R2001B Adjustable Components and Alignment Procedures

R2001B Adjustable Components and Alignment - Created 03-May-16 by WA1MIK. Many of these procedures were discovered and perfected by Steve K7LJZ, for whom grateful thanks and appreciation are given for the many hours he spent with his units.

Revised: 20-Aug-17, 02-Nov-17, 08-Jan-20, 02-Feb-20, 04-Feb-20, 05-Feb-20, 17-Feb-20, 22-Jun-20, 25-Jun-20, 26-Jun-20, 03-Jul-20, 08-Jul-20, 10-Jul-20, 18-Jul-20, 19-Jul-20, 22-Jul-20, 23-Jul-20, 25-Jul-20, 30-Jul-20, 16-Aug-20, 17-Aug-20, 19-Aug-20, 20-Aug-20, 21-Aug-20, 26-Sep-20.

All "Comp." references are shown as a letter and three digits with leading zeroes so they line up. Some schematic references omit that first digit while others have it. In A1 and A11 (multi-board assemblies), that first digit signifies the board number in the set.

Assy.	Assy. or Board	Comp.	Adjusts	Align	Equipment.
A01A1	LVPS Switcher	none	- - -	none	none
A01A2	LVPS Output	none	- - -	none	none
A01A3	LVPS Ctrl.	R315	Current Limit	us	none
A01A3	LVPS Ctrl.	R320	+5 Volt Adjust	us	DMM
A01A3	LVPS Ctrl.	R328	Dead Time	us	OS
A01A4	LVPS Relay	none	- - -	none	none
A02	V/H Scope Ampl.	C005	Horizontal Time Base Fine	Y	vis
A02	V/H Scope Ampl.	R011	Intensity Balance	Y	vis
A02	V/H Scope Ampl.	R033	Intensity Bias	Y	vis
A02	V/H Scope Ampl.	R062	Horizontal Time Base Coarse	Y	vis
A02	V/H Scope Ampl.	R088	Trace Rotation	Y	vis
A02	V/H Scope Ampl.	R091	Astigmatism	Y	vis
A02	V/H Scope Ampl.	R094	Geometry	Y	vis
A02	V/H Scope Ampl.	R100	Vertical Gain	Y	vis, OS
A02	V/H Scope Ampl.	R108	Vertical Position	Y	vis, OS
A02	V/H Scope Ampl.	R144	Horizontal Gain	Y	vis, OS
A02	V/H Scope Ampl.	R154	Horizontal Position	Y	vis, OS
A03	Scope/DVM Ctrl.	C075	BFO Oscillator Frequency	DSM	vis
A03	Scope/DVM Ctrl.	R002	SINAD Notch	Y	vis
A03	Scope/DVM Ctrl.	R007	SINAD Notch	Y	vis
A03	Scope/DVM Ctrl.	R009	Vertical Character Width	Y	vis
A03	Scope/DVM Ctrl.	R021	AM Detector Frequency	us	vis, SG
A03	Scope/DVM Ctrl.	R067	Positive Peak Detector Zero	us	DMM
A03	Scope/DVM Ctrl.	R078	Negative Peak Detector Zero	us	DMM
A03	Scope/DVM Ctrl.	R103	Horizontal Character Width	Y	vis
A03	Scope/DVM Ctrl.	R167	DVM X0.1 Gain	us	DC, DMM
A03	Scope/DVM Ctrl.	R168	Spectrum Analyzer Centering	Y	vis
A04	Receiver	C002	Spectrum Analyzer Tuning	Y	ext, SG, vis
A04	Receiver	C049	10.245 MHz VCO Tuning	us	ext, FC, vis
A04	Receiver	C083	Spectrum Analyzer Tuning	Y	ext, SG, vis
A04	Receiver	C088	Spectrum Analyzer Tuning	Y	ext, SG, vis
A04	Receiver	C096	Spectrum Analyzer Tuning	Y	ext, SG, vis
A04	Receiver	R057	IF Overload Adjust	DSM	ext, SG, vis

