

ELECRAFT KDSP2

INTERNAL DSP FILTER and REAL-TIME CLOCK

Assembly and Operating Instructions

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Introduction

The KDSP2 DSP Filter is designed specifically for internal operation with an Elecraft K2 transceiver.

For the CW operator

The KDSP2 provides filter bandwidths from 50 to 800 Hz, with center frequencies from 400 Hz to 1,300 Hz, to help eliminate nearby interfering signals. The filters may be easily adjusted from the front panel, and up to four (4) filters may be selected by the AFIL button.

Noise reduction helps reduce QRN, and may be used with any of the CW filters.

For the SSB operator

A tunable bandpass filter is settable from the front panel, offering low-frequency cutoff (high pass filter function) from a few tens of Hz to 600 Hz, and a high frequency cutoff (low pass filter function) from 1.6 kHz to 3.0 kHz.

In addition to the tunable bandpass filter, an automatic notch filter quickly locates and suppresses interfering carriers, such as those caused by other stations tuning up nearby. Noise reduction is also available and may be used in conjunction with the bandpass and autonotch filters.

For the Data operator

Bandpass filters tuned for common HF data modes, such as RTTY, Packet and PSK31 are provided. Center frequencies vary from 1 to 2.5 kHz, and widths from 50 Hz to 1 kHz.

Noise reduction and notch filters are not available in data modes as phase distortion may result in poor copy on an otherwise clean-sounding signal.

Convenience Features

All filters are adjustable from the front panel. Up to four (4) filters per mode (CW/SSB/DATA) may be memorized. The filters are then selected by simply pressing the AFIL button. A front-panel selectable bypass mode is available which significantly reduces current consumption.

Real-Time Clock

The real-time clock displays 24-hour time, as well as date. You'll find the clock convenient for field operation. Time can be easily set from the front panel of the K2. The on-board lithium cell will power the clock for several years.

Flash-based Software

The KDSP2 functions are fully defined in software. The DSPx Module is Flash-based. The microcontroller on the interface card is also Flash-based.

Specifications

Band-pass filters	Flatness: better than 1 dB, Attenuation: better than -50 dB Center frequency adjustable 400 Hz to 1 kHz in 50 Hz steps, and from 1 kHz to 2500 Hz in 100 Hz steps, mode dependent . Width adjustable 50 Hz to 3 kHz in 50 Hz or 100 Hz steps, mode dependent. Normal and "soft" filters available in CW mode.
Automatic Notch	Adaptive, with coefficient adjustment by operator.
Noise Reduction	Adaptive, with level and coefficient adjustment by operator
Clock Accuracy	+/- 20 ppm (+/- 1.7 seconds per day) at 25 degrees C
Date Formats	MM-DD-YY or DD-MM-YY; handles all calendar months and leap years
Current Drain	Approximately 60 mA active, 10 mA standby
Size	3.12" (L) x 1.2" (D) x 2.1" (H) (8.1 x 3.1 x 5.2 cm)



NOTE: Some parts in this kit can be damaged by static discharge. Before handling any transistors or ICs, put on an anti-static wrist strap, or touch a grounded, unpainted metal surface.

Firmware Requirements

The main microcontroller firmware in the K2 must be version **2.01** or later. If you have an earlier version, contact Elecraft for an update. You can install the firmware upgrade during assembly of the KDSP2, but we recommend you install it ahead of time and verify correct operation of your K2 **before** you build and install the KDSP2.

The firmware resides in the main microcontroller (U6) of the K2, on the K2 Control Board. You may check the firmware revision by holding any button when powering up your K2. When you release the button, the firmware revision will be briefly shown on the left side of the display.

Assembly

Parts Inventory

Please check the enclosed parts with this list. Check off each item in the space provided. The number following the check-off space is the quantity required. The part numbers referenced are not necessarily marked on the parts. Rather, they are provided for reference when ordering replacement parts.

Parts Sorting

As you sort the parts, you may find it convenient to place them in a compartmented container for ready access. Be careful of static electricity issues if you use an insulated container to hold the parts. Use of tape to hold sorted parts is discouraged, as there is danger of static buildup as well as contamination of the leads from adhesive residue.



NOTE: do not put ICs or any semiconductor component in a Styrofoam or other plastic container, or damage from static may occur. Leave such parts in the envelope or foam provided until they are called out in the assembly instructions.

