

# ELECRAFT XG3 RF SIGNAL SOURCE

## Owner's Manual

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Elecraft manuals with color images may be downloaded from [www.elecraft.com](http://www.elecraft.com).

## Introduction

The XG3 is a miniature RF signal source that provides output from 1.5 MHz through 1400 MHz. Four commonly used selectable output levels are calibrated from 1.5 through 200 MHz.

The XG3 may be operated from its internal battery or from an external 11-14VDC source. It is housed in a protective enclosure with easy-to-use front panel switches and LED indicators.

Since the XG3 is small and portable it's ideal for quickly checking the performance of equipment in the field as well as at the home station (see Reverse Power on pg 14).

Never apply RF power or voltage to the XG3 RF OUT connector.

If you are working with a transmitter or transceiver, disable the transmitter (turn the power to minimum, disconnect any microphone or key or, if available, put the transceiver in a test or standby mode so transmit is disabled.) Transmitting into your XG3, even briefly, will damage it. Such damage is not covered under the Elecraft warranty.

If connecting the XG3 to circuits where voltages are present, use a blocking capacitor to keep those voltages from reaching the XG3. A fusible trace is provided that may protect the XG3 in the event you accidentally apply voltage or RF power to the RF OUT connector. If that happens, you may be able to restore operation by installing a jumper to bypass the trace as described in *Appendix A* on pg 30.

A computer interface permits selecting up to 12 preset frequencies that are stored so they are available when the XG3 is used without the computer. In addition, two sweep frequency ranges may be chosen with a selectable sweep step size a sweep rate as little as 1 ms. An RS232 interface cable for connecting the XG3 to your computer is included.

The XG3 is a versatile tool that may be used for receiver testing, receiver alignment, RF signal tracing and troubleshooting and may even serve as a VFO or local oscillator or homebrew projects (see *Applications* on pg 14).

## Specifications

|                           |  |
|---------------------------|--|
| Frequency Range:          | 1.5-200 MHz range, with a typical resolution of 1-24 Hz. (Up to 1400 MHz via harmonics)  |
| Frequency Stability:      | ±50 ppm, maximum.  |
| Signal Characteristics:   | Highly stable RF square wave; phase noise -105 dBc/Hz  |
| Reverse Power:            | Shunt diodes and a fusible pc trace link provide limited protection. See <i>Reverse Power</i> , pg 14.   |
| Preset Frequencies:       | 12 frequencies preset at the factory - one in each Amateur band from 160 through 2 meters. Frequencies may be changed using a personal computer (pg 8).  |
| Sweep Mode:               | Two frequency ranges preset. The sweep speed and the frequency increment for each step may be programmed using a personal computer (pg 8).   |
| Computer Interface:       | RS-232; Allows changing the preset frequencies and operating the XG3 from a personal computer using the XG3 Utility program available free from Elecraft. Note: For information on writing your own XG3 control programs, see <i>XG3 Remote Control Commands</i> on pg 18. |
| Selectable Output Levels: | Four levels, calibrated from 1.5 through 200 MHz:<br>0 dBm (± 3 dB), -33 dBm, -73 dBm, - 107 dBm (± 1 dB typ).   |
| Output Impedance:         | 50 ohms.   |
| Power:                    | Internal 9-volt battery or external 11-14 VDC supply   |
| Power Consumption:        | External supply, 60 mA maximum at 0 dBm output. Less at lower output levels.<br><br>Internal battery drain, up to 50 mA at 0dBm output, 25 mA typical at lower output levels.<br><br>Programmable automatic power shutoff.   |
| Frequency Resolution:     | Limited by the internal PLL divisor precision. Typical values are as follows:<br>1.5 to 66 MHz: 1 to 10 Hz.<br>67 to 159 MHz: 1 to 12 Hz.<br>160 to 200 MHz: 1 to 24 Hz  |

## Customer Service and Support

### Technical Assistance

You can send e-mail to [support@elecraft.com](mailto:support@elecraft.com) and we will respond quickly - typically the same day Monday through Friday. Telephone assistance is available from 9 A.M. to 5 P.M. Pacific time (weekdays only) at 831-763-4211. Please use e-mail rather than calling when possible since this gives us a written record of the details of your problem and allows us to handle a larger number of requests each day.

### Repair / Alignment Service *(We want to make sure everyone succeeds!)*

If necessary, you may return your Elecraft product to us for repair or alignment. (Note: We offer unlimited email and phone support to get your kit running, so please try that route first as we can usually help you find the problem quickly.)

**IMPORTANT: You must contact Elecraft before mailing your product** to obtain authorization for the return, what address to ship it to and current information on repair fees and turnaround times. (Frequently we can determine the cause of your problem and save you the trouble of shipping it back to us.) Our repair location is different from our factory location in Aptos. We will give you the address to ship your kit to at the time of repair authorization. *Packages shipped to Aptos without authorization will incur an additional shipping charge for reshipment from Aptos to our repair depot.*

### Elecraft's 1-Year Limited Warranty

This warranty is effective as of the date of first consumer purchase (or if shipped from factory, date product is shipped to customer). It covers both our kits and fully assembled products. For kits, before requesting warranty service, you should fully complete the assembly, carefully following all instructions in the manual.

**Who is covered:** This warranty covers the original owner of the Elecraft product as disclosed to Elecraft at the time of order. Elecraft products transferred by the purchaser to a third party, either by sale, gift or other method, who is not disclosed to Elecraft at the time of original order, are not covered by this warranty. If the Elecraft product is being bought indirectly for a third party, the third party's name and address must be provided to Elecraft at time of order to insure warranty coverage.

**What is covered:** During the first year after date of purchase, Elecraft will replace defective or missing parts free of charge (post-paid). We will also correct any malfunction to kits or assembled units caused by defective parts and materials. Purchaser pays inbound shipping to Elecraft for warranty repair, Elecraft will pay shipping to return the repaired equipment to you by UPS ground service or equivalent to the continental USA and Canada. Alaska, Hawaii and outside U.S. and Canada actual return shipping cost paid by owner.

**What is not covered:** This warranty does not cover correction of kit assembly errors. It also does not cover misalignment; repair of damage caused by misuse, negligence, or builder modifications; or any performance malfunctions involving non-Elecraft accessory equipment. The use of acid-core solder, water-soluble flux solder, or any corrosive or conductive flux or solvent will void this warranty in its entirety. Also not covered is reimbursement for loss of use, inconvenience, customer assembly or alignment time, or cost of unauthorized service.

**Limitation of incidental or consequential damages:** This warranty does not extend to non-Elecraft equipment or components used in conjunction with our products. Any such repair or replacement is the responsibility of the customer. Elecraft will not be liable for any special, indirect, incidental or consequential damages, including but not limited to any loss of business or profits.

