Equipment List

The following table lists the equipment required to perform the M64700G-25 Mobile Radio Factory Test Procedure:

TABLE 10: EQUIPMENT REQUIRED TO PEREFORM FACTORY TEST PROCEDURE

QTY	DESCRIPTION	MANUFACTURER	MODEL
2	PC's One for Mobile One for Base	Windows 9X w/ *IP*Message AVR	
1	Service Monitor – Communication Test Set	HP	HP8920B or equivalent
1	Digital multi-meter	Tektronix Fluke	77 or equivalent
1	DC power supply w/ ammeter, 13.8V, 23 Amps or more	Astron	RM35A
1	4-Channel Scope	Tektronix	TDS 460A
1	M64700G-25 Mobile Radio		
1	B32450-25 Calibrated Base Station		
1	Internet Protocol Network Controller (IPNC)		
1	100 watt dummy load/attenuator	Pasternack	PE7021-40 or equivalent
2	UHF Antennas (generic mag mount)		
1	Serial cable DB9M-DB9F connectors		IPMN p/n: 156-0245-020
1	IP power cable		IPMN p/n: 502-82017-52
1	3-foot RF jumper cable with type N connectors (generic)		
1	Scope test probe (generic, X1 attenuation)		
1	Ceramic tuning tool		IPMN p/n: 44010006
1 ea	#0, #1, and #2 Phillips screwdrivers (generic)		

Programming and Configuring Mobile Radio

Once the appropriate equipment for performing the factory test are gathered, perform the following steps to program and configure an M64700G-25 Mobile Radio:

Step 1 Enter the mobile radio serial number, date test being performed, and tester's name on the ***Test Data Sheet (see Appendix B)***.

Step 2 Program the radio to the current Firmware revision using the AVR programming utility.

Step 3 Connect a PC to the radio and launch the *IP*Message program. In the *IP*Message window, type **`factory default`**, press **[ENTER]**, and the radio displays the radio's default values.

