# Lectrosonics Automated Test & Alignment Procedure

| | | | | | |
|---|---|---|---|---|---|
| **Part number(s):** | IFBT4-VHF | **Hardware version(s):** | 17465A | **Firmware version(s):** | 0.07 |
| **Common name:** | IFB transmitter | **Author(s):** | Rodney Wildhagen & Cruz Garcia | **Test procedure version:** | 1.0 |
| **Date:** | 21 May 2015 | | | | |

**Initial setup:**

- LCD display & control board connected to DUT 17465 transmitter board
- VCO shield (P/N ~~26006~~) and DSP/Processor shield (P/N ~~26715~~) installed tabs bent 45°
- Power switch SW3 to OFF position
- Insert jumper (P/N 21407) at JMP6 pin1 to pin2 (XLR gnd lift)
- Rear Panel DIP switches SW1 set to LINE input, 1 & 2 UP, 3 & 4 down
- All voltage measurements referenced to circuit common (TP24 or equivalent)
- Various part numbers use different power levels for different countries.
- Initial audio stimulus signals coupled into rear XLR jack as 50 ohms Unbalanced input 1 if using the ATS1 Audio Precision analyzer, XLR pin 1 audio common, Pin 2 audio +, Pin 3 audio -
- All audio signal Noise, and Distortion measurements made with 22Hz HPF, 22kHz LPF
- All audio signal Amplitude measurements made with < 10Hz HPF, 80kHz LPF
- Note: Rear panel XLR connector Pin1=GRN to P1, XLR Pin2=BLK to P2, XLR Pin3=WHT to P3
- Connect LectroLink device to J7 (red wire to J7-1)
- `This font indicates use the Alternate Method to manual testing using the LectroLink apparatus and either the LecNet2 Command Terminal Utility. Sub-steps bearing the same number indicate alternate method(s). Use of the LectroLink apparatus creates an additional opportunity for ground loop currents which commonly disrupt LectroLink communications so use of an optically isolated USB hub (B and B Electronics model UISOHUB4 or equivalent) is recommended.`
- **Momentarily shorting TP19 to TP20 will set the DUT in a Factory Mode State** where several peramiter can be adjusted by scrolling to the menu, Some peramiter can only be set useing the Alterante method useing a Lectro Link device.
- The firmware and database selections are also dependent on the part number, see ifbt4.ini for versions and database names.

| step | ***Measurement name*** **& description** | Measurement result | (Typ.) |
|---|---|---|---|
| 10 | *Program, µC IC* | | |

This need only be performed at the factory the first time it is powered up, when µC IC is replaced, or when a firmware update is desired and confirmed to be appropriate.

12VDC in at rear panel 6-18VDC power jack (ctr +).

Measure current draw µC IC not programed

Connect ICSP rigging at J6

Power switch (SW3) to XMIT position

Program µC IC

Verify that programming operation is indicated as successful, methods vary depending on tools used

If µC IC does not program successfully measure DC voltage at TP 51 for +5 VDC (+/- 0.25 V)

Disconnect ICSP rigging

Verify message at LCD immediately after µC IC is programed

| µC State | typ |
|---|---|
| not programmed | 60 |
| PLL unlocked | 90 |
| PLL locked | 170 |
| 200 to 800 mA | |
| **DUT Type and Firmware** | |
| `id?` | IFBTV-VHF |
| `version?` | "VX.XX" |

| |
|---|
| `id?` |
| `version?` |

DUT name

Firmware version

Disconnect DC power from DUT

It is noteworthy that the device programmer provides the clock signal during programming and verification. If programming appears to be successful and yet the DUT does not appear to boot up when the ICSP rigging is disconnected, first ensure the µC IC clock oscillator is running.

