headend Set-up

Set-up of Reverse Sweep (see diagram below)

A diplex filter is used to combine the reverse signals into the rack mount unit, instead of a splitter or DC-12, because of isolation issues and the return fiber receiver is more than likely 5-200 MHz. This could cause jitter on the forward sweep if not set up properly. Because the Stealth Transmitter (Tx) must see itself, be careful with what is in this "loop", such as launch amps, filters, etc. It could cause problems.

Note: Be sure input levels are between 4 and 12 dBmV. The recommended is 6 dBmV \pm 2. If levels are too high, distortions will be created in the Tx, which appear as common path distortions (CPD) when viewing the "Noise" mode. The recommended input for reverse RF is 0 dBmV \pm 2. It may work between \pm 10 dBmV, but it depends on the aggregate noise floor.



The Tip Box

When making labels, the up and down diamond keys can be used to access special symbols (i.e., "@", "\$", etc.).

Build Channel Plan (Configure; Channel Plan)

Note: The newest Stealth field meter replaced many of the menus with icons. The "Set-up" button has been replaced with a "Configure" mode, which can be accessed through the "Navigator" mode, or by pressing "func" (green key) and the number 3 key. Channel plans and files names are limited to 15 characters.

Sweep Transmitter (Configure; Sweep Transmitter).

"Sweep Mode" must be in the appropriate mode to allow proper operation. The "Transmit" mode is the older Stealth Sweep, whereas the new "Transmit (SDA Compatible)" mode is for the faster sweep refresh with digital and scrambled carriers present. The wrong mode selection will create erroneous readings.

"Forward Telemetry Frequency" must be in the vacant spectrum and at least 500 kHz from any other carrier; it must also be within the bandwidth of the downstream spectrum. This is an FSK carrier and approximately 500 kHz wide. The factory default is 51 MHz on the Tx, 52 MHz on the Rx, and 53 MHz on the PathTrak HSM.

Note: If diplex filters in the actives have a sharp roll-off, it may be wise to move the telemetry to a frequency that is more reliable. Make sure that the Tx and Rx have different telemetry frequencies. The location and level of the telemetry can cause its second harmonic to interfere with existing channels if not taken into account.

"Forward Telemetry Level" determines the level of the telemetry signal (FSK). This should be set 10 dB below the video reference level. The telemetry level is adjustable from 20-50 dBmV in 2 dB increments. The max is 50 dBmV, however some older units may have a max of only 40 dBmV.

"Forward Sweep Insertion Level" is not applicable for reverse sweeping.

"Include Audio Carriers" is not applicable for reverse sweeping.

"Enable Reverse Sweep" allows reverse sweep to operate in the Tx. If disabled, the forward sweep will be faster but reverse sweep will be inoperable.

"Enable Live Headend Ingress View" allows reverse noise to be transmitted on the forward telemetry. If disabled, the forward sweep will be faster.

"Reverse Telemetry Frequency" is set-up on the Tx or Rx and not on the field unit.

Note: Be sure to select a reliable frequency void of interference in the most stable part of the passband, not in the roll-off or below 15 MHz.

"Reverse Channel Plans" are built and/or edited for the upstream direction. The reverse channel plan must be set-up on the Tx. It will automatically be communicated to the field unit via the forward telemetry. Notice this menu is found under Set-up / Sweep Transmitter / Reverse Channel Plans.

Field Unit Settings

On the field unit select (Configure; Measurements) and insert all the required information (Temperature Units, Signal Level Units, Fundamental Hum Frequency, Scan Rate, etc.).

Note: Select "func" and "7" to enter the Test Point compensation. You can also access the Test Point compensation through the Navigator screen on the newest unit. There is a toggle button to select forward or reverse Test Point compensation.

Before You Leave the Headend

On the receiver select (Configure; Sweep Receiver) and set the forward sweep telemetry frequency to be the same as the Tx and/or Rx. Set for the sweep mode intended to be used. Depending on the options installed in the field unit, these modes are as follows: "Sweepless", "Stealth", "SDA Compatible", "Loopback Sweep", "Transmit", and "Transmit (SDA Compatible)". Normally we would select "Stealth" or "SDA Compatible". Also set the reverse sweep insertion and telemetry levels as close to the system specifications as possible, taking into consideration insertion losses.

Note: Sweep and telemetry levels >15 dB above the recommended input could cause return laser clipping and erroneous balancing and sweep traces. This depends upon the type of laser and return hybrids used.

Put in "Single User" mode if using the Tx for reverse sweeping, or in "Multiple User" mode if using the Rx. Be sure the Tx is in the sweep mode and the reverse is enabled.