Step 4 Enter the appropriate values for the radio's frequency band. The following values were used for a 764 to 806 MHz mobile radio:

```
[From: 172.16.22.10] Host serial = 115200,N,8,1, timeout=200
[From: 172.16.22.10] Model = HS800
[From: 172.16.22.10] Host framing = Ethernet, no status messages
[From: 172.16.22.10] Channel = 0
[From: 172.16.22.10]          Channel      Tx freq           Rx freq          Inj freq
[From: 172.16.22.10] Frequency=0      ,    805.000000,    775.000000,    820.000000
[From: 172.16.22.10] IP Address = 172.16.22.10, Netmask = 255.255.255.0 (VIU = 0.0.0.0, PC = 172.16.20.10)
[From: 172.16.22.10] IPNC = 255.255.255.255
[From: 172.16.22.10] PC netmask = 255.255.255.0
[From: 172.16.22.10] Radio MAC Address = 00:08:ce:00:00:00
[From: 172.16.22.10] Injection = LOW SIDE,    45.0000 MHz
[From: 172.16.22.10] Serial number: undefined
[From: 172.16.22.10] TX Power = 150
[From: 172.16.22.10] TX quiet time = 5
[From: 172.16.22.10] TX sync time = 12 milliseconds
[From: 172.16.22.10] TX tail time = 5
[From: 172.16.22.10] Tx delay = 2 slots
[From: 172.16.22.10] Radio data rate = 32000
[From: 172.16.22.10] PLL load to txkey delay = 2 milliseconds
[From: 172.16.22.10] Carrier detect delay time = 7 milliseconds
[From: 172.16.22.10] roam status time = 1800 seconds, type = 1
[From: 172.16.22.10] roam lost time = 60 seconds
[From: 172.16.22.10] Polarity = TX-, RX-
[From: 172.16.22.10] RSSI step = 12    (=234mV)
[From: 172.16.22.10] num timeslots = 24
[From: 172.16.22.10] timeslot period = 984ms
[From: 172.16.22.10] timeslots per voice packet = 4
[From: 172.16.22.10] noise = -117dBm, -117dBm
[From: 172.16.22.10] receiver = auto
[From: 172.16.22.10] Receiver Hysteresis = 0
[From: 172.16.22.10] diversity speed = 4
[From: 172.16.22.10] 12dB SINAD = -117dBm (63 on RX0)
[From: 172.16.22.10] 12dB SINAD = -117dBm (9 on RX1)
[From: 172.16.22.10] 30dB S/N = -106dBm (96 on RX0)
[From: 172.16.22.10] 30dB S/N = -102dBm (93 on RX1)
[From: 172.16.22.10] 40dB S/N = -100dBm (110 on RX0)
[From: 172.16.22.10] 40dB S/N = -94dBm (128 on RX1)
[From: 172.16.22.10] -40dBm = (225 on RX0)
[From: 172.16.22.10] -40dBm = (227 on RX1)
[From: 172.16.22.10] Modem FEC = on
[From: 172.16.22.10] Suspend Tx = 90 seconds
[From: 172.16.22.10] DHCP Client disabled
[From: 172.16.22.10] DHCP Server enabled
[From: 172.16.22.10] diag message level = 2
[From: 172.16.22.10] TFTP options = 256 (block size), 3 (interval)
[From: 172.16.22.10] Reference Frequency =    16.800000 MHz
[From: 172.16.22.10] MTU = 1480
[From: 172.16.22.10] 06 Feb 2036 22:28:30 (PST), calibration=-236
[From: 172.16.22.10] uptime = 0h:00m:14s
[From: 172.16.22.10] Radio Firmware Rev. 35-01.000.003, Sep  7 2004 - 17:33:10
[From: 172.16.22.10] Temp period = 2s
[From: 172.16.22.10] Temp Maximum = 80C
[From: 172.16.22.10] Comparison Frequency = 400000 Hz
[From: 172.16.22.10] Reflected power limit = 20
```

Adjustment / Alignment Procedures

Receiver Injection

Perform the following steps to adjust the receiver injection and injection frequency:

Step 1 While monitoring the receiver injection frequency at RXINJ1, input the value for the DAC frequency control for minimum frequency error (+/- 100Hz). Record this value on the ***Test Data Sheet***.

Step 2 While monitoring the 44.545 MHz 2nd injection frequency at U6 pin 4, adjust trimmer capacitor CV22 for the maximum amplitude of this injection frequency. The maximum amplitude must be between -3 to -5 dBm. Record this value on the ***Test Data Sheet***.

Step 3 Repeat Step 2 by monitoring U9 pin 4 and adjusting CV20 for Receiver2 IFLO. Record this value on the ***Test Data Sheet***.

Receiver 1

Perform the following steps to adjust receiver 1:

Step1 Inject an on-frequency carrier signal with amplitude of -80 dBm, modulated with a 1 kHz test tone at +/- 5.0 kHz deviation into receiver 1's antenna port.

Step 2 While monitoring the voltage at RSSI1 Test Point with a DMM, adjust trimmer capacitor CV15 and C16 to midway between the points where the oscillation stops.

Step 3 While monitoring the DC level of the recovered modulation; adjust potentiometer RV6 for a reading of 2.500 VDC +/- 1 mV DC.

Step 4 While monitoring the amplitude of the recovered audio signal, adjust potentiometer RV5 and RV6 for a reading of 350 mV RMS and 2.500 VDC.

Step 5 Steps 3 and 4 are interactive adjustments, therefore repeat steps 3 and 4 until further adjustment is no longer required (i.e. when 350 mV RMS and 2.500 VDC are realized).

Step 6 While monitoring the recovered audio signal at TP1, verify the distortion is less than 3% adjust CV15 and CV16 if necessary to achieve less than 3% distortion. Record this value on the ***Test Data Sheet***.