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Assy.	Assy. or Board	Comp.	Adjusts	Align	Equipment.
A04	Receiver	R060	AM Detector Level	Y	ext, SG, vis
A04	Receiver	R068	Detector Zero Adjust	Y	ext, SG, vis
A04	Receiver	R070	FM Wide Detector Level	Y	ext, SG, vis
A04	Receiver	R091	Spectrum Analyzer Linearity	Y	ext, SG, vis
A04	Receiver	R100	Spectrum Analyzer Linearity	Y	ext, SG, vis
A04	Receiver	R119	Spectrum Analyzer Offset	Y	ext, SG, vis
A04	Receiver	R121	Spectrum Analyzer Gain	Y	ext, SG, vis
A04	Receiver	R124	Spectrum Analyzer Linearity	Y	ext, SG, vis
A04	Receiver	R125	FM Narrow Detector Level	Y	ext, SG, vis
A05A1	RF Synth.	R122	60.5 MHz Detector Threshold	us	cbl, ext, DMM
A05A2	RF Synth.	R354	FM Deviation	DSM	cbl, ext, MM
A06	Audio Synth.	none	- - -	none	none
A07	Processor I/O	R033	A/D Balance	Y	DMM
A07	Processor I/O	R041	A/D Gain	Y	DMM
A07	Processor I/O	R044	A/D Zero	Y	DMM
A08	IEEE Intf.	none	- - -	none	none
A09	Processor	none	- - -	none	none
A10	HVPS	R037	HV Adjust	DSM	DMM, HVP
A11A1	RF Input/Power	R122	Wattmeter Gain	DSM	cbl, WM
A11A1	RF Input/Power	R143	Wattmeter Offset	DSM	cbl, WM
A11A2	Wideband Ampl.	C232	10.7 MHz Filter Tuning	us	cbl, SA, SG
A11A2	Wideband Ampl.	L212	10.7 MHz Filter Tuning	us	cbl, SA, SG
A11A2	Wideband Ampl.	R252	RF Level / AM Mod. Gain	us	cbl, SA, vis
A11A2	Wideband Ampl.	R258	IF Output Level	us	cbl, SA, SG
A11A2	Wideband Ampl.	R276	RF Level / AM Mod. Zero	us	cbl, SA, vis
A11A3	Offset Generator	C306	Fine Duplex Offset	us	cbl, SA
A11A3	Offset Generator	C309	Duplex Output Tuning	us	cbl, FC
A11A3	Offset Generator	C319	Coarse Duplex Offset	us	cbl, FC
A11A3	Offset Generator	R305	Duplex FM Deviation	us	cbl, MM
A12	Front Panel Intf.	C011	Input HF Compensation	DSM	FG
A12	Front Panel Intf.	R019	Input Vertical Gain	Y	vis, OS
A12	Front Panel Intf.	R025	Vertical Balance	us	vis
A12	Front Panel Intf.	R041	DVM Buffer Gain	Y	DC, DMM
A12	Front Panel Intf.	R054	DVM Zero Coarse	Y	DMM
A12	Front Panel Intf.	R055	DVM Zero Fine	Y	DMM
A13	10 MHz Freq. Std.	R016	Oven Indicator Adjust	DSM	vis
A14	Front Panel	none	- - -	none	none

SEE COLUMN NOTES ON THE NEXT PAGE.

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NOTES for "Align" Column:
"none" means there are no adjustments on this module.
"Y" means it's documented in the "B" or "C" manual.
"us" means we've documented our own procedure.
"DSM" means it's our own procedure based on info we found in the D Service Manual.

NOTES for "Equipment" Column:
DC = Variable DC Power Supply.
DMM = Digital Multi-Meter.
cbl = Coax Cable Extenders.
ext = Board Extender and Coax Cable Extenders.
FC = Frequency Counter.
FG = Function (square-wave) Generator.
HVP = 6kV High Voltage probe (Fluke 80K-6).
MM = Modulation Meter.
OS = Oscilloscope.
PM = Power Meter.
SA = Spectrum Analyzer.
SG = RF Signal Generator.
SM = Service Monitor (the unit being worked on).
vis = observe results visually on CRT.
WM = RF Watt Meter.

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NOTE: THE ALIGNMENT PROCEDURES AND STEPS BELOW WERE DEVISED BY BOB AND STEVE AND ARE LISTED AS "US" OR "DSM" IN THE ABOVE TABLE. THEY ARE IN COMPONENT DESIGNATION ORDER. SOME STEPS SHOULD BE DONE BEFORE OTHERS AND THEY ARE SO INDICATED.

In general:
Do the CRT and scope first.
Do a careful calibration of the DVM next.
Set the generate deviation at the end.

Suggested Alignment order: LVPS, HVPS, CRT and Scope, DVM, DVM X0.1 Gain, Positive and Negative Peak Detectors, AM detector frequency, A11, everything else.