## Battery Installation

The XG3 uses a single 9-volt battery (common ANSI/NEDA 1604 size). The battery compartment is on the lower back. Slide the cover open by pushing it toward the bottom of the XG3. Align the battery so the narrower (+) battery terminal is aligned with the narrower contact in the battery holder (Figure 1) and press the battery down so the back is against the support shown.

If transporting the XG3, you can ensure it won't accidentally be turned on by flipping the battery over so the battery terminals are facing away from the contacts in the XG3.

Note the XG3 has reverse-polarity protection in the event you insert the battery incorrectly.

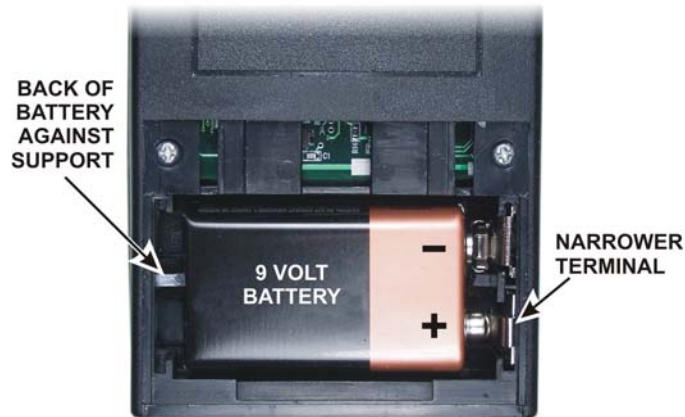


Figure 1. Installing Battery

## External Power Supply

The XG3 may be powered by an external 11 to 14 VDC supply capable of supplying at least 60 mA. The XGC power jack accepts a 2.1 mm coaxial connector: negative to the outer ring and positive to the inner terminal (see Figure 2). The battery may be left in the XG3. No current drain from the battery occurs as long as external power is applied.




Figure 2. External Power Connector

## Basic Operation

### CAUTION

When connecting the XG3 to the output of a transceiver or transmitter, be sure to prevent accidentally keying the transmitter even for brief periods. The XG3 has protection against low-level signals applied to the RF OUT connector, but transmitting into the XG3 even for a brief period will destroy internal components. Such damage is not covered under the Elecraft warranty (see *Reverse Power* on pg 14).

The XG3 may be operated as an independent, stand-alone RF signal generator using the four red switches on the front. Tap (press briefly) the On/Off switch to turn the unit on. One of the Band LEDs and one of the Level LEDs will light. To turn the XG3 off, hold (press for more than 1 second) the On/Off switch. To conserve the battery, the XG3 will turn itself off after 10 minutes without any user input.

 **Note:** If you hold the On/Off switch down more than 10 seconds, the XG3 will go into “boot loader” mode shown by a blinking 0 dBm LED. To restore normal operation, disconnect external power (if used), then remove and reinstall the battery.

Select the band desired using the Band + and – switches. The XG3 is pre-programmed with a test frequency in each band as shown below. You can change these frequencies using a computer as described below under *Computer Controlled Operation*.

| BAND | FREQ (MHz) |
|------|------------|
| 160  | 1.820000   |
| 80   | 3.520000   |
| 60   | 5.330500   |
| 40   | 7.020000   |

| BAND | FREQ (MHz) |
|------|------------|
| 30   | 10.120000  |
| 20   | 14.020000  |
| 17   | 18.120000  |
| 15   | 21.020000  |

| BAND | FREQ (MHz) |
|------|------------|
| 12   | 24.900000  |
| 10   | 28.020000  |
| 6    | 50.120000  |
| 2    | 144.220000 |

The output signal level is shown by the LEDs next to the Level switch. Tap the switch to cycle through the three lower output levels. The highest signal level, 0 dBm (1 milliwatt), is selected by holding the Level switch for at least 1 second. An external power supply (pg 7) is recommended if you need to operate the XG3 at the 0 dBm output level for an extended period of time.

## Computer Controlled Operation

A personal computer will allow you to change the test frequencies and customize other parameters. The XG3 may be operated from the computer interface or you may program your XG3 and then use it as a stand-alone RF signal generator with the parameters you chose.

A serial cable is provided with your XG3. You will need:

- A computer with an RS232 port or a USB interface and a USB to RS232 converter such as the KUSB universal serial bus adapter available from Elecraft.
- The XG3 Utility program for your computer. It may be downloaded free from [www.elecraft.com](http://www.elecraft.com).



### Launch the XG3 Utility Program:

- Connect your XG3 to your computer using the RS232 interface. Be sure the interface cable connector is inserted all the way into the jack on the top of the XG3.
- Launch the XG3 utility program and turn the XG3 on.
- Click on the utility program PORT tab and select the active port. Confirm that the computer is communicating with the XG3 by clicking on TEST COMMUNICATIONS. A pop-up window should open reporting the XG3 firmware version and the RS232 speed if you have selected the correct serial port and the cables are properly connected.

### Operating and Programming Your XG3

- Click on the utility program OPERATE tab. All of the frequencies shown on this page are in MHz and the least significant digit shown is Hz.
- The CURRENT FREQUENCY (MHz) shows the current frequency reported by the XG3.
- To the right is STEP SIZE. This is the amount by which the XG3's frequency will be moved if you click the up and down arrows next to the CURRENT FREQUENCY window. You can edit this value as desired.
- You can change the frequency to any value from 1.500000 MHz to 1400.000000 MHz by entering it in the CURRENT FREQUENCY window and then pressing Enter on your computer keyboard to transfer the frequency data to the XG3. You don't need to enter all the zeros, just the significant places. The utility program fills in the remaining zeros when you leave that window.



If the utility program stops allowing you to make changes, check the XG3. It turns off automatically after a period of time (the default is 10 minutes) unless one of its front panel switches has been pressed. If needed, simply turn the XG3 on again to continue.

- In the Frequency Memories area, clicking on the button next to a band will transfer the frequency shown on the button to the XG3.
- Click on Edit to change the frequency associated with each band. An Edit Memory Frequencies window will open. Type in the desired frequency for each band. You can enter any frequency between 1.500000 and 1400.000000 MHz for any band position. That is, you can assign 900.000000 MHz to the 80 meter band if you wish. The band wavelength numbers (e.g. 160, 80, 60, 40, etc.) are there to help you remember which frequency is associated with each position when you use the XG3 without the computer.
- Click on OK to accept the new frequencies you have assigned to the band locations. Click on Set All to Factory Default to return them to the default frequencies.