Step 7 While monitoring the recovered audio signal at TP1, verify the SINAD is -118 dBm or better. Record this value on the ***Test Data Sheet***.

Receiver 2

Perform the following steps to adjust receiver 2:

Step 1 Inject an on-frequency carrier signal with amplitude of -80 dBm, modulated with a 1 kHz test tone at +/- 5.0 kHz deviation into Receiver 2's antenna port.

Step 2 While monitoring the voltage at RSSI2 Test Point with a DMM, adjust trimmer capacitor CV6 and CV7 to midway between the points where the oscillation stops.

Step 3 While monitoring the DC level of the recovered modulation, adjust potentiometer RV4 for a reading of 350 mV (+/-10 mV) RMS.

Step 4 While monitoring the amplitude of the recovered audio signal, adjust potentiometer RV3 for a reading of 2.500 (+/-10 mV) VDC.

Step 5 Steps 3 and 4 are interactive adjustments, therefore repeat steps 3 and 4 until further adjustment is no longer required (i.e. when 350 mV RMS and 2.500 VDC are realized).

Step 6 While monitoring the recovered audio signal at TP1, verify the distortion is less than 3%, adjust CV3 if necessary to achieve less than 3% distortion. Record this value on the ***Test Data Sheet***.

Step 7 While monitoring the recovered audio signal at TP1, verify the SINAD is -118 dBm or better. Record this value on the ***Test Data Sheet***.

Transmit Data

Perform the following steps to adjust transmit data:

Step 1 Use *IP*Message to set the transmit power to 0.

Step 2 Using the **x=1400,n** command of *IP*Message to generate transmit data messages while observing the transmitted signal on the HP RF communications test set, adjust pot R33 for minimum frequency error while transmitting data messages.

Step 3 Turn potentiometer RV1 fully counterclockwise.

Step 4 Adjust RV2 for deviation of 4.9 kHz.

Step 5 Using calibrated base station, and monitoring the uplink received data quality on the base station's Hyperterminal screen, slowly turn RV1 clockwise until consistent data quality readings of 240 - 248 are achieved using 1400 character test messages. Data quality reading should not be less than 240 for 1400 character messages.

If unable to reach the data quality readings then ask for Technical Support. Poor data quality readings are indicative of poor group delay performance, or other defect.

Step 6 Verify transmit deviation, frequency error, and transmitting data messages quality and record this data on the ***Test Data Sheet***.

Power Setting

Perform the following steps to adjust the transmit power control:

Step 1 Attach a power attenuator to the transmit port of the radio.

Step 2 Using the **x=1400,n** command of *IP*Message, and while monitoring the transmit power level on the HP communications test set, check the level of the transmit power. Using *IP*Message set the power setting to **txpower=0**. The radio should have an output power level of approximately 1 mW. Record this value on the ***Test Data Sheet***.

Step 3 Using *IP*Message send the **txpower=** command to increase the power level settings until 30 Watts of output power is obtained. Record this value on the ***Test Data Sheet***. Note that values on the table are to plot the codes vs. power output. The 30-Watt setting can be a code not on the table. Adjust **txpower** until the code is found that does not exceed 30.0 Watts. Record this value on the ***Test Data Sheet***.

> Do not to exceed 30 Watts of output power, as this may reduce the life of the amplifier.

Receive Data

Perform the following steps to verify the receive data performance:

Step 1 Using the DOS **ping** command on the PC connected to the radio, ping the network controller to generate uplink and downlink data messages. The following command will generate one Hundred 500 character messages:

```
>;Ping 192.168.3.3 -n 100 -l 500
```

Step 2 Observe the data quality readings on the *IP*Message window of the PC connected to the radio using the **V** (for Verbose) command in the *IP*Message program. With the mobile radio's antenna connected to receiver 1, verify the received data quality readings are consistently 248s. Data quality readings should also be verified at the base station using the **V** command on the Hyperterminal window.