Resistors

¼ watt, 5%, carbon film

OK	Qty	Reference	Value	Color Code	Part Number
	3	R6-8	120 ohm	brown-red-brown-gold	E500022
	2	R11, R13	220 ohm	red-red-brown-gold	E500002
	2	R17, R18	470 ohm	yellow-violet-brown-gold	E500003
	2	R15, R16	2.2K	red-red-red-gold	E500107
	7	R1-5, R10, R19	10K	brown-black-orange-gold	E500015
	1	R9	47K	yellow-violet -orange-gold	E500067
	1	R14	1M	brown-black-green-gold	E500024

2 watt, 5%, metal oxide

OK	Qty	Reference	Value	Marking	Part Number
	1	R12	43 ohm	430J or yellow-orange-black-gold	E500108

Capacitors

OK	Qty	Reference	Value	Type	Marking	Part Number
	1	C6	33 pF	Ceramic Monolithic	33 or 330	E530144
	1	C12	470 pF	Ceramic Monolithic	471	E530080
	3	C7, C9, C13	0.01 uF	Ceramic Monolithic	103	E530019
	4	C3,-5, C8	0.1 uF	Ceramic Monolithic	104	E530020
	2	C11, C15	0.33 uF	Film	330n or 334	E530145
	2	C10, C14	10 uF	Electrolytic, low profile	10 uF	E530045
	2	C1, C16	10 uF	Electrolytic	10 uF	E530142
	1	C2	22 uF	Electrolytic	22 uF	E530143

Connectors

OK	Qty	Reference	Value	Description	Part Number
	1	P2	3-pin	Male Header, 1x3, 0.025" square post	E620053
	1	P1	5-pin	Male Header, 1x5, 0.025" square post	E620052
	1	Ctrl-J2	3-pin	Female Header, 1x3	E620009
	1	Ctrl-J1	5-pin	Female Header, 1x5	E620051
	1	J2	12-pin	Female Header, 1x12	E620008
	1	J1	20-pin	Female Header, 2x10	E620038
	1		28-pin	IC Socket, 0.300" wide	E620011
	1		3-pin	Lithium Cell Holder	E980040

Transistors

OK	Qty	Reference	Value	Marking	Part Number
	4	Q1, Q3-4, Q7	2N3904	2222, 3904	E580017
	1	Q2	2N3906	2907, 3906	E580000
	2	Q5-6	J309	J309	E580009

Diodes

OK	Qty	Reference	Value	Marking	Part Number
	1	LED1	LED, Red	None	E570012
	4	D1-4	1N5711 or SD101A	1N5711, SD101A	E560004
	2	D5-6	1N4148	1N4148	E560002

Integrated Circuits

OK	Qty	Reference	Value	Marking	Part Number
	1	U1	ATmega8L	ATMEGA8L	E610015
	1	U2	LM340T-5.0	LM340, 7805	E600024
	1	U3	NJU6355ED	NJU6355	E600038

Note that U3 is pre-programmed with the KDSP2 application code.

Hardware

OK	Qty	Description	Part Number
	1	4-40x1/4" Philips pan head screw	E700005
	1	4-40x0.5" Aluminum hex male-female threaded spacer	E700057

Miscellaneous

OK	Qty	Reference	Value	Description	Part Number
	1	Y1	32.768 kHz	Crystal, Cylindrical	E660015
	1	Z1	4 MHz	Ceramic Resonator, 3-pin	E660001
	1	BT1	3V	CR-2032 Lithium Cell	E980039
	1		DSPx	Assembled DSP Module	DSPX
	1		DSP2	Printed Circuit Board	E100179
	1		KDSP2	Instruction Manual	E740050
	1			1/2 x 3/8 x 2 Gray Foam	E980070
	1			3/8 x3/16 x 2 Black Foam	E980069

Installing Components

Please install the parts in the order shown. After you mount a part, you may solder it in place. Double check to be sure the part is snug against the printed circuit board (PCB). After soldering, clip the leads close to the PCB surface.

Use a temperature-controlled soldering iron, set between 700 and 735 degrees F (370 to 390 C). Keep the tip clean. Use rosin-core solder. Use of improper flux, or improper cleaning procedures may result in corrosion of the soldered joint. Sometimes this takes days or weeks to appear.



It is important that leads be clipped close to the bottom of the PCB. Use a pair of flush-cutting pliers, or pre-trim the leads before soldering.

As you install the following parts, check the box only **after** you have inspected the solder connection and clipped the leads (unless directed to not clip the leads).

You should pre-bend the leads of resistors close to the body and at right angles. Quarter-watt resistor locations on the PCB have 0.35" centers (9mm).