- The Output Level radio buttons allow you to set the output level from the computer instead of using the Level switch on the XG3. The Output Level selections are accurate only for frequencies up to 200 MHz since higher frequencies rely on harmonics of the fundamental RF signal.
- The Enable Output radio button allows you to turn the XG3 RF output off or on. When RF output is disabled, the XG3 is otherwise fully operational and can be programmed.
- You can adjust the time the XG3 will operate without a switch being pressed. The default is 10 minutes. Click on the CONFIGURATION tab, then on OTHER SETTINGS, enter the desired Automatic Power Off time and press Enter to send the new value to the XG3. Do not change the Calibration Factor unless you want to adjust the XG3's factory- set frequency calibration (see pg 11).

## Programmable Sweep Functions

Two programmable functions that sweep the signal across a range of frequencies are provided. Once programmed, they can be initiated by holding the PF1 or PF2 switches on the XG3 or by clicking on the Sweep 1 or Sweep 2 buttons on the XG3 utility OPERATE tab. When a sweep is in progress, one of the band LEDs on the XG3 will blink. The blinking LED will be whichever one was selected last before the sweep was initiated.

Program a sweep as follows:

- With the XG3 connected to a personal computer (see *Computer Controlled Operation* above) and the XG3 Utility program running, click on the OPERATE tab.
- Click on Edit Sweeps to open the Edit Programmable Sweep Memories page.
- Enter the Start Frequency and End Frequency. Note that the starting frequency must be lower than the ending frequency. That is, the frequency always increases during a sweep.
- Enter the Step Frequency. This is the amount the frequency will increment during each step in the sweep.
- Enter the desired Step Time (the time the signal remains at each step before continuing) in milliseconds (1000 ms = 1 second).
- If you want the sweep to repeat, check the Repeat box. The XG3 will sweep to the end frequency and then return to the starting frequency and begin a new sweep.
- Click on APPLY to send the data to the XG3 and leave the window open or OK to send the data to the XG3 and close the window.

 **NOTE: The XG3's frequency steps occur rapidly, without a shaping envelope. This allows very fast sweeps. However, each transition will generate sidebands that will be audible in a receiver and visible on a spectrum analyzer.**

## Programmable Morse and RTTY Sender

The XG3 contains a Morse code and RTTY sender with memory function. The Morse code sender can be adjusted for WPM (words per minute), and the memory can hold up to 60 characters. Meta-characters can be embedded in the memory string and can be used to change the mode to RTTY, introduce pauses, turn the carrier on or off, repeat the entire string and perform other functions. The XG3 will save the prior output state and restore it after sending the sequence. A convenient way to enter serial commands is to use the XG3 Utility's Command Tester (far right tab).

For RTTY, the standard of 170 Hz FSK at 45.45 baud is implemented, with the space frequency 170 Hz below the mark frequency. The mark frequency is the current output frequency of the XG3.

The complete set of Morse Memory meta-characters are listed below:

### Morse Memory Meta-characters

|      |   |   |
|------|---|---|
| {    | - | turn on RTTY mode, characters following will be transmitted in RTTY       |
| }    | - | turn on CW mode, characters following will be transmitted in CW           |
| ~nn  | - | send RTTY diddles (LTRS) for nn seconds (00 to 99) (RTTY only)            |
| \n   | - | send LF (RTTY only)   |
| \r   | - | send CR (RTTY only)   |
| \b   | - | send BELL (RTTY only)   |
| \    | - | sends the character following the '\' without translation. i.e. \\$ or \# |
| [nn  | - | changes wpm to nn (05 to 50) (CW only)                                    |
| ^n   | - | set level to n (0 = 0 dBm, 1 = -33, 2 = -73, 3 = -107)                    |
| :nn  | - | turn carrier on for nn seconds (00 to 99)                                 |
| \$nn | - | pauses for nn seconds (00 to 99)  |
| nn   | - | recall band/memory nn (0 to 11)   |
| #    | - | repeat entire sequence  |
| _    | - | space   |

### Supported Morse Characters

Letters: A-Z

Numbers: 0-9

Punctuation: . / ? @

Special: \* = SK, + = AR, - = BK, \_ = word space

Automatic power down is disabled during Morse memory transmission.

Meta-characters only work with the Morse memory.

All serial commands must be terminated with a semi-colon (;).

**WM[character string.....]**

*programs the Morse/RTTY Memory*

Fills the Morse Memory with the string following the command. Up to 60 characters total may be entered. Entering WM without any arguments displays the current contents.

Send WM,de\_w1aw\_\*;  
XG3: *nothing*  
Send: WM;  
XG3: WM,de\_w1aw\_\*;

**W[character,string,.....]**

*sends the character string or Morse Memory*

The character string will be sent out. If no character string is specified, the contents of the Morse memory will be sent.

Send W,rig\_is\_xg3\_de\_W1AW\_73\_\*;  
XG3: *nothing*  
Send the Morse memory:  
Send: W;  
XG3: *nothing*

**RT,character\_string,....**

*immediately sends the character string using RTTY*

To embed a space, use the ‘\_’ (underscore) character, \n for LF, \r for CR etc.

Send: RT,\r\n\_rig\_is\_xg3\_de\_W1AW\_73;  
XG3: *nothing*

**WP[,wpm]**

*sets/views the Morse word per minute rate (wpm)*

The XG3 can send Morse code at a rate of between roughly 5 and 50 words per minute (wpm).

Send WP,25;  
XG3: *nothing*  
Send: WP;  
XG3: WP,25;

**PF,01[,mode]**

*sets/views the programmable function mode*

PF1 can run either a programmed sweep (mode=00) or send the Morse code memory (mode=01).

Set PF1 to send the Morse memory

Send: PF,01,01;  
XG3: *nothing*

Send PF,01;  
XG3: PF,01,01;

### **Morse/RTTY Memory Examples**

Use the XG3 Utility's Command Tester (far right tab) to enter these commands:

**WM,^0de\_w1aw:10^1:10^2:10\*\$60#;**

Changes the level to 0 dBm, then sends 'de w1aw', sends carrier at 0 dBm for 10 seconds, then changes the level to -33 dBm, sends carrier for 10 seconds, changes level to -73 dBm, sends carrier for 10 seconds, sends SK, pauses silent for 60 seconds and repeats indefinitely.

**WM,{RYRYRYRYRYRY~05#;**

Changes to RTTY output mode, sends RY 6 times, then sends diddles for 5 seconds and repeats indefinitely.

**WM,{\n\rRIG\_IS\_XG3\$03}de\_w1aw#;**

Changes to RTTY and sends LF,CR then "RIG\_IS\_XG3", then waits 3 seconds, changes to CW and sends "de w1aw" and then repeats.

**WM,{QTH\_IS\_APTOS\_CA\#95001\_#;**

Here is an example of using the '\` character to embed a # in the message, while the # on the end signals repeat message.

**WM,[13de\_w1aw:03[20de\_w1aw:03[30de\_w1aw:03[40de\_w1aw:03#;**

Changes WPM to 13 and sends 'de w1aw' followed by 5 seconds of carrier, then changes to 20 wpm and sends the same message, then 5 seconds of carrier, then changes to 30 wpm, ..... then 40 wpm.