Step 3 Verify receiver 2 data quality readings are also consistently 240 to 248s by changing the antenna from receiver 1 port to receiver 2 port. In this manner both uplink and downlink data quality can be verified. Record this data on the ***Test Data Sheet***.

Final Test

A final test **must** be performed prior to shipping the M64700G-25 mobile radio to the customer. This final test will verify that the timing characteristics are correct and that both transmit and receive data quality readings are consistently high.

Perform the following steps for the final test:

Step 1 Attach the 40dB 100-Watt power attenuator to the transmit port of the radio.

Step 2 Program the radio for full power operation. The **tx power** level setting can be found in the radio's ***Test Data Sheet***.

> The setting must not to exceed 40 Watts.

Step 3 Attach a digital scope to the base station as described in section the next section, ***Uplink Hardware Timing Verification***. Using the **x=1400,19** command (which will cause the radio to transmit 19, 1400 character messages), verify the following:

Transmit frequency of radio is adjusted for minimum frequency error of +/- 100 Hz.

The **x=1400,19** command will generate different messages with differing DC components. Each message will slightly slew the frequency off from the center frequency). Be careful to closely monitor the variation in transmit frequency due to these different messages and ensure that on average the transit frequency error has been minimized to within +/-100 Hz. This indicates that some of these test messages will be slightly high in frequency, some messages will be slightly low in frequency, and some messages will be right on frequency.

Step 4 Verify the transmit deviation is 4.9 kHz

Step 5 Verify the timing characteristics are identical to the plots in the next section, ***Uplink Hardware Timing Verification***.

Step 6 At the base station monitor PC, verify that all the data quality readings are 240 and higher.

Step 7 Move the scope probes to monitor the timing at the mobile radio as described in ***Downlink Hardware Timing Verification***. Generate test messages by issuing a ping command to the IPNC from the PC attached to the radio. The following command will cause 100 pings, 500 bytes in length to be transmitted from the mobile radio and echoed by the IPNC through the base station:

```
.>;Ping 192.168.3.3 -n 100 -l 500 -w 2000
```

Step 8 Set **CRC =1 Enable** on the radio

Step 9 Verify the timing characteristics are identical to those in ***Downlink Hardware Timing Verification***.

Step 10 Verify that both receivers on the mobile radio report data quality readings of 240 or higher (248 is typical). This can be accomplished by installing the antenna on the TX/RX1 port and verifying RX1 is selected by observing the RX1 LED on the mobile radio and installing the antenna on the RX2 port and verifying RX2 is selected by observing the RX2 LED on the mobile radio.

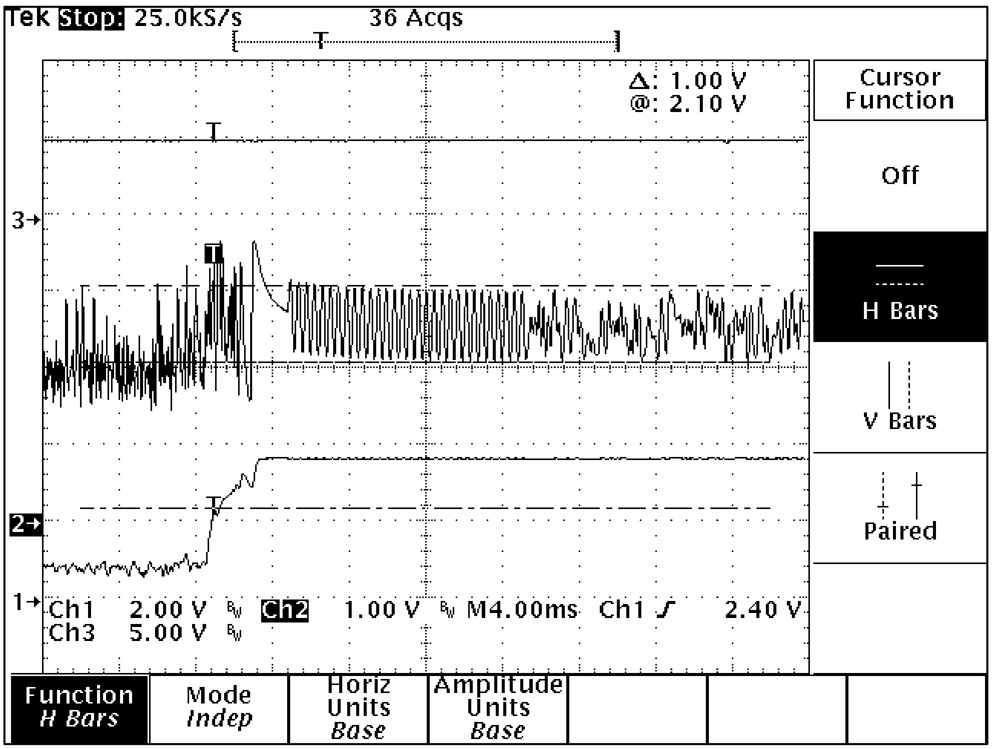
Step 11 Reset **CRC = 0 Disable** on the radio