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Low Voltage Power Supply A1:
There are three adjustments on the LVPS A1A3 card: Dead Time, Voltage, and Current Limit. The pots are labeled on the component side of the circuit board.

With the unit fully operational and set for normal power-up conditions, set the Dead Time pot R328 fully CCW, then rotate it CW slowly while listening for a growling or groaning sound coming from the power supply. Stop as soon as you hear something then rotate the pot about 10-15 degrees CCW. If you want to take the time to connect a pair of wires to Q103 and Q104's mounting screws, you can connect those wires to a dual-channel oscilloscope and adjust the Dead Time pot so the two square waves do not overlap at all. If they DO overlap, that means both transistors are turned on at the same time, and that load causes the power supply to growl or groan and draw a LOT of current.

Use a digital multi-meter set to a 5V range and connect it to TP202 on the A2 card and Ground to TP201. Adjust the Voltage pot R320 on the A3 card for a reading of +5.2VDC. Check the -5VDC supply at TP203 and it should be -4.9VDC to -5.1VDC. If you DO change the voltage by more than 0.1V, you will most likely have to fully align the rest of the service monitor.

Turn the Current Limit pot R315 CCW until the supply starts pulsing or shutting down, then back it off by 10-15 degrees CW.

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Scope/DVM Control A3:
BFO Centering is adjusted by C075. Set unit to GEN/MON or MON mode, open the squelch, select SSB/DSBSC, and turn the BFO on. Set C075 for the same +/- kHz BFO ERROR display while rotating the BFO knob from end to end. This should be around +/- 4 kHz. If you feed in the REF OUT signal and tune the unit to 10.0 MHz, you will hear the beat note. It should be zero when the display says 0.0 kHz.

The AM Detector Frequency pot R021 is used to center the bandwidth at low input signal levels. Set to MON mode, AM, Wide bandwidth, input attenuator to 0dB. You can use any input frequency from an external signal generator set to 30% AM with 1 kHz modulation tone and an RF level between -70dBm and -100dBm. Adjust R021 for the ERROR kHz as close to 0.0 kHz as possible. Make small changes and allow the reading to settle.

The Positive Peak Detector Zero pot R067 is adjusted by monitoring A3 TP4 with a DC Voltmeter and adjusting the pot for a zero indication on the voltmeter with no input signal at all. This means short the front panel DVM input jack and turn all the internal modulation sources fully CCW or OFF. Set to FM Generate mode.

The Negative Peak Detector Zero pot R078 is adjusted by monitoring A3 TP2 with a DC Voltmeter and adjusting the pot for a zero indication on the voltmeter with no input signal at all. This means short the front panel DVM input jack and turn all the internal modulation sources fully CCW or OFF. Set to FM Generate mode.

Make sure you do the DVM peak detector zero adjustments first. The DVM X0.1 Gain pot R167 is not so easy to adjust because the CPU is busy rapidly switching the DVM circuitry and the pot is only active when the X0.1 gain is chosen. Select GEN, FM Narrow, GEN/MON display, and adjust the 1 kHz internal modulation for 2-3VDC at A3 TP2. Monitor the DC voltage level at A3 TP8. Stop the CPU by grounding its HALT* line (use a mini-grabber on the right side of A9 R3 to ground) and watch for A3 TP8 to have a level about 1/10 of what you measured at A3 TP2. You may have to halt the CPU several times until you get it to stop at the correct spot. R3 is located directly above the crystal, which is directly above the CPU chip on A9. Vary the 1 kHz internal modulation level to make sure you've got the CPU stopped at the correct gain setting and the signal on A3 TP8 is about 1/10 what you have on A3 TP2. Reset the level at A3 TP2 for 3.000VDC then adjust R167 for a level of 0.3000VDC on A3 TP8 to four significant figures.

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Receiver A4:

The 10.245 MHz Local Oscillator is adjusted by C049. This signal leaves the module on J2. Use a high impedance input frequency counter and set C049 for 10.245 MHz +/- 100 Hz.

The IF Overload trip point is adjusted by R057. Set the input attenuator to 0dBm. Select AM, narrow, MON mode. Feed in an AM signal at -50dBm with 40% modulation and increase it until the "increase attenuator" alarm is displayed on the screen. Adjust R057 so this happens between -40dBm and -35dBm.

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RF Synthesizer A5:

The 60.5 MHz Detector Threshold pot R122 is adjusted by removing A5, its two back cover screws, and its back cover. Install A5 on an extender board. Measure the DC voltage on point E7 along the top of the board. Measure U118 pin 3 and adjust R122 for a voltage that's about 0.25V below what you measured on E7.