Reverse Balancing and Sweeping

The Tip Box

The quickest way to determine if your field unit has reverse capability is to verify that there are two connections on the top of the field unit.

First, balance the forward path and press "Sweep" to verify all is well, then proceed with reverse.

Check the sweep in both directions. Change the sweep direction on the receiver to reverse by using the left diamond key or selecting the following sequence: (Configure; Sweep Receiver; Sweep Direction).

Note: *The NS-6 or DDC-20 is necessary for firmware version 8.5 or earlier. A summation network for return path sweeping is not necessary for versions 9.x or later. There must be a place to inject the sweep, which will make its way to the Tx or Rx. Record the reverse telemetry level, recommended reverse input, and test point loss. A reverse sweep reference can also be taken at this time by selecting the sequence: ("func" and "6"). A name must be entered for your reference.*

Take a normalized reference at the node; at each leg if warranted.

Note: *It's good to compare "apples" to "apples". Don't change things like in-line pads and test leads once a reference has been stored. Store a new reference otherwise.*

If you use the internal, directional test point, it must be an injection test point. You may be able to sweep in reverse using the forward test point if it is on the outside of the diplex filter. Otherwise, bi-directional test points can be used, but may give misleading displays because of standing waves. Use a tap if possible. You must use a splitter or diplex filter when using the same TP for injection and reading.

Note: *Be sure to turn off the ALC in the reverse rack mount receiver if present. Also turn off the ALC in any LAN return amplifiers. Each ALC sensitivity will have to be adjusted after balancing is completed.*

Note: *The "max/min" displays the peak-to-valley between the markers. The delta displays the difference in level and frequency at the markers.*

Proceed to the first amplifier from the node and reverse sweep and balance to a flat line using an EQ. Use the corresponding node reference for the leg being balanced.

Use a pad to achieve a telemetry level X dB higher than what was documented when the reference was stored. $X = (A-B)$ where A = the recommended reverse input of the active where the reference was taken + test point loss + accessory losses + Summation Network loss. B = the recommended reverse input of the amplifier being balanced + test point loss + accessory losses + Summation Network loss. Only losses in the reverse injection path are considered.

Note: *The recommended injection level is dependent upon if you are balancing constant inputs to the port or hybrid, and where the actual injection point is located. Many systems balance constant inputs to the port and take into account extra accessory losses such as internal "feeder-makers" and input pads if warranted. The reasoning behind constant inputs to the port vs hybrid is beyond the scope of this application note.*

The reference line on the display should also be X dB. Look at M1 and M2 on the Stealth field unit display to verify. The "Ref" on the sweep display is the middle graticular line, not the actual sweep level.

Note: *The sweep trace displayed on the field unit will change if someone in the headend changes the test point compensation on the Tx. This also affects the Reverse Alignment mode on the field unit.*

Others may use test point compensation and change the injected telemetry level to account for different test points, different recommended injection levels, and extra accessories. They then balance to a 0 dB reference line and the same telemetry reading as was achieved at the reference.

Note: *The newest unit works a little differently. The reverse test probe value adds to the telemetry and sweep values to give the actual output of the field unit. It also has a Reverse Alignment mode, which can only be accessed through the Navigator mode. The markers give actual received levels in the Headend as if using 2 CW carriers with a "Raw" sweep behind it.*

Another Way

Suppose you have a node with 20 dB test points and a recommended in of 15 dBmV, and a trunk amp with 25 dB TPs and recommended in of 17 dBmV. The Bridger amp with 20 dB TPs has a recommended in of 12 because you are inserting at the hybrid, balancing constant inputs of 17 dBmV to the port, and the internal loss from the test point to the hybrid is 5 dB. There is also an LE with a 26 dB tap for injection and a recommended in of 17 dBmV.

After adding all the numbers and the extra loss of 3.5 dB from the summation network (splitter) used in reverse balancing, the total generator output would be:

$$\text{Node} = 20 + 15 + 3.5 = 38.5, \text{Trunk} = 25 + 17 + 3.5 = 45.5, \\ \text{Bridger} = 20 + 12 + 3.5 = 35.5, \text{LE} = 26 + 17 + 3.5 = 46.5$$

Find the highest number and set the Sweep and Telemetry close to this. For instance, the highest number is 46.5 so they are set for 46 dBmV.

Store a reference at the node with an 8 dB in-line pad installed. This will automatically knock down the sweep and telemetry level without having to change the generator output and the associated problems with doing that (explained later). Store a reference and record the telemetry.