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20 *Reverse Power polarity protection circuit test*

Prerequisite(s)

| | | |
|---|---|---|
| µC IC programmed | (SW3) to XMIT position | 12 VDC, 400mA is at power jack (ctr +) |

| Current Draw | |
|---|---|
| **Tol** | **Typ** |
| 300/500 | 355 |

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6VDC, 5A current limit in at rear penal 6-18VDC power jack (ctr -). This is a reverse power power polarity connection

Wait 5 sec. to allow polyfuse temp to stabilize

Measure current draw

Remove DC power from DUT

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30 *Current draw measurement*

Prerequisite(s)

| | | |
|---|---|---|
| µC IC programmed | (SW3) to XMIT position | 12 VDC, 400mA is at power jack (ctr +) |

| µC State | Typ |
|---|---|
| not programmed | 43 |
| PLL unlocked | 90 |
| PLL locked | 177 |
| 50 to 400 mA | |

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12 VDC, 400mA current limit in at rear panel 6-18VDC power jack (ctr +). This is a appropriate power polarity connection

Measure current draw

State of the DUT is unknown at this time. Expected current draw values are:

The goal here is only to ensure the DUT is powered up and is not burning up with fever. A tighter tolerance current draw measurement will be made later.

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40 *DC voltage measurements & LCD contrast adjustment*

* Prerequisite(s):

| | | |
|---|---|---|
| µC IC programmed | (SW3) to XMIT position | 12 VDC, 400mA is at power jack (ctr +) |

| Input | Tol | Typ |
|---|---|---|
| 18V | +4.9/+5.3 | +5.2 |
| 6V | +4.9/+5.3 | +5.4 |
| 12V | +4.9/+5.3 | +5.2 |

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Measure DC voltage at transmitter board TP51 with DUT input voltage set to various. Leave input voltages leave at 12VDC input

Measure DC voltage at TP:

| TP | Tolerance | typ | TP | Tolerance | typ | TP | Tolerance | typ |
|---|---|---|---|---|---|---|---|---|
| tp57 | +1.75/+1.9 | +1.83 | tp13 | -15.8/-15.2 | -15.5 | tp45 | +1.28/+1.68 | +1.48 |
| tp52 | +3.23/+3.43 | +3.31 | tp 4 | +15.2/+15.8 | +15.5 | tp44 | tp45+/-500mV | +200 |

Adjust R50 for -1.2 VDC at TP25 (adjusts LCD display contrast)

| Tol | Typ |
|---|---|
| -1.15/-1.25VDC | -1.2 |

Be sure to use an LCD display equivalent to the one that is expected to ship with the transmitter or contrast may need to

be re-adjusted.

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70 *11.3 MHz oscillator amplitude measurement*

| | | |
|---|---|---|
| µC IC programmed | (SW3) to XMIT position | 12 VDC, 400mA is at power jack (ctr +) |

| | | |
|---|---|---|
| **Amplitude** | -6/-14 | -10 |
| **Frequency** | ~~11.299~~/~~11.30~~Mhz | 11.45 |

Measure 11.3 MHz oscillator signal attributes at TP34 (TP18 is circuit common) with a 50O Probe

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80 *Carrier VCO check*

Prerequisite(s)

| | | |
|---|---|---|
| µC IC programmed | (SW3) to XMIT position | 12 VDC, 400mA is at power jack (ctr +) |

| **VCO Voltage TP1 (VDC)** | | | |
|---|---|---|---|
| Hi Freq | | Lo Freq | |
| Tol | Typ | Tol | Typ |
| +3.7/+4.3 | +3.96 | +0.7/+1.5 | +1.0 |

Set DUT to Highest carrier frequency `channel=238`

`channel=0`

Note Anytime carrier frequency is changed SW3 must be set to "TUNE" first. Changing carrier frequency via LectroLink SW3 can also be in XMIT

Measure VCO voltage at DUT TP1

Set DUT to Lowest carrier frequency

Measure VCO voltage at DUT TP1

NOTE Flashing Frequency in splash screen indicate PLL is not locked

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90 *Carrier signal power adjust and measurement*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | 12 VDC, 400mA is at power jack (ctr +) | `Channel=0` | SW3 set to XMIT |