The FM Deviation pot R354 is adjusted by measuring the generated FM deviation on an external modulation meter and setting the pot so the internal deviation indication matches what's seen on the external meter. Note that the range is approximately 0-20 kHz in "Narrow" mode and 0-80 kHz in "Wide" mode. The two modes should differ by a factor of exactly 4.

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High Voltage Power Supply A10:

The High Voltage Adjust pot R037 should be adjusted for -2,000VDC at the cathode of the CRT. This is hard to get to. I ended up pulling the tube socket off the back of the CRT and wrapped the lead of a 10 ohm 1/4w resistor around pin 2 (cathode) then put the socket back on, letting the resistor hang out the side where I could touch it with a probe. This gave me access to that pin and I used my 6kV high voltage probe and DMM to measure the voltage. Remove the resistor when you've finished. You can also measure the second anode voltage and set the high voltage to around 4,000 to 4,100 VDC but it's not as accurate.

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RF Input Module A11 Alignment Notes:
To adjust anything on A11, the entire assembly has to be removed from the service monitor and all its cover plates must be removed. You will have to reconnect just about everything, which means you'll need to extend the coax cables. You need to unplug the cable going to J5 when adjusting A11A2. YOU SHOULD ALIGN A11 BEFORE YOU ALIGN A4. Also, SET THE STEP ATTENUATOR TO 0dBm BEFORE REMOVING THE A11 MODULE.

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RF Input A11A1:
The wattmeter is calibrated using two pots in the Attenuator assembly (A11A1). Set the two pots at their mid rotation position and select the Power display mode. With a calibrated 1 watt 500 MHz signal, adjust the Offset pot R143 so the R2001 reads 1 watt. With a calibrated 50 watt 500 MHz signal, adjust the Gain pot R122 so the R2001 reads 50 watts. Repeat these two adjustments several times as they interact.

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Wideband Amplifier A11A2:
C232 and L212 tune the IF amplifier. Feed an un-modulated signal into the RF IN jack in MON mode. Monitor the 10.7 MHz IF Output at J5 and adjust C232 and L212 for a maximum signal amplitude.

R258 adjusts the 10.7 MHz IF output level. Set to Monitor FM. Wide or Narrow doesn’t seem to make a difference. Set the step attenuator to 0dBm. Feed a -40dBm un-modulated signal into the RF IN jack. Monitor the 10.7 MHz signal on J5. Adjust R258 for -25dBm output at J7.

The output generator variable span is calibrated using two pots in the Amplifier section (A11A2). Set the two pots at their mid rotation position. Generate FM, any frequency, and any deviation. Set the step attenuator to 0dBm and set the "Variable Output" front panel control for 0dBm on the CRT. Adjust R276 for 0dBm output on an external power meter or spectrum analyzer. Set the "Variable Output" control for +10dBm on the CRT and adjust R252 for +10dBm output on an external power meter or spectrum analyzer. Repeat these two adjustments several times as they interact.

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Duplex Generator A11A3 Alignment Notes:
The Duplex Offset Generator is fully independent and won't affect any other instrument function or operation. It is active in monitor mode if you have the Offset selector toggle switch set to something besides OFF. The only time you can see your setting for deviation on the Offset Generator is when you are in Duplex Gen AND the mode switch is in GEN. Otherwise the Duplex Gen screen shows the deviation of the signal feeding the RF IN/OUT jack.

Mark the position of C306, C309, C319, and R305 before you adjust them.

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Set the service monitor to 250 MHz, Narrow, High Injection, 1 kHz level to minimum stop. Set the Duplex Generator Fine Frequency knob so its centerline is straight up. Set the Coarse Frequency knob fully clockwise. Set the Offset switch to 0-10 MHz. Select DUPLEX GEN for the display function.

Set your Spectrum Analyzer center frequency to 250 MHz, span to 100 MHz, reference level to 0dBm, 10dBm per division, and connect to Duplex out jack. There should be a peak at the 250 MHz center. Read the Duplex Generator frequency on the CRT. It should be very close to 250 MHz and / or agree with the SA.

Make a test run through "Test Your Setup" below; do not adjust anything and record your findings and results. If all is well, don't touch anything; you are finished!

Test Your Setup:
Keep your sticky little fingers off the Fine Adjust pot! The Duplex Generator in its 10 MHz position is rich in harmonics!