Go to the trunk amp and install an in-line 1 pad, and reverse balance to the same reference and telemetry. Go to the bridger amp and install an 11 dB in-line pad. Balance to the same telemetry and reference. Go to the LE and disconnect the in-line pad. Balance back to the same reference of 0 and telemetry that was recorded when the reference was stored.

The one caveat to this is the inconsistency with in-line pads. One more variable is added to the equation!

Considerations

There are some things to consider when changing the sweep and telemetry levels on the field unit for different balancing scenarios. This may influence your balancing method.

1. Changing the sweep insertion level on the field unit does not change where the sweep is displayed. The display you see is gain or loss, not the headend unit received. If you increase the sweep insertion level on the field unit, the sweep trace will not increase on the display.
2. Changing TP compensation changes where the sweep is displayed on the screen.
3. Changing the telemetry insertion may not have a 1 for 1 effect, and it's only in 2 dB increments.
4. Do you trust all the technicians to change the level correctly.

Note: Because this is a sweep, ingress can affect the outcome. It may be advantageous to terminate all reverse port pads or keep all amplifiers terminated until activation.

Common Return Sweep Problems

Standing Waves

- Use a directional, injection test point if available. Standing waves could still occur if a mismatch is close and severe enough.
- Inject into a tap. Some lower value taps may still give reflections depending on port-to-port isolation and port-to-output isolation.
- Use a plug-in test point, not a probe. Probes will always be bi-directional unless they are in series with the circuit and a directional coupler is used.
- Keep all proceeding actives terminated for return sweeping. Don't pre-stuff the reverse pad and EQ. The noise funneling may hamper your ability to sweep properly. A high value pad or terminator is recommended.
- Terminate all low value tap ports. Even an unterminated splitter in a subscriber's house a few thousand feet away can cause standing waves. Coax attenuation at the lower frequencies is slight, which allows the reflected wave to make it back without much loss.
- Install a terminating tap (4 port 8 or 8 port 11) if you have the luxury. It's an easy way to isolate the system.
- Verify that test leads, connectors, F-81 barrels, etc. are good. Use an in-line pad to see if the standing wave goes away. If so, there is a reflection being created between the field unit and test point.

Spikes

- Keep the resolution to approximately 1 MHz for reverse sweep. This lowers the probability of inadvertent, overlapping sweep points and transients. A sweep point every 1 MHz is sufficient in most situations for reverse sweeping. It also creates a faster sweep update and less memory required for each stored trace.
- Verify proper set-up, levels, no overlapping sweep and actual channels, etc.
- Avoid common problem areas (strong off-air shortwave, ham, and CB at 27 MHz)

No Communication

- Check forward sweep to confirm communication path between the transmitters and field unit.
- Set to "Single User" for Tx return sweeping and "Multiple User" for Rx.
- It could be collisions with other people reverse sweeping on the same Tx. Use a Rx if warranted.
- Verify the appropriate telemetry, keep it high & located in the passband. Watch out for sharp diplex filter roll-off and old 550 MHz passives in a 750 MHz system. The minimum level for forward telemetry is approximately -15 dBmV, but can also overload with greater than approximately +12 dBmV. We sometimes lose communication on input test points because of the lack of gain from the active and the test point loss. Use the spectrum mode with "max hold" on to verify the existence of the telemetry and the level. Make sure test point compensation is 0.

- Check return path continuity. Verify test equipment connections, amplifier continuity, active gain, and that no terminators are installed. Look at the noise floor level on the reverse input and compare with the reverse output. It should be higher by the amount of gain of the amplifier, but not necessarily. The noise reading could be affected by the test equipment noise floor. It may be warranted to inject a carrier and read the output to verify continuity. Use the new "CW Loopback" mode to verify continuity and gain. Use "Diagnostics" to send a CW carrier to the headend. Have someone in the headend use the Tx "Level" mode to read the reverse carrier level. Be sure to put it back in "Sweep" mode when finished!
- Reverse telemetry must have >20 dB S/N. To calculate the S/N for the reverse, find the telemetry level at the headend read on the field unit while sweeping, activate the "Noise" mode and move the marker to the same frequency. Record the difference.

Note: The number of node returns is limited for the Stealth reverse set-up because the reverse telemetry signal needs to have > 20 dB S/N. Probably less than 40 nodes should be combined into the headend unit. This may also influence where you place the telemetry. Stay away from 5-15 MHz because of the inherent noisy nature of this passband and the upper band because of diplex filter rolloff. Stay away from 27 MHz because of CB ingress and any multiple of 6 MHz because of common path distortions (CPD).