**Set up the PF1 key for Morse memory sending:**

**PF,01,01;**            configure PF1 to send Morse memory.

**To play the memory, either hold down the Band+/PF1 key or send S,01; over the serial port.**

## Calibrating the XG3's Output Frequency

The XG3 is supplied factory calibrated. If desired, you can adjust the calibration to match your frequency standard if you find a discrepancy. Note that although the XG3 uses a crystal reference oscillator, there will be some drift with changes in temperature. Recommend that you perform the calibration at 10 MHz or an even multiple of 10 MHz for best accuracy.

- With the XG3 connected to a personal computer (see *Computer Controlled Operation* above) and the XG3 Utility program running, set up your XG3 to measure the frequency of your standard.
- Click on the CONFIGURATION tab and then click on the OTHER SETTINGS to open the EDIT OTHER SETTINGS window. The CALIBRATION FACTOR value shown is the correction to calibrate the XG3 frequency. Recommend you note the factory set value shown now in case you want to return to it. Note there may be a minus (–) sign ahead of the numerical value. A minus value decreases the reference while a positive value increases it.
- Enter a new CALIBRATION FACTOR and click on APPLY send the value to the XG3. Repeat this process until the XG3 output is on the correct frequency.

## Reverse Power

Never apply RF power, a DC or an AC voltage to the XG3 RF OUT.

If you are working with a transmitter or transceiver, disable the transmitter (turn the power to minimum, disconnect any microphone or key or, if available, put the transceiver in a test or standby mode so it is disabled.) Transmitting into your XG3, even briefly, will damage it. Such damage is not covered under the Elecraft warranty.

If connecting the XG3 to circuits where voltages are present, use a blocking capacitor to keep those voltages from reaching the XG3.

If you accidentally apply power or voltages to the XG3 RF OUT that only burns the protective fusible link, you may jumper the link as described in Appendix A.

## Applications

The following are just a few examples of how your XG3 can be used to test and calibrate a receiver. More examples are found throughout the Amateur Radio literature including the ARRL Handbook and others (available from Elecraft at [www.elecraft.com](http://www.elecraft.com)).

- Receiver testing
- Receiver alignment
- RF signal tracing and troubleshooting
- VFO/LO for experimentation

## Receiver Testing

You will need a way to connect your XG3 to the receiver to be tested. Most receivers have either a BNC or SO239 (UHF) antenna jack. A male-to-male BNC adapter is available to connect the XG3 directly to a BNC jack on the receiver (order BNC-MM from the Elecraft web site).

### Measuring Receiver Sensitivity

This procedure measures absolute receiver sensitivity, allowing you to confirm that your receiver is operating as expected or for comparing receivers. If you make these measurements in advance, you can easily check to see if your receiver performance has degraded over time, especially after exposure to lightning or other traumatic events.

You will need a DMM capable of measuring the AC audio output level of your receiver at the speaker or headphones jack. A true RMS meter is ideal, but a common DMM will result in only a small error of about 1 dB. (If you have an Elecraft K3, a true RMS audio voltmeter is built in. See *VFO B Alternate Displays* in your K3 Owner's Manual.) Also, you'll need to do some logarithmic calculations. You can use any calculator with a "log" function key including the scientific calculator built into most Windows operating systems under "Accessories" (after opening the basic calculator you may have to select "View/Scientific").

The procedure is done in two parts. First you'll collect data from the receiver using your XG3. Secondly you'll calculate the Signal-to-Noise plus Noise (S+N/N ratio) with a standard 1  $\mu$ V test signal and estimate the Minimum Discernable Signal (MDS).

Collect the data as follows:

1. If working with a transceiver that has a built-in antenna tuner (ATU), put it in bypass so it is no longer in the circuit.
2. Connect the XG3 to the receiver's antenna jack and turn the receiver on.
3. Set the receiver controls as follows:

|                |   |
|----------------|---|
| AGC Off        | If possible.  |
| RF Gain        | Maximum (if adjustable).  |
| Attenuator Off | If present.   |
| Preamp On      | If present.   |
| CW Mode        |   |
| I.F. Bandwidth | 500 Hz, if adjustable. This is the standard for lab receiver tests. |
| Audio Filter   | If present, set for widest possible audio bandwidth.                |
4. Connect your DMM across the loudspeaker terminals or, if necessary, across the headphones jack. If you use the headphones jack, do not plug headphones in at the same time to avoid reducing the available audio voltage.
5. Turn on the DMM and set it to read AC voltage on a low range (probably 2 to 3 VAC maximum).

6. Turn on the XG3 and tune the receiver to its frequency. Watching your DMM or the receiver S-meter, peak the XG3 signal in the receiver passband. Note: If the peak response does not occur at the expected beat frequency tone, the receiver's I.F. filter may need to be re-aligned. If the filter peak does not correspond with the expected beat note, the sensitivity will suffer.
7. Set the XG3 output level to -107 dBm 1  $\mu$ V.
8. Set the receiver audio gain to maximum. If this results in enough gain that it may damage the loudspeaker or that causes distortion, reduce the gain setting as needed, but note the setting so you can repeat it to properly compare future tests on the same receiver.
9. Note the DMM's reading: \_\_\_\_\_ VAC. This is the signal + noise (S+N) reading.
10. Turn the XG3 off and note the new reading without touching any other controls: \_\_\_\_\_ VAC. This is the noise (N) reading.

Perform the Calculations as follows:

1. Divide the S+N by N; call the result R.
2. Take the base-10 logarithm of R ("log" key on most calculators).
3. Multiply the result by 20 to obtain the S+N/N ratio in dB for a 1 microvolt signal.
4. If the S+N/N ratio is greater than 10 dB, you can approximate the minimum discernable signal (MDS) by subtracting the S+N/N ratio from -107 dBm.

Sample Calculation:

Assume the DMM reads 1.0 VAC with the XG3 supplying 1  $\mu$ V and 0.030 VAC with no signal applied.

$$1 / 0.03 = 33$$

$$\text{Log } 33 = 1.52$$

$$1.52 \times 20 = 30 \text{ dB This is the Signal+Noise/Noise (S+N/N) Ratio.}$$

Since the S+N/N ratio is greater than 10 dB , the minimum discernable signal is about:

$$-30-107 = -137 \text{ dBm}$$

### **S-Meter Calibration**

Many S-meter readings vary according to whether a preamp or attenuator is switched in (e.g. the Elecraft K2), while others compensate for the preamp and attenuator to produce consistent signal readings (e.g. Elecraft K3 when S-meter is set for absolute mode). A long-accepted standard is for a 50  $\mu$ V signal to produce an S-9 reading on the S-meter. However, S-meter calibration varies from manufacturer to manufacturer. If in doubt consult your receiver owner's manual. You'll also need to consult your owner's manual for how to adjust your receiver to produce a specific S-meter reading.