Step 12 In *IP*Message, type the **?** command to radio. Copy the radio settings and paste them into the ***Test Data File***.

Step 13 Perform a close visual inspection of the radio closely inspecting manufacturing related problems (loose screws, solder particles, etc.).

Uplink Hardware Timing Verification

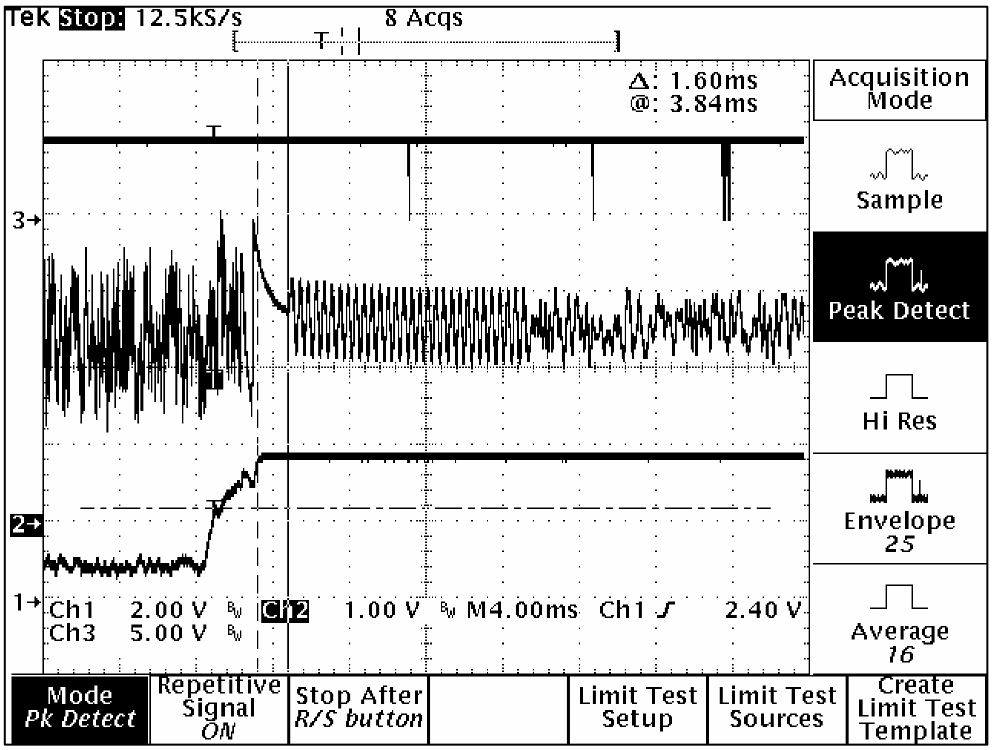
The figure below displays an oscilloscope plot of an uplink data message from the mobile to the base station. Channel 1 is connected to the base station's RSSI (XXX-12), channel 2 is connected to the base station's recovered modulation, and channel 3 is connected to the base station's modem chip select line. The scopes acquisition mode is high-resolution.