Set DUT to calibration frequency 1-5 `channel=`

Query Calibration point (`powercal(p)?`) `powercal(p)?`

Adjust RF Carrier Power for +17dBu target (`(powercal(p)=`) `powercal(p)=`

Measure current draw

| **powercal(p)** | **Channel=** |
|---|---|
| 1 | 0 (00) |
| 2 | 64 (40) |
| 3 | 128 (80) |
| 4 | 192 (C0) |
| 5 | 238 (EE) |
| **Carrier Power (dBm)** | |
| **Tol** | **Typ** |
| +16.6/+17.3 | +17.0 |
| **Current draw** | |
| **Tol** | **Typ** |
| 160/200 | 170 |

Note It is necessary to move the transmitter to the carrier frequency whose RF carrier power is to be adjusted before adjustment, otherwise you will be changing a setting but unable to observe the effect. Also it is considered best to query `powercal(p)?` to discover the initial value so you will know what the next assigned value should be to achieve an increase or decrease as indicated by the measured value.

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*Spurious & carrier mute measurements*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | 12 VDC, 400mA is at power jack (ctr +) | `Channel=238` | SW3 set to XMIT |

| **Spurious (dBm)** | | |
|---|---|---|
| | **137-230MHz** | **All else = 1GHz** |
| = 50mW | = -54 | = -36 |

Carrier signal measurements made w/ RF spectrum analyzer

Measure spurious emissions at DUT JU2 at low, mid, and high carrier power frequencies

Measure muted carrier power relative to unmuted carrier power, leave unmuted

| xmitsw=0 |
|---|
| xmitsw=1 |

| Mute (dBC) | |
|---|---|
| Tol | Typ |
| = -60 | -72 |

Note LabView spur tool leaves DUT at middle carrier frequency

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100 *Carrier frequency, modulation level adjust and distortion measurement*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | 12 VDC, 400mA is at power jack (ctr +) | Channel=128 | SW3 set to XMIT |
| DIP switches SW1set to line | | | |

Measure carrier frequency and Fine adjust for target channel 128

Activate 1kHz test tone (`tone=1`)

Set DUT to Devcomp carrier frequency and adjust deviation (`devcomp(p)=`)

Measure distortion of demodulated carrier (see table to right)

Repeat for each devcomp index; devcomp(1 - 5)

Measure THD+N at all 5 calibration point

Deactivate 1kHz (`tone=0`) test tone after all 5 calibration points have been adjusted

| finetune= |
|---|
| tone=1 |
| channel= |
| devcomp(p)= |
| tone=0 |

Freq tol= target +/- 750Hz

| devcomp(p) | channel= |
|---|---|
| 1 | 0 (00) |
| 2 | 64 (40) |
| 3 | 128 (80) |
| 4 | 192 (C0) |
| 5 | 238 (EE) |

| Mod (kHz) | | Dist (%THD+N) | |
|---|---|---|---|
| Tol | Target | Tol | Typ |
| 99/101 | 100 | = 1 | 0.64 |

It is necessary to move the transmitter to the carrier frequency whose modulation is to be adjusted before adjustment, otherwise you will be changing a setting but unable to observe the effect. Also it is considered best to query `devcomp?` to discover the initial value so you will know what the next assigned value should be to achieve an increase or decrease as indicated by the measured value. Deviation moves about 0.5kHz per step

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120 *Pilot signal deviation & frequency measurements*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | 12 VDC, 400mA is at power jack (ctr +) | DIP switches SW1set to line | channel=238 |
| no audio in at DUT XLR | Factor mode (if test manually) | SW3 to XMIT | |

DUT set to IFB mode

Audio input Gain set to minimum

Activate pilot tone bypass (`pilotbp=1`)

No audio stimulus in at rear panel XLR

Measure and note noise in khz of deviation

Deactivate pilot tone bypass (`pilotbp=0`)

| compat=5 |
|---|
| level=-18 |
| pilotbp=1 |
| pilotbp=0 |
| channel=0 |

| Pilot Tone (kHz) | | |
|---|---|---|
| Freq | Dev | |
| | Tol | Typ |
| Hi carrier | 4.5/6.5 | 4.6 |
| Lo carrier | 4.5/6.5 | 5.0 |
| Pilot Tolerance | | |
| 29.995/29.999 kHz | | |

