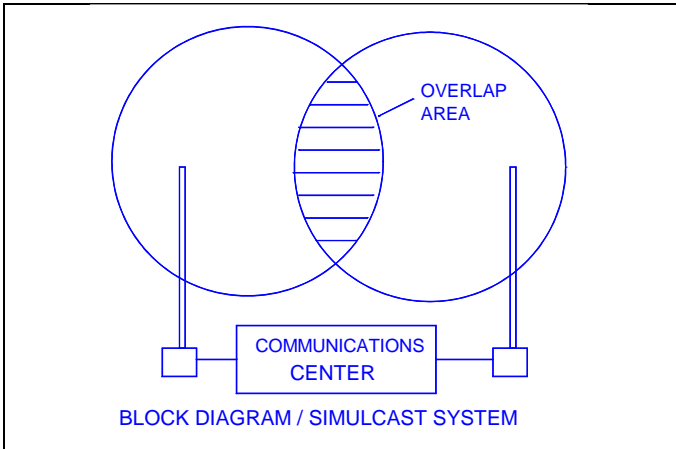


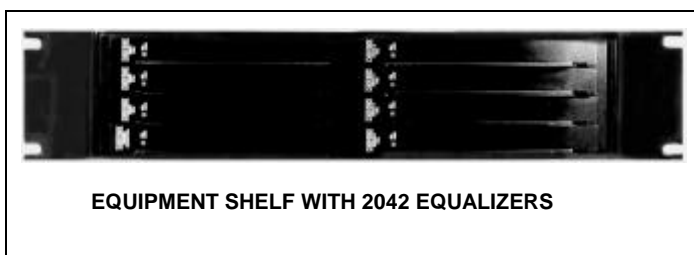
Simulcast Radio Systems optimize the use of available spectrum by synchronizing transmission from multiple overlapping antennas. Under this system, all baseband (VF) channels are assigned to identical RF frequencies at each transmitter. This arrangement makes best use of the available RF band and permits mobile units to leave radios set to the same frequency while traversing the entire service area.



In an "overlap" area, receivers pickup signals from two or more antennas. To have clear reception, signals have to be synchronized - **four ways**:

- 1 **RF carrier frequencies are matched to within a few Hz.**
- 2 **The phase response of the VF channels are matched to within 30 degrees.**
- 3 **The amplitude response of the VF channels are matched to within 0.2 dB.**
- 4 **The absolute time delay of the VF channels are matched to within 10 micro-seconds.**

Convex Corporation produces PC controlled equipment and software to handle the VF matching. VF transmission is routed through a Convex **2042 Simulcast Equalizer**. The 2042 provides response correction, gain, and time delay adjustment needed to match all channels.

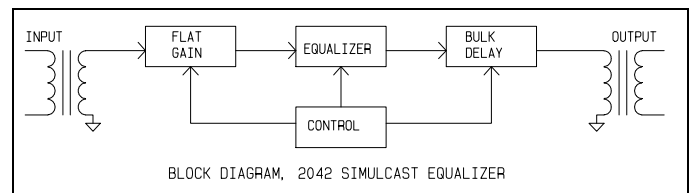


This is accomplished with three functional blocks:

FLAT GAIN - Amplifies or attenuates all frequencies by a variable factor to compensate for difference in loss to diverse transmitters.

DELAY / AMPLITUDE EQUALIZER - Selective frequency controls shape delay and amplitude responses. High resolution adjustments permit all channels to be set to a common, flat characteristic.

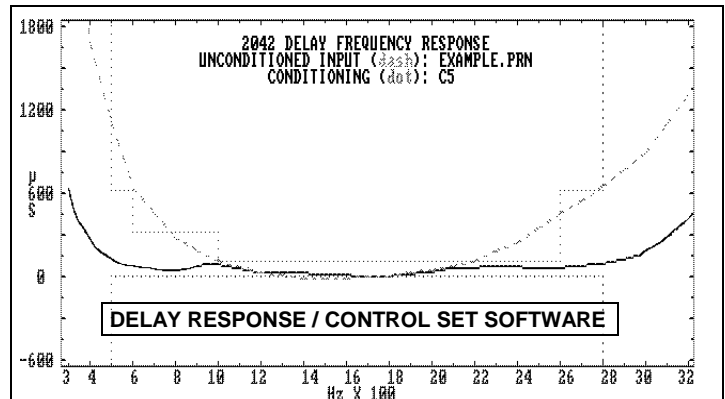
BULK DELAY - Delays all frequencies by a variable time factor to compensate for difference in transmission delay to diverse transmitters. *The range is 0 to 500,000 microseconds in 1 uS. steps!*



Channel characteristics are measured using the Convex **806AR TIMS**. The 806A is a general purpose transmission test set which is used to measure signal amplitude, amplitude response, delay response, and round-trip time delay. (It also measures noise, signal to noise ratio and impulse noise.) A 2 minute **auto-test** feature measures delay and amplitude response - simultaneously. The response data is saved as a PC file, and subsequently used to calculate equalizer settings.