1. Set up your XG3 and receiver as shown in steps 1, 2 and 3 under *Measuring Receiver Sensitivity* on pg 15 except leave (or turn) the receiver AGC on.



2. Switch the XG3 on and select the -73 dBm 50  $\mu$ V output level.
3. Tune the receiver for maximum indication on the S-meter and note the reading.
4. Consult your owner's manual and make adjustments as needed to correct the S-meter reading, if needed.

### **Receiver Alignment**

The XG3 is ideal for use in aligning band-pass filters, I.F. strips, etc. For example, some Elecraft transceiver kits suggest using a signal generator for initial alignment of the filters in receive mode on each band. Note: Do not attempt to adjust the band pass filters on the Elecraft K3. These are carefully adjusted at the factory for optimal flatness across each band.

### **RF Signal Tracing and Troubleshooting**

The XG3 can be used to inject a signal into an RF or I.F. strip for troubleshooting or measurement purposes. For example, the XG3's 0-dBm output level can substitute for the crystal oscillator described in several Elecraft transceiver manuals. The XG3 is far more versatile, as it can be used on any band and can be programmed for use on either the RF band or at the I.F. (intermediate frequency).

**CAUTION:** Use a blocking capacitor to isolate the XG3 from any circuits carrying voltage. Avoid injecting large RF signals into the XG3. See *Reverse Power* on pg 14.

When using the XG3 for low-level signal injection, you may want to couple it to the circuit through a resistor or small-value capacitor to lower the injection level, provide isolation or impedance matching. However, for many applications one of the four output levels provided will suffice.

### **VFO/LO for Experimentation**

The XG3 can be used as a VFO or local oscillator for many receiver and transmitter projects. The XG3 utility program can be used to move the frequency up or down in discrete steps or you can write your own XG3 control program (see XG3 Remote Control Commands on pg 18).

If you need a sine wave rather than a square wave for injection at a particular stage, you can follow the XG3's output with a low-pass filter. See the *ARRL Handbook* for suggested filter components. Many mixer designs can use a square wave, however.

The XG3 could be used as a remote-controlled CW transmitter with an appropriate software application. In this case it should be followed by a driver stage with shaped keying, a power amplifier, and suitable harmonic filters.


Many other applications are possible. The XG3 could form the basis for a home-made antenna impedance analyzer, LC meter, etc.

## Updating Firmware

From time to time updated and improved firmware may become available for the XG3. The latest firmware may be downloaded from Elecraft and installed using the computer interface and the XG3Utility program.

Connect your XG3 to your computer and launch the XG3Utility program (see *Computer Controlled Operation*, page 8). Updated firmware may be obtained in two ways.

1. Click on Firmware tab and then the Click on Copy Firmware Files from Elecraft to download the latest production released firmware or,
2. Download the new file from the Elecraft web site manually and place it in a local folder, then click on Browse... to locate the folder on your computer. This is the way to access the latest Beta firmware available from Elecraft.

 If the XG3 does not respond properly to the firmware download, be sure the interface cable connector is inserted all the way into the jack on the top of the XG3.

To install new firmware in your XG3, click on the utility Send Firmware to the XG3 button to start the transfer and follow the on-screen instructions. The 0 dBm LED will flash rapidly in bursts while the firmware is being transferred. The XG3 will return to its normal power on state when the transfer is completed.

## XG3 Remote Control Commands

You can control your XG3 using the XG3 Utility Program or, if you wish, you can write your own software to produce a custom control program. The following is a list of the control commands:

### Serial Port Settings

9600 bits/s 8 data bits, 1 stop bit, no parity.

### Boot

- During a normal boot, the XG3 serial port will not display anything; however it will echo the ‘;’ character.

### Transmission Protocol

- Commands can be terminated by either a semicolon ‘;’ or CR.
- If the command is entered so that it will return a value, only then will the command be echoed back along with the displayed value. *See examples below:*

Examples:

Host sends: Y;

XG3 sends: *nothing*

Host sends: V;  
XG3 sends: V,1.00;

Host sends: F;  
XG3 sends: F,00014025000;

Host sends: M,01,00003850000;  
XG3 sends: *nothing*

Host sends: M,01;  
XG3 sends: M,01,00003850000;

### **Command Entry, Arguments and Device Limits**

- Commands consist of a single letter and may be followed by additional arguments.
- Commands and arguments may be entered in either upper or lower case.
- Arguments are delimited with a space or comma (,).
- Arguments follow the command after a comma (,). *See examples above.*
- Frequencies are entered and displayed using an 11 digit representation, pre-pended with zeros. (0). Example: 14.025 MHz would be displayed/entered as: 00014025000
- The setter/getter convention is used.
- If an unknown command is entered, the XG3 will simply ignore the command and do nothing.
- If a command is ill formed, the XG3 will ignore the command and do nothing.
- There are currently 12 frequency memory locations, 0 to 11. Location 0 is associated with the 160M LED, and location 11 is associated with the 2M LED. (*See Y command for list.*)
- Currently the XG3 has a fundamental frequency range of between 1.5 and 200 MHz. Frequencies above 200 MHz may be generated by simply entering them into the XG3. The XG3 will automatically compute the necessary frequency that will generate the 3<sup>rd</sup>, 5<sup>th</sup> or 7<sup>th</sup> harmonic needed. In other words, you can simply send whatever frequency you want (between 1.5 and 1400 MHz) and the XG3 will figure it out. Frequencies that rely on the 3<sup>rd</sup>, 5<sup>th</sup> and 7<sup>th</sup> harmonics will have substantially lower amplitudes than what is indicated.
- Since the XG3 generates a square wave output, strong odd harmonics are present on the output. This can be used as a feature as frequencies outside usable range can be generated. For example the 70cm band is a 3rd harmonic of the 2m band (see above, regarding harmonics).
- Four (4) output levels are available: 03 = -107, 02 = -74, 01 = -33 and 0 = 0 dBm. *See Level command.*
- Backspaces and other control characters are not supported.

- Semicolons are synonymous with CR except that they are echoed.
- Using the ‘;’ command as means of handshaking is highly recommended. An extra ‘;’ can be sent with each command. The host then waits for the echo of the second ‘;’ which signals that the previous command has been executed.

## Command Reference

### **B[, +/-offset]**

*Set/display the current calibration factor.*

Send: B,-587;                *Sets the current calibration factor to -587*

XG3: *nothing*

Send: B;

XG3: B,-587;

Sets/views the current calibration factor. The calibration factor will ‘adjust’ the 10 MHz reference oscillator. Valid range is +/- 32767. Each time this command executes it will automatically recompute and re-output the current frequency.