Measure pilot tone deviation - the noise measure in previous step

Measure pilot tone Frequency

Set DUT to lowest carrier frequency

Repeat steps ###.###v to ###

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*Noise measurements (low gain branch)*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | 12 VDC, 400mA is at power jack (ctr +) | `compat=5` (IFB default) | level=-18 |
| no audio in at DUT XLR | Factor mode (if test manually) | DIP switches SW1set to line | SW3 to XMIT |

| Noise (dBu) | | |
|---|---|---|
| **Gain** | **Tol** | **Typ** |
| Min | =-64 | -67 |

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Set DUT to highest carrier Frequency

Set DUT to passthrou CLP mode (`passthu=1`,`pilotbp=1`,`limitcal=1`)

Select Low gain branch

Measure Noise Signal Amplitude of the demodulated carrier

| |
|---|
| `channel=238` |
| `passthru=1` |
| `pilotbp=1` |
| `limitcal=1` |
| `gainsw=2` |

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*Noise measurements and microphonics measurements (high gain branch)*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | `compat=5` (IFB default) | DIP switches SW1set to line | `channel=238` |
| 12 VDC, 400mA is at power jack (ctr +) | Factor mode (if test manually) | SW3 to XMIT | `passthru=1` |
| no audio in at DUT XLR | passthru CLP | `level=-18` | `pilotbp=1` |

| Noise (dBu) | | |
|---|---|---|
| **Gain** | **Tol** | **Typ** |
| Min | =-64 | -67 |
| Max | =-64 | -67 |
| **Microphonic (dB(r))** | | |
| **Gain** | **Tol** | **Typ** |
| Max | = ref +18 | 10 |

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Select Low gain branch (`gainsw=1`)

Measure Noise Signal Amplitude of the demodulated carrier

| |
|---|
| `gainsw=1` |
| `level=24` |

Set DUT gain to Max

Measure Noise Signal Amplitude of the demodulated carrier

Repeatedly and gently tap edge of DUT farthest from VCO while measuring noise amplitude using a peak hold instrument

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*Mic gain pot taper test*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | `compat=5` (IFB default) | DIP switches SW1set to line | `passthru=1` |
| 12 VDC, 400mA is at power jack (ctr +) | Factor mode (if test manually) | SW3 to XMIT | `pilotbp=1` |

| Amplitude (dB(r)) | | |
|---|---|---|
| **Gain** | **Tol** | **Typ** |
| 24 | Ref | 0 |
| -18 | ~~-43/-41~~ | -16.9 |
| 0 | ~~-26/-24~~ | -10 |

| | | | |
|---|---|---|---|
| no audio in at DUT XLR | passthru CLP | `channel=238` | `limitcal=1` |
| | | | `level=24` |

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**-10dBu, 1kHz, low distortion, sinusoidal signal in at rear panel XLR**

`gainsw=0`
`level=-18`
`level=0`

Select Normal gain branch (`gainsw=0`)

Measure and note audio signal Amplitude at demodulated carrier

Audio Input Gain Level to -18

Measure audio signal Amplitude at demodulated carrier

Audio Input Gain Level to 0

Measure audio signal Amplitude at demodulated carrier

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130

*Limiter range adjustment*

| Amplitude (dB(r)) | | |
|---|---|---|
| | **Tol** | **Typ** |
| LIMIITREF | Ref | 0 |
| LIMITCAL | -8/-10 | -9 |

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | `compat=5` (IFB default) | DIP switches SW1set to line | `passthru=1` |
| 12 VDC, 400mA is at power jack (ctr +) | Factor mode (if test manually) | SW3 to XMIT | `pilotbp=1` |
| no audio in at DUT XLR | passthru C-P | `channel=238` | `level=0` |

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`channel=128`
`limitcal=2`
`lscale?`
`lscale=`
`limitcal=0`