Turn the Coarse control CCW and keep track of the center peak at -20dBm. As you near 260 MHz (240 MHz in low) harmonics will come in from off the screen and merge with the desired peak. Keep track of the right bump for frequency.

A little over 260 MHz (test cases about 260.6 MHz) the VCO will lose sync and you don't care. At this point the CRT will have displayed an "out of range" warning anyway.

Switch the Offset to 45 MHz. Notice there are 2 major and 2 minor peaks. Check the peak at 295 MHz for high injection. It should be dead on and about -24dBm. Flip to Low Injection and that peak should be at 205 MHz and also be at about -24dBm.

As long as your results match the test move on. If not proceed to: Duplex Generator A11A3.

Other useful information:
The Fine adjust VCO frequency is 34.3 MHz at its center with a total range of about 600 kHz.
The Coarse adjust VCO frequency range is 35 to 45 MHz.

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Duplex Generator A11A3:
Look at the CRT and adjust C319 for a Duplex Generator frequency as close to 250.0 MHz as you can get. Expect the Duplex Generator output level to be close to -20dBm; there is no adjustment. NOTE: If you need to move C319 more than 45 degrees or the spectrum analyzer does not read 250 MHz, be suspect of other problems.

Next, look at the spectrum analyzer and adjust C309 for minimum extraneous signals while adjusting C306 to keep the frequency centered on 250.0 MHz. NOTE: If you need to move either more than 30 degrees, be suspect that you are out in left field. Reset all three trimmers and start these procedures over again.

The FM deviation in Duplex Offset mode is adjusted by R305. You must adjust C306 and C309 first. Select FM, GEN, DUPLEX, 45 MHz offset, high or low injection, 200 MHz frequency. Connect an external modulation meter to the Duplex Output jack, set the internal 1 kHz FM modulation to 20 kHz on the CRT display then adjust R305 so the external meter reads 20 kHz. That's about the maximum deviation available on the Duplex Output. The modulation level on the Duplex Gen screen only displays correctly when the Function Switch is in GEN. The actual modulation at the Duplex Out jack will remain the same in any Function or Display mode. If modulation range is way off there is most likely a problem with your settings for C306 and C309.

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Front Panel Interface A12 Alignment Notes:
The manual says you have to drop the front panel to perform the adjustments. You do not. Just be careful when pressing on the pots as you access them from the top of the service monitor. You may want to add dabs of hot-glue behind the pots that are mounted at right angles to the A12 board, to prevent movement.

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Front Panel Interface A12:
The Input HF Compensation capacitor C011 is adjusted by feeding in a 1Vp-p 1 kHz square wave signal into the scope vertical input and selecting the DC Scope function mode. Adjust C011 for no overshoot or undershoot on the leading edges of the waveform.

The Vertical Balance pot R025 can be adjusted in scope mode to minimize the trace shift while varying the Vertical Range switch and the Vertical Gain vernier pot on the Vertical Range switch. Ideally the baseline should not shift as the vertical range or gain is rotated.

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10 MHz Frequency Standard A13:
There are two different 10 MHz reference oscillators: the standard TCXO and the optional high-stability OCXO. Units with the OCXO usually have "/HS" for "High Stability" added to the end of the model number designation.

On the standard TCXO non-ovenized, 10 MHz oscillator, the "Oven Ready" LED on the front panel should be lit whenever the unit is plugged in and the power switch is in the STDBY or ON positions. Adjust R016 fully clockwise so the "Oven Ready" LED is lit in these situations.

On the optional high-stability OCXO ovenized, 10 MHz oscillator, turn the unit on and let it run for at least 30 minutes, then adjust R016 so the "Oven Ready" LED is just fully lit. It should not light when the unit has been unplugged for a while and the oven is cold, and it should cycle on and off as the oven heats up, remaining on steadily when it reaches equilibrium, as long as the power switch is in the STDBY or ON positions.

Miscellaneous Notes:

DSB-SC (Double Side Band, Suppressed Carrier):
The carrier and sideband amplitudes are not adjustable. They are whatever they are. The R2000-series can receive SSB but it can only generate DSB. The DSB-SC carrier suppression is specified as >= 25dB. One unit had a carrier level of -30dBm and the sidebands reached -10dBm. Another unit had a carrier level of -50dBm and the sidebands reached -25dBm. This is with the internal 1 kHz modulation set to maximum level. The "GEN" screen shows only the frequency; the variable output level control does nothing. The step attenuator and audio level control the DSB-SC output signal. There is no indication of the output level on the service monitor.