### **C[,location#]**

*Call memory.*

Send: C,01;

XG3: *nothing*

Send: C;

XG3: C,01;

Recalls the passed frequency memory location. The output frequency will change and the associated location LED will be illuminated. Valid locations are 00 - 11, as there are currently 12 bands/memories in the XG3. If no location is given, the current active band location is displayed.

### **F[,frequency]**

*Set/display the current frequency.*

Send: F,00014025000;

XG3: *nothing*

Send: F;

XG3: F,00014025000;

Sets the current output frequency or views the frequency currently being generated. This command does not affect the stored memory locations. If a frequency lower than the minimum supported frequency (1.50 MHz) is entered, the XG3 will use the minimum supported frequency of 1.50 MHz. If a frequency greater than 1400 MHz is entered, the XG3 will use the maximum supported frequency of 1400 MHz.

**G[,led brightness level]**

*Set/display the current LED brightness level.*

Send: G,02;

XG3: nothing

Send: G;

XG3: G,02;

Sets the LED brightness or views the current setting. Valid brightness settings are 0 (brightest), 1, 2, 3 (dimmet).

**H**

?

*Display help screen.*

Displays the list of currently supported commands. *Note: additional commands may be added at a future date.*

**I**

*Display current informational status.*

Send: I;

XG3: I,0014600000,02,11,00,01,00,00,00;

| Position | Description  |
|----------|--|
| 0        | Echoed 'I' command   |
| 1        | Current frequency in MHz, represented using 11 digits with leading zeros |
| 2        | Current Level: 00 = 0dBm, 01 = -33, 02 = -73, 03 = -107                  |
| 3        | Current band memory: 00 - 11   |
| 4        | Output: 01 = on, 00 = off  |
| 5        | PLL Lock: 01 = locked, 00 = unlocked                                     |
| 6-8      | Future use   |

**L[,level#]**

*Set current output level or display current output level.*

Valid levels are 0 ,1,2 or 3. 0 = 0 dBm, 1 = -33 dBm, 2 = -73 dBm, 3 = -107 dBm

Send: L,02; *sets output level to -73dBm*

XG3: nothing

Send L;

XG3: L,02;

**M,location#[,frequency]**

*Program or view the specified memory location.*

Valid memory locations are 0 - 11. Memory location# is a required argument. If no frequency argument is given, the contents of that memory location will be displayed. Frequencies are entered

using an 11 digit format, with pre-pended zeros. If a frequency lower than the minimum supported frequency (1.50 MHz) is entered, the XG3 will use the minimum supported frequency of 1.50 MHz. If a frequency greater than 1400 MHz is entered, the XG3 will use the maximum supported frequency of 1400 MHz. Programming a memory location does not affect the current output frequency. *See C(all) command.*

Send: M,00,00001850000; *programs 1.850 MHz into location 0, 160M LED*

XG3: *nothing*

Send M,00;

XG3: M,00,0001850000;

#### **O[,control]**

*Turn the output on or off or display the current output state.*

Turns on or off the output of the XG3 independent of the level. Pass 01 to turn output on, or 00 to turn it off. If no argument is given, the current state will be shown. Note: the XG3 output is turned on by default.

Send: O,00; *turns output off*

XG3: *nothing*

Send: O;

XG3: O,00;

#### **P[,minutes]**

*Set or view the auto-power off timer value.*

Allows setting or viewing the auto-power off timer. Setting the power off timer to 0 disables auto-power off. Valid range is 0 to 9999

Send: P,10; *sets a 10 minute auto-power off*

XG3: *nothing*

Send: P;

XG3: P,0010;

#### **Q,loc#[,start frequency, end frequency, step frequency step time, repeat]**

*Program or view the specified sweep memory location*

Valid sweep memory locations are 1 or 2. Location# is a required argument. If no other arguments are given, the contents of that sweep memory are displayed. Start, end and step frequencies are entered using an 11 digit format, with leading zeros. Programming a sweep memory location does not affect the current output frequency. *See S,01 & S,02 commands.*

Start, End, Step Frequency: any frequency from 1.5 to 1400 MHz

Step Time: 1 to 65535 ms (0 = 65536)

Repeat: 01 or 00

Program sweep memory 01, start at 7.020 MHz, end at 7.120 MHz, step at 100 Hz, 10 ms per step, no repeat

Send: Q,01,00007020000,00007120000,00000000100,00010,00;

XG3: *nothing*

Program sweep memory 02, start: 145 MHz, end: 146 MHz, step: 20 KHz, 5 seconds per step, repeat

Send: Q,02,00145000000,00146000000,00000020000,05000,01;

XG3: *nothing*

Send Q,01;

XG3: Q,01,00007020000,00007120000,00000000100,00010,00;

### **S,[sweep#]**

*Run programmable sweep 1 or 2*

When the sweep is running, sending any command **except the (I)info command and ‘;’** will terminate the sweep. This allows the Info command to be used to determine the current frequency during the sweep. *See Q command for programming the 2 sweep memories.*

Send: S,01;

XG3: *nothing*

### **T[,control]**

*Turn on/off tech mode.*

Enables/disables tech mode. Certain commands are disabled by default. Enabling tech mode allows access to these commands. Tech mode is disabled by default and is not saved during a power down. (see tech mode section at the end of this document)

Send: T,01; *turns tech mode on*

XG3: *nothing*

Send T;

XG3: T,01;

### **V**

*Display current version*

Send: V;

XG3: V,1.00;

### **X**

*Power off*

Turns the power off on the unit.

Once this command is executed, the power to the unit will be turned off.

Enter: X;

Displays: *nothing* (power turns off)

**Y**

*Set factory defaults*

Fills the frequency memory locations 0 - 11 with the factory default values:

|      |        |             |             |
|------|--------|-------------|-------------|
| 160m | LED 0  | 00001820000 | 1.820 MHz   |
| 80m  | LED 1  | 00003520000 | 3.520 MHz   |
| 60m  | LED 2  | 00005330500 | 5.3305 MHz  |
| 40m  | LED 3  | 00007020000 | 7.020 MHz   |
| 30m  | LED 4  | 00010120000 | 10.120 MHz  |
| 20m  | LED 5  | 00014020000 | 14.020 MHz  |
| 17m  | LED 6  | 00018120000 | 18.120 MHz  |
| 15m  | LED 7  | 00021020000 | 21.020 MHz  |
| 12m  | LED 8  | 00024900000 | 24.900 MHz  |
| 10m  | LED 9  | 00028020000 | 28.020 MHz  |
| 6m   | LED 10 | 00050120000 | 50.120 MHz  |
| 2m   | LED 11 | 00144220000 | 144.220 MHz |

PF1 sweep memory 1: 7.020 to 7.120 MHz, 100 Hz step, 20 ms per step, no repeat

PF2 sweep memory 2: 144 to 148 MHz, 10000 Hz Step, 1000 ms per step, repeat

Send: Y;

XG3: *nothing*





## **N**

### *Read Keyboard.*

Waits for a key to be pressed on the keyboard and then returns the key code. Note: during this command keyboard entry and operation of the unit will be suspended. Returned key codes are: 001 = On/Off Key, 002 = Level Key, 003 = Band -, 004 = Band +. When the N command is sent, the XG3 will not display anything until a key is pressed.