-10dBu, 1kHz, low distortion, sinusoidal signal in at rear panel XLR

Set carrier frequency to Mid

Set DUT to LIMITREF SET TO 0 window

Measure and record audio signal amplitude of the demodulated carrier at DUT JU2, this is the reference to the next amplitude measurement

Set limiter to cal mode and adjust limiter scale for 9 dB below reference amplitude in test sub-step

It is noteworthy that to perform this step manually (without the aid of the LectroLink apparatus) it is necessary to set PASSTHRU to C-P indicating that the limiter is active but to perform it using LectroLink limitcal is assigned the value of 1 indicating that the limiter is disabled. While this seems contradictory it has been confirmed to be true. It is believed that only the firmware author understands the reason for this. Also, it is noteworthy that the LCD display does not reflect changes in limitcal value assignment as would seem appropriate.

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*Frequency response (low gain, high branch), deviation, and distortion measurements*

| Freq Resp (dB(r)) | | | |
|---|---|---|---|
| **R/O** | **Freq** | **Tol** | **Typ** |
| 50 | 1Khz Ref | 0/0 | 0 |
| 50 | 20kHz | -2.4/+1.6 | -0.4 |
| | | | |

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | `compat=5` (IFB default) | DIP switches SW1set to line | `passthru=1` |
| | | | |

| | | | |
|---|---|---|---|
| 12 VDC, 400mA is at power jack (ctr +) | Factor mode (if test manually) | SW3 to XMIT | `pilotbp=1` |
| no audio in at DUT XLR | passthru C-P | `channel=128` | `level=0` |

| | | | |
|---|---|---|---|
| 50 | 31.5Hz | -22.2/-18.2 | -20.2 |
| 35 | 31.5Hz | -10.7/-6.7 | -8.7 |

| **Dist(THD+N)** | | |
|---|---|---|
| | **Tol** | **Typ** |
| **Low Gain** | 0.8% | 0.4 |
| **Hi Gain** | 0.8% | 0.4 |

| **Dev(kHz)** | | |
|---|---|---|
| | **Tol** | **Typ** |
| **Low Gain** | 10.5/11.7 | 10.7 |
| **Hi Gain** | 10.5/11.7 | 10.5 |

**+5dBu, 1kHz, low distortion, sinusoidal signal in at rear panel XLR**

`limitcal=1`
`gainsw=2`
`rolloff=1`
`rolloff=0`
`gainsw=1`

Disable compressor, limiter and Pilot - Passthru CLP

Select Low gain branch (`gainsw=2`)

Set ROLLOFF to 50

Measure freq response of demodulated carrier at J2 (1k ref)

Set ROLLOFF to 35 and measure freq response at 31.5kHz (Ref 1k)

-5dBu, 1kHz, low distortion, sinusoidal signal in at rear panel XLR

Measure audio signal Deviation of demodulated carrier at J2

Measure audio signal Distortion of demodulated carrier at J2

Select High gain branch (`gainsw=1`)

Repeat steps ### to ### measuring freq response at 35.5Hz only

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220 *Phase measurement*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | `compat=5` (IFB default) | DIP switches SW1set to line | `passthru=1` |
| 12 VDC, 400mA is at power jack (ctr +) | Factor mode (if test manually) | SW3 to XMIT | `pilotbp=1` |
| no audio in at DUT XLR | passthru CLP | channel=128 | `limitcal=1` |
| | | | `level=0` |

| **Phase (°)** | |
|---|---|
| **Tol** | **Typ** |
| +~~221/+257 or -55/-91~~ | +~~235~~or +7 |

+5dBu, 1kHz, low distortion, sinusoidal signal in at rear panel XLR

`gainsw=0`

Select gainsw to auto (`gainsw=0`)

Measure phase of the demodulated carrier at the output of Hewlett Packard 8901A modulation analyzer relative to the signal source (DUT input)