Near the upper left hand corner of the PCB:

- R1 10K ohm ¼ watt 5% carbon film resistor (brown-black-orange-gold)
- R2 10K ohm ¼ watt 5% carbon film resistor (brown-black-orange-gold)
- R3 10K ohm ¼ watt 5% carbon film resistor (brown-black-orange-gold)
- R4 10K ohm ¼ watt 5% carbon film resistor (brown-black-orange-gold)
- R5 10K ohm ¼ watt 5% carbon film resistor (brown-black-orange-gold)
- R6 120 ohm ¼ watt 5% carbon film resistor (brown-red-brown-gold)
- R7 120 ohm ¼ watt 5% carbon film resistor (brown-red-brown-gold)
- R8 120 ohm ¼ watt 5% carbon film resistor (brown-red-brown-gold)

Careful! Don't confuse the 470 ohm and 47K ohm resistors. The color codes are **very** similar in appearance.

- R9 47K ohm ¼ watt 5% carbon film resistor (yellow-violet-orange-gold)
- R10 10K ohm ¼ watt 5% carbon film resistor (brown-black-orange-gold)

Careful! Don't confuse the 220 ohm and 2.2K ohm resistors. The color codes are **very** similar in appearance.

- R11 220 ohm ¼ watt 5% carbon film resistor (red-red-brown-gold)

Near the lower left hand corner of the PCB:

- R15 2.2K ohm ¼ watt 5% carbon film resistor (red-red-red-gold)

- R16 2.2K ohm ¼ watt 5% carbon film resistor (red-red-red-gold)
- R13 220 ohm ¼ watt 5% carbon film resistor (red-red-brown-gold)
- R14 1M ohm ¼ watt 5% carbon film resistor (brown-black-green-gold)
- R17 470 ohm ¼ watt 5% carbon film resistor (yellow-violet-brown-gold)
- R18 470 ohm ¼ watt 5% carbon film resistor (yellow-violet-brown-gold)
- R19 10K ohm ¼ watt 5% carbon film resistor (brown-black-orange-gold)

- You should have **no** ¼ watt carbon film resistors remaining.

Diodes are polarized parts. Each has a band at one end, indicating the cathode. Be sure to orient each part correctly when you install it. The **banded** end (cathode) should go to the **square** pad. The band is also marked on the silkscreen.

The 1N5711 (or SD101A) and 1N4148 parts look identical. The only way to tell them apart is by reading the tiny markings on them. They are quite different in their characteristics, however, so it is very important that you install the correct ones.

- Locate the two 1N4148 diodes.

Near the lower left hand corner of the PCB:

- D5 1N4148
- D6 1N4148

Next, install the 1N5711 diodes. Near the upper center of the PCB:

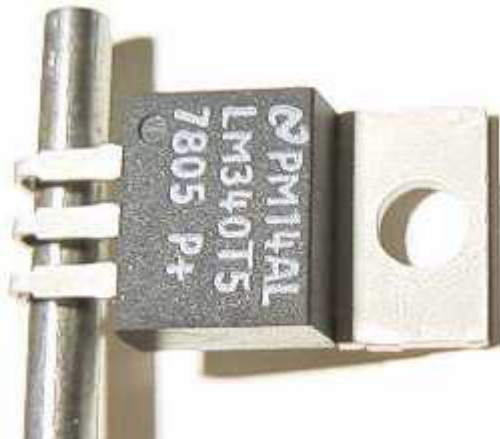
- D2 1N5711 or SD101A
- D3 1N5711 or SD101A
- D1 1N5711 or SD101A
- D4 1N5711 or SD101A

- You should have **no** diodes remaining.

Now it gets interesting! U2 is a TO-220 cased +5-volt regulator. This part may get a little warm, so it will share some of its heat with the rest of the K2 via a metal spacer as well as the PCB.

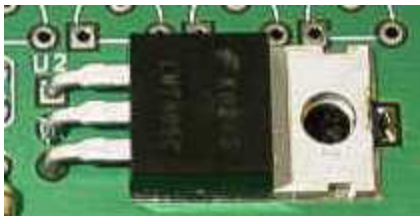
Locate U2 and match it to the PCB. Pre-bend the leads to align with the holes in the PCB **while keeping the mounting hole in U2's tab in line with the mounting hole near the center of the PCB.**

You may notice that the mounting hole area of the board near U2 has a keyhole shape isolated from the rest of the top of the PC board, but that there are four thin traces, like the spokes of a wheel, connecting them. This is normal - don't cut the small traces!



You may find it helpful to use a 1/8" (0.8 mm) drill bit as a form to bend the leads of U2.

Verify the holes are aligned **before** you solder.