Send:        N;

XG3:        *nothing*

XG3 after a key is pressed: *N,001;*

*(normal operation resumes)*

## **Z**

Internal Use Only

## **U**

Internal Use Only

## Circuit Description

Refer to the schematic diagram on page 28. The RF signal is generated by U1, a CS2100 fractional N clock synthesizer and multiplier that synthesizes the desired output frequency from a stable, crystal-controlled 10 MHz clock.

The four selectable signal output levels from the XG3 are provided by six pHEMT, GaAs FET IC switches (U3, U5, U7, U8, U10 and U11). Each switch passes the signal between pin 5 and pin 1 or between pin 5 and pin 3. The U3 and U5 switch pair directs the RF signal through either a -13 dB attenuator formed by R10, R11 and R12 or through the MAR6 wideband amplifier that provides +20 dB gain. The U7 and U9 switch pair direct the signal through C21 without attenuation or through a -40 dB attenuator formed by R15, R16, R17, R18 and R19. In the same manner, the U10 and U11 switch pair either pass the signal through C26 without attenuation or through a -34 dB attenuator formed by R20, R21, R22, R23 and R31. The MAR6 amplifier and attenuators are switched into the circuit as needed to produce output levels of 0 dBm, -33 dBm, -73 dBm and -107 dBm. The RF output is protected from moderately excessive levels by D4 and D18.

Power is applied to the MAR6 amplifier only when it is needed to conserve the battery. Q1 is switched on by Q4 only when the signal is routed to the amplifier.

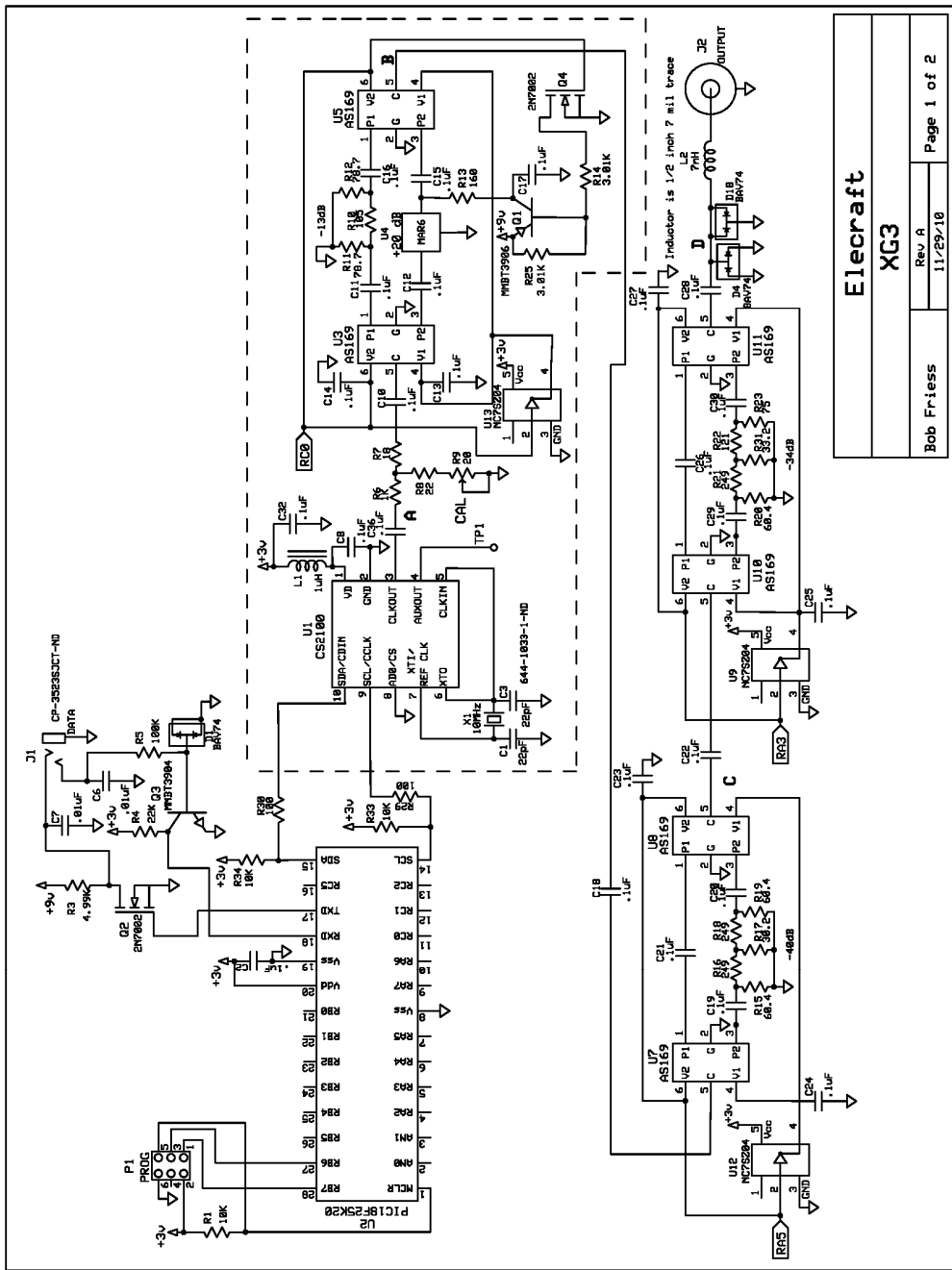
U2 is a flash microcontroller that provides frequency data to U1 and operates the IC switches to provide the requested output level. U13, U12 and U9 are inverters to provide the correct control polarity to the V1 inputs of the IC switches.

Connector P1 is used only by the factory for initial programming of the microcontroller.