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230 *Rear panel DIP switch test*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | SW3 to XMIT | DIP switches SW1set to line | `passthru=1` |
| 12 VDC, 400mA is at power jack | Factor mode (if test | channel=128 | `pilotbp=1` |

| **Dev (kHz)** | | |
|---|---|---|
| **audio input** | **Tol** | **Typ** |
| +5 dBu | 4.0/6.0 | 5.0 |
| -32 dBu | 58/68 | 63 |

| | | | |
|---|---|---|---|
| (ctr +) | manually) | | |
| `compat=5` (IFB default) | passthru CLP | level=0 | `limitcal=1` |

**+5 dBu, 1kHz, low distortion, sinusoidal signal in at rear panel XLR**

When using the ATS1 audio analyzer it is necessary to exit the phase measurement function to make the following deviation measurement

Rear DIP switches set to input (all DOWN)

Measure peak carrier deviation at J2

**-32 dBu, 1kHz, low distortion, sinusoidal signal in at rear panel XLR**

Rear DIP switches set to input (all UP)

Measure peak carrier deviation at J2

Return Rear DIP switches to LINE input (1,2 UP, 3,4 DOWN)

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240 *Carrier deviation measurement*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | `compat=5` (IFB default) | SW3 to XMIT | `channel=128` |
| 12 VDC, 400mA is at power jack (ctr +) | Factor mode (if test manually) | `DIP switches SW1set to line` | `level=0` |
| no audio in at DUT XLR | | | |

| Dev (kHz) | | |
|---|---|---|
| **audio input** | **Tol** | **Typ** |
| 0 dBu | 18/21 | 20 |

Cycle power to DUT this changes Passthru to ---

**+10 dBu, 1kHz, low distortion, sinusoidal signal in at rear panel XLR**

Measure carrier signal peak deviation at J2

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250 *Audio signal level indicator, audio gain check, and limiter adjustment verification*

Prerequisite(s)

| | | | |
|---|---|---|---|
| µC IC programmed | `compat=5` (IFB default) | SW3 to XMIT | `channel=128` |
| 12 VDC, 400mA is at power jack (ctr +) | Factor mode (if test manually) | `DIP switches SW1set to line` | `level=0` |
| no audio in at DUT XLR | passthru(---) | | |

| DUT Audio level indicator | | | |
|---|---|---|---|
| **Audio Input** | **Gain** | **Tol** | **Typ** |
| 0 dBu | 0 | 34/36 | 35 |
| 0 dBu | -1 | 34/36 | 35 |
| 0 dBu | -10 | 33/35 | 31 |
| -10 dBu | 0 | 17/19 | -18 |

**+10 dBu, 1kHz, low distortion, sinusoidal signal in at rear panel XLR**

Observe audio level bar graph indicator on DUT (`ameter?`)

Set DUT to various Audio Input Gain setting and query bar graph indicator (`ameter?`)

-10 dBu, 1kHz, low distortion, sinusoidal signal in at rear panel XLR

| |
|---|
| `ameter?` |
| `level=-1` |
| `level=-10` |
| `level=0` |

Set DUT to Audio Input Gain 0

Observe audio level bar graph indicator on DUT (`ameter?`)

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260 *Power off function (and delay thereoff) test*

| | | |
|---|---|---|
| µC IC programmed | 12 VDC, 400mA is at power jack (ctr +) | SW3 to XMIT |

Query DUT for switch position command is (`xmitsw?`) `xmitsw?`

SW3 to TUNE

Query DUT for switch position command is (`xmitsw?`)

Measure current draw (to ensure TX powers down)

| | Power Switch State | |
|---|---|---|
| **SW3** | **Tol** | **Typ** |
| **XMIT** | 0 | 1 |
| **TUNE** | 0 | 0 |
| | **Current Draw(mA)** | |
| | **Tol** | **Typ** |
| **OFF** | | 0 |

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*Final inspection and finishing work*

Verify shields are installed and tabs are bent approximately 45° and are clear of any short circuit hazards, remove any shavings which have occurred during tab bending.

Inspect your work

There is no need to disable carrier frequencies in the radio astronomy band on block 23 as this is accomplished as a function of firmware.

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