Convex **C40CSS Control Set Software** is used to determine equalizer settings which "flatten" the delay and amplitude response. Inputs are measured response files. Outputs are "setting" files which are downloaded to the 2042 Equalizers.

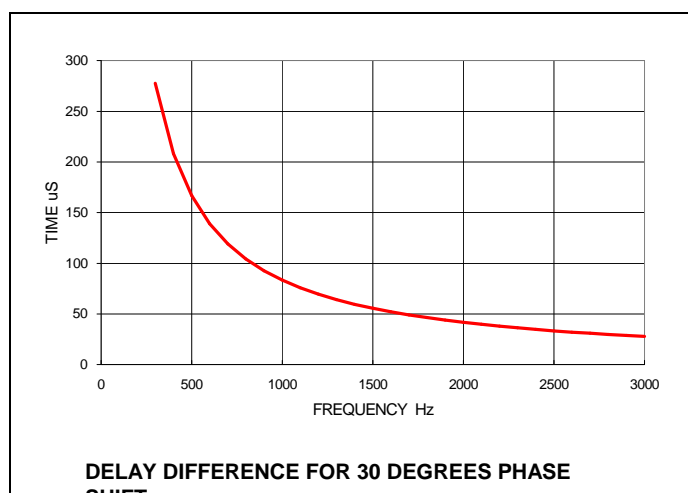




VF CHANNEL MATCHING

INTRODUCTION In simulcast radio systems, VF channels need to be matched to provide clear transmission in RF overlap areas. In these areas, received signal is the sum of signals coming from multiple transmitters. Therefore it is crucial that all voice frequencies be maintained near the same phase and amplitude so that the composite signal is a true replica of the parts. This is required for both human intelligibility and modem accuracy.

The objective is 0.2 dB of amplitude match, and 30 degree phase match (or better) between 300 and 3,000 Hz. 30 degrees equates to a delay difference of about 28 microseconds At 3,000 Hz.



Delay and amplitude response are controlled by the Convex **2042 Simulcast Equalizer**. The 2042 has frequency selective control needed to shape the *relative* delay and amplitude response. "Bulk Delay" and "Flat Gain" functions adjust the *absolute* delay and level of the channel. Measurements required to align the equalizers are made with a Convex **806A** or **806AR Test Set**.

VF TESTING Tests are run using a test receiver with one transmitter at a time. The 806AR (generator) test signal is applied to the active transmitter, picked-up by the test receiver, and returned to the 806AR. Measurements are stored as PC files.

CURVE MATCHING involves determining equalizer settings that will adjust each channel to a common response curve. Convex **C40CSS Control Set Software** is used for this process. It accepts measurement files produced by the test set and outputs equalizer settings files.

TIME MATCHING - Last, the 806AR is used to measure the round trip time delay of each channel. This data is used to set the Bulk Delay on the 2042 Simulcast Equalizers so that all channels are delayed as much as the slowest channel.

PROCEDURE There are four main steps to matching process.

1 Measure the response of each channel - with the equalizers patched out of the circuit.

2 Compute equalizer settings for a flat channel response. **Download** setting files to equalizers.

3 Verify the response of each channel by re-measuring with the equalizers in the circuit.

4 Measure, adjust, and verify round trip delay of all channel with the equalizers in the circuit.

RESPONSE MEASUREMENT Control the Convex 806AR Test Set with a PC. Run the VF Auto-Test in Delay Mode. Save the measured data as PC files - one file per channel per site.

SETTING CALCULATIONS Run C40CSS Control Set Software. Input the measured response files and solve for equalizer settings which provide flat delay and amplitude response. Download the setting files to the equalizers. *Set the Bulk Delay on all equalizers to 200 microseconds to provide some downward range.*

ROUND TRIP DELAY Put the 806AR Test Set in Delay Mode, set the Filter to 15 kHz. Set the send frequency to 1804 Hz.

ZERO - *Open the normal I/O connections on the test set. Connect the test set send port directly to the receive. Zero the delay reading when the display settles. Remove the direct connection and reconnect the normal I/O lines.*

Measure and record the round trip delay of each channel for each site. Reestablish the above "zero" connection to verify that the zero reference remained.

Adjust the "**Bulk Delay**" of each equalizer so that all channels from all sites have the same round trip delay to the center of their RF overlap area.