- Verify the instrument is sweeping in the correct direction. Press the left diamond key and look in the upper right corner of the field unit display.
- Press "Sweep" on the Tx and make sure reverse is enabled. (Sometimes it's the little things that kill.)
- Firmware versions must be the same on the transmitters and receivers. Older Stealth units with firmware versions 8.5 and 9.3 are not compatible and will yield inaccurate sweep measurement results. Version 9.3 will work with the new SDA units, but not in the SDA Compatible mode.

Bad Response

- Verify accessories are operating correctly such as cable, push-ons, older summation networks (DDC-20), pads, etc.
- Low sweep points may get confused with the noise floor, especially from the total noise funneling. This could cause the "grassy" effect on the sweep display. Increase the sweep insertion level on the field unit to verify.
- Use the correct sweep mode. The wrong mode could lead to problems.
- High forward levels into the meter can cause severe intermodulation that can affect the reverse sweep.

Faster Reverse Sweep

- Make a bogus forward sweep plan on the Tx with only 1 sweep point. By sweeping the forward faster, the reverse will also be faster, but forward sweep will not be usable.
- Use a Rx for up to 10 concurrent sweepers. This will decrease the probability of collisions with other sweepers off the same device. It also eliminates the chance of forward level overload.

Frequency Response Identification

- Refer to the "Forward Sweep and Balance Application Note."

Other Applications

Acterna's portable Stealth Receiver with Transmitter Option can be utilized to perform the following:

- Segmented sweeping; Moving the transmitter out in the field to sweep and balance certain spans or legs of a cable plant.
- Active gain, frequency verification, or single amp bench alignment; When in the Loopback mode, the portable sweep transmitter/receiver reads its own signals. One could use it to see the frequency response and gain of a single amplifier. Set-up a channel plan with sweep points every 1 MHz for good resolution. The total number of points is limited to around 500.
- Segmented "Noise" mode for troubleshooting; Instead of getting the aggregate noise from many receivers being combined in the headend, one could use the portable transmitter in the field for better segmentation of the aggregate noise. You could also get a PathTrak system for remote analyzing and performance archiving. Contact Acterna for more information.
- The "Noise" Mode
 - Refer to the Return Path Troubleshooting Application Note.

Tips & Hints

1. The field unit is capable of a frequency agile, CW carrier at 50 dBmV (40 dBmV for the older version). Select (Configure; Diagnostics; Transmitter Diagnostics) and set the Tx frequency, attenuation, and turn the Tx on.
- Note: You must leave the field unit in this mode for the Tx to stay active. The cable must be attached to the "OPT" port on the field unit.*
2. The field unit is dc blocking to 200V peak-to-peak. This equates to approximately 100 Vac.
 3. Once a trace is stored, you can alter the dB/div, start & stop freq., etc. To print this altered trace, hit "Func" & "Print". (Use the printer serial cable supported by Acterna.)
 4. The sweep file overlay is a nice feature to view an existing stored file and see the actual sweep trace overlaid. Select (Configure; Sweep Receiver, Sweep File Overlay) and turn it on. You can even upload an old file from Stealthware into the field unit to do an overlay.
 5. The de-facto standard is 2 dB/div for sweeping and 5 or 10 dB/div for spectrum analyzer viewing.
 6. Select "Func" & "i" for information about the instrument such as calibration date, serial number, options installed.
 7. The new SDA unit has added a CW Loopback mode that is accessed through the Navigator screen and many other features. Consult Acterna for a list of these features.
 8. The Tx will transmit/broadcast the ingress from all the return amplifiers connected to it back to the field unit. This will be transmitted on the forward telemetry with 280 kHz of resolution. Return continuity is not needed for this reception. The noise mode on the Rx transmits the total noise in the headend also, but with a resolution based off the return channel plan resolution.

9. You can change the start and stop frequencies in the sweep mode of the field unit, which makes it easier to move your markers around.
10. Type in the frequency and press "enter" to make a marker jump to that frequency.
11. Use "Zoom" to zoom in between the markers.
12. Ten people can reverse sweep at the same time with the Rx. The Stealth receiver unit must be set for the correct telemetry and for "Multiple Users". NOTE: The Rx must have firmware version 9.3 installed or be a new SDA-5510 to communicate with the SSA-1000 or SDA-5000. The sweep mode must be the same as well.
13. The Rx not only displays the noise received, but can also be used to determine who is reverse sweeping.
14. The number of sweep points is limited to 500, but inserting too many will make the refresh of the sweep display slower and take up more memory for storage of files. The sweep update time is dependent on the set-up.

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