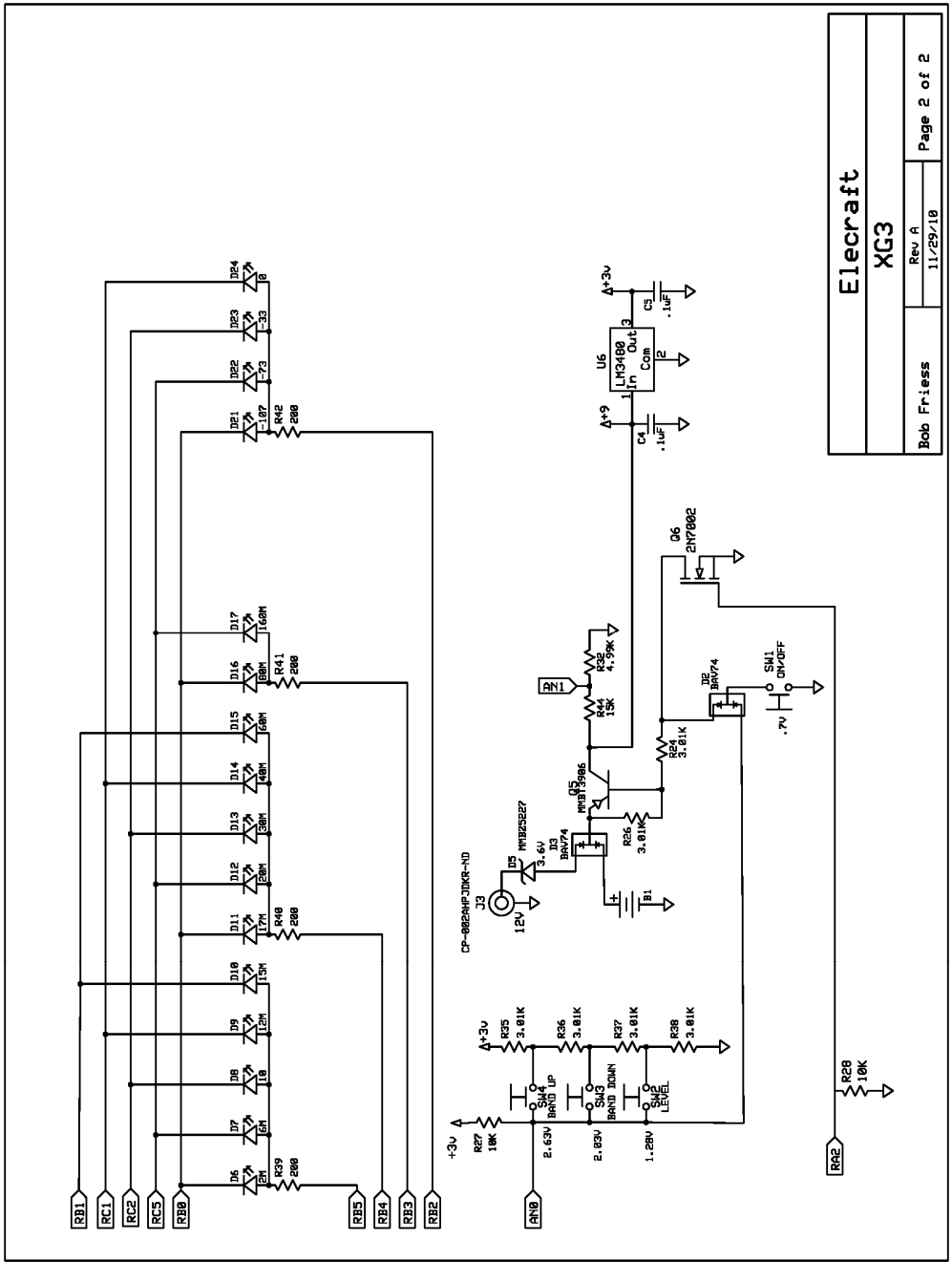
Firmware is input from an RS232 line via J1. Q2 and Q3 convert the RS232 signal levels at J1 to the proper levels for the microcontroller.

The LEDs and supply power inputs are shown on page 29. The Band and Level LEDs are driven directly from the microcontroller outputs shown.

The XG3 may be powered from an external 12V supply or its internal 9V battery. D5 is a 3.6 V Zener diode that drops the nominal 12V supply to about 8.4 VDC. D3 provides reverse voltage protection in case the battery or external supply is connected incorrectly. Q5 and Q6 and SW1 control power the XG3. U6 is a voltage regulator that provides the 3VDC needed by the microcontroller.



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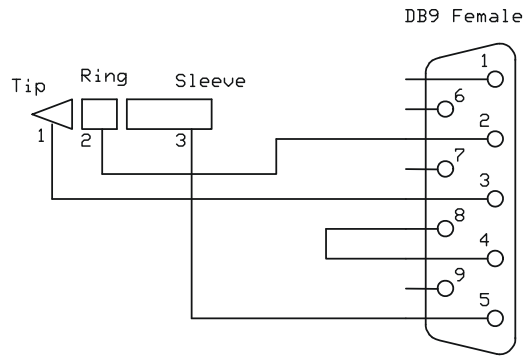
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## Serial Interface Cable Schematic

The serial interface cable (Elecrafit part number E850369) is provided with your XG3.



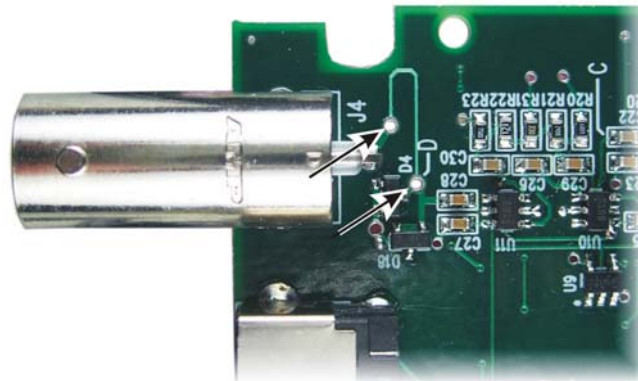
## APPENDIX A – JUMPERING THE FUSIBLE TRACE

The XG3 circuit board contains a fusible trace that may burn open to break the connection to the RF OUT connector, thereby protecting the rest of the XG3 components if you accidentally apply voltage or RF power to the XG3 RF OUT connector. Whether the trace will open before other components in the XG3 are damaged depends on many variables, including the amount of RF power or voltage applied.

You can check and jumper the fusible trace if it has been burned open as follows. You will need a Number 0 Phillips screwdriver, an ESD-safe soldering station, small diameter rosin core solder, diagonal cutters and a short length of thin wire.

**CAUTION!** Use an ESD-safe wrist strap or touch a bare metal ground before touching the XG3 pc board. A static dissipating mat is recommended.

1. Remove the battery cover and battery.
2. Remove the four screws visible on the back cover: two are normally hidden by the battery cover.
3. Lift the rear cover off of the XG3, taking care not to break the two wires leading to the battery holder clips.
4. Locate the solder pads at each end of the thin trace near the RF OUT connector (J4 on the pc board) shown in Figure 3.
5. It is not always obvious that the trace has opened. Use your DMM to determine whether you have continuity between the pads at each end of the trace.
6. If the trace is open, solder a short jumper wire between the pads at the ends of the trace.
7. Reassemble your XG3, taking care to replace the foam pad that holds the pc board in place.



**Figure 3. Fusible Trace Solder Pads.**