As seen in the above plot, the mobile radio's transmit carrier has ramped up to full power (channel 1) in just a few milliseconds. The recovered modulation (channel 2) is stable by this time. There follows a few milliseconds of quiet time followed by 12 milliseconds of symbol sync time.

The recovered modulation from a mobile radio should look identical to this plot. The recovered modulation signal should be approximately 1.0 Volts peak-to-peak and should be centered at approximately 2.5 VDC as is indicated in the figure above.

The figure below displays another oscilloscope plot of an up-link data message from the mobile to the base station. As in the last plot, channel 1 is connected to the base station's RSSI (J5-12), channel 2 is connected to the base station's recovered modulation test point, and channel 3 is connected to the base station's modem chip select line (U16-13). The scope's acquisition mode is now in the peak detect mode. This enables the base station's modem CS (Chip Select) line to be viewed.

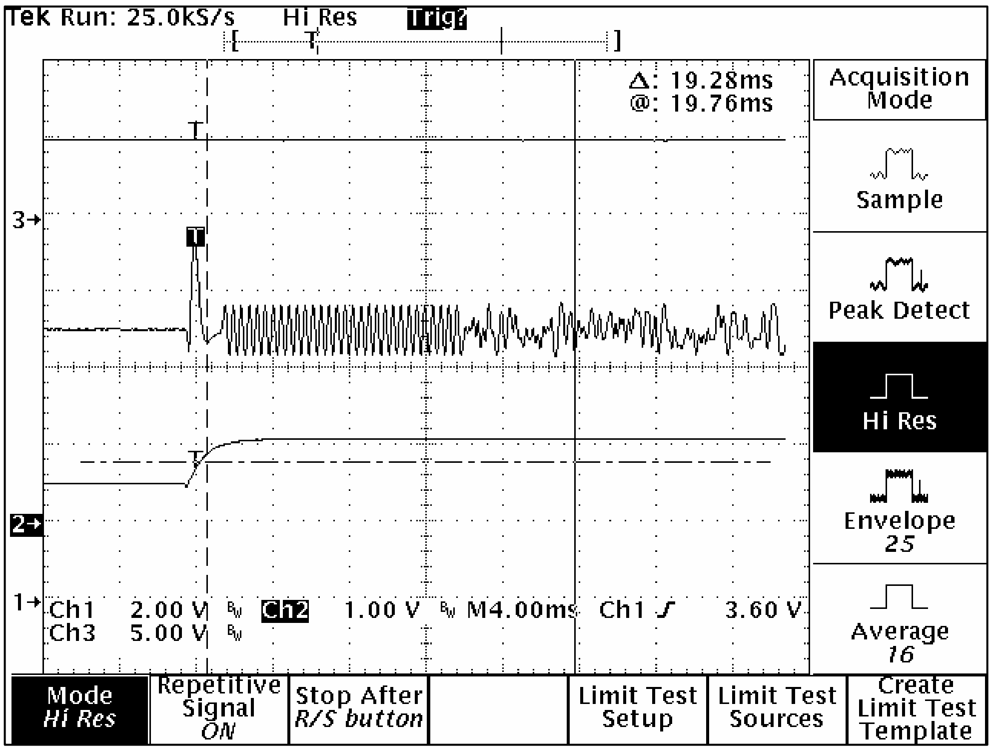


The base station's microcontroller, upon detecting a step response in the RSSI (caused by the mobile radio's transmitter coming up to power), waits a period of time equal to the programmed value of the base station's carrier detect delay time. The microcontroller then instructs the modem to search for the modem synchronization preamble. When the base station instructs the modem to look for sync tones, the modem's CS line transitions low. This can be seen in the above plot. Approximately 10 milliseconds after the mobile radio's transmitter causes a step increase in the base station's RSSI, the CS signal goes low momentarily. As can be seen, the sync tones are stable by this time and the modem quickly establishes synchronization.

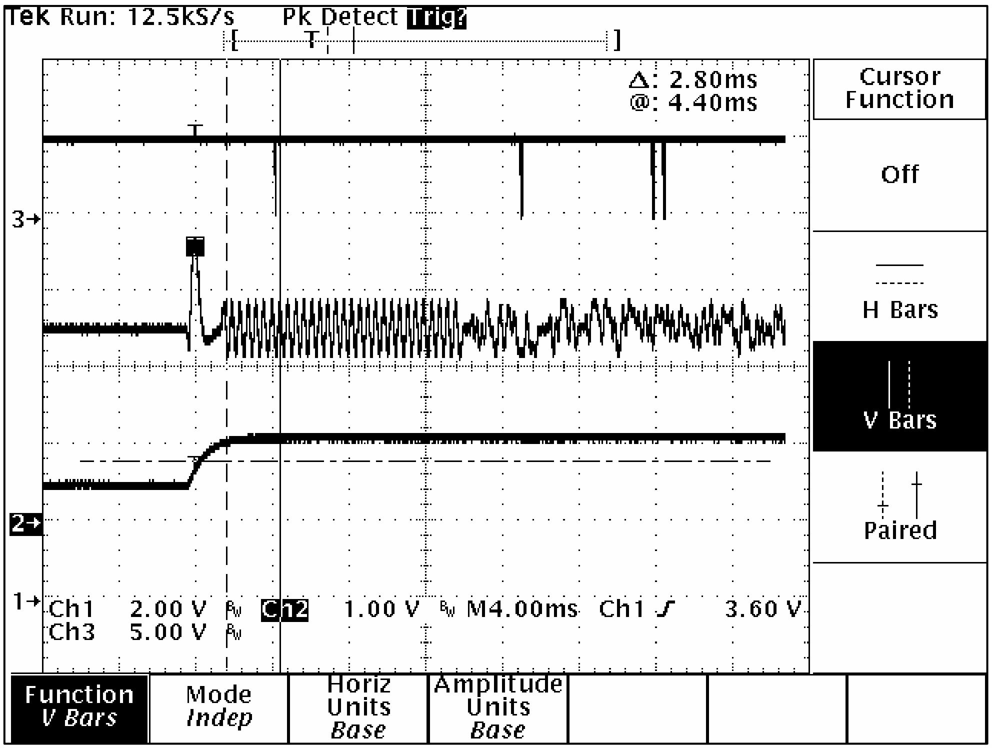
Downlink Hardware Timing Verification

The figure below displays a plot of the downlink timing characteristics. Channel 1 is connected to RSSI, channel 2 is connected to recovered audio, and channel 3 is connected to the modem CS pin. The scope is in the high-resolution acquisition mode.

There is a very short period of quiet time (no modulation) followed by approximately 12 milliseconds of modem synchronization time (sync time).



The plot shown in the figure below is the same as before but now the scope is in the peak detect acquisition mode. After the mobile radio detects a step response in the RSSI (caused by a down-link transmission), the radio's microcontroller waits an amount of time equal to the programmed value of the "carrier detect delay time" then instructs the modem to look for frame sync. When the microcontroller instructs the modem to look for frame sync, it asserts the modem's CS line (active low). In this plot, the modem's CS line can be seen to transition low approximately 3 milliseconds after the base station's transmitter has come up to full power.



The recovered modulation should be centered at approximately 2.5 VDC and should have an amplitude of approximately 800 mV peal-to-peak as indicated in the plot above.