Near the center of the PCB:

U2 LM340T (LM340, 7805)

Solder the tab to the board near the end of the tab. This requires more heat than the other connections in the board. Use a larger iron if you have one available. You do not need much solder, and **DO NOT** solder near the mounting hole. The reason for soldering is to relieve mechanical stress from the leads of U2 when the KDSP2 PCB is mounted and the mounting screw tightened

The following capacitors are ceramic monolithic with radial leads. The capacitor should sit flush to the PCB, with exposed leads not more than about 1/32" (1mm) above the PCB.

Starting near the center left hand side of the PCB:

- C5 0.1 uF (104)
- C8 0.1 uF (104)
- C3 0.1 uF (104)
- C4 0.1 uF (104)

Starting near the lower left hand side of the PCB:

- C12 (skip for now)
- C9 0.01 uF (103)
- C13 0.01 uF (103)
- C6 33 pF (33 or 330 - **NOT** the large, rectangular capacitor that may be marked 330n)

In the following step, pay particular attention to ensure that the leads of C7 do not extend below the bottom of the PC board. You may find it easiest to pre-trim the leads **before** you solder.

- C7 0.01 uF (103)

You should have **one** 470 pF ceramic monolithic capacitor remaining, and location C12 should be empty.

The following capacitors are **polarized**. This means that it matters which lead goes into which hole on the PCB! Take a moment to examine the electrolytic capacitors supplied. The positive (+) lead is typically longer than the other. In addition, the **negative** lead side is usually marked on the case with a bold stripe. Be sure you know which lead is the **positive** lead.

On the PCB, the **positive** lead has a square pad, and is marked with a + symbol.

There are two physical sizes of 10 uF capacitor supplied. One is much smaller than the other. Use the **small** capacitors in the following two steps.

Near the bottom center of the PCB:

- C10 10 uF **low profile** capacitor (10 uF or 106)
- C14 10 uF **low profile** capacitor (10 uF or 106)

- You should have **no** low profile electrolytic capacitors remaining.

Install the remaining electrolytic capacitors, starting near the upper left hand corner of the PCB:

- C1 10 uF (10uF or 106)
- C2 22 uF (22 uF or 226)
- C16 (skip for now)

- You should have **one** 10 uF electrolytic capacitor remaining, and location C16 should be empty.

The next component is a resistor, physically larger than those previously installed. The PCB lead spacing is 0.6" (15mm). As before, bend the leads close to, and at right angles with, the body of the resistor before installing it on the PCB. The holes in the PCB are intentionally a little close, and the resistor may sit slightly off the surface of the PCB.

- R12 43 ohm, 2W (43 or yellow-orange-black-gold)

The next parts are in a TO-92 plastic case. These are three-legged parts. Orient the part so that the flat side of the case matches the PCB outline. The holes in the PCB are on a 0.1" (2.5mm) grid. You will need to carefully spread the leads on the part before installing it onto the PCB. It is important that the parts sit fairly close to the PCB, with the top of the case not more than 0.375" (3/8" or 9.5mm) above the PCB. This is to provide clearance for the DSPx module which will sit above the KDSP2 PCB assembly.

These parts all look very similar, but there are three different part types. You will first install the two parts that are different than the others.

Q5 and Q6 are Field Effect Transistors, used to mute audio when required. **They are sensitive to static charges, so be sure to follow correct anti-static handling procedures when installing these parts.**

Near the center of the lower edge of the PCB:

- Q5 J309 FET (J309)
- Q6 J309 FET (J309)

Q2 is a PNP transistor, used in driving the K2 auxbus.

Near the center of the PCB:

Note that the transistor is to the **right** of the legend **Q2**.

- Q2 2N3906 (2907, 3906)

The remaining TO-92 parts are NPN transistors. Q1 and Q3 are used in the auxbus interface, Q4 drives the LED and Q7 drives the audio muting circuit.

Starting near the center left hand side of the PCB:

Q1 2N3904 (2222, 3904)

Q3 2N3904 (2222, 3904)

Q4 2N3904 (2222, 3904)

Q7 2N3904 (2222, 3904)

You should have **no** TO-92 style components remaining.

The next component is the ceramic resonator. This sets the operating frequency of the microcontroller. It is **not** polarized - just be sure the center lead goes in the middle hole!

Near the center of the PCB:

Z1 4.0 MHz (4, 4.0 or 4.00)

U1 is the microcontroller that operates the KDSP2. It is socketed, and you will next install the socket.

Be sure the socket pins are all through the PCB before you solder, as it is easy to bend one or fold one or more. Also, note that **the socket is polarized** with a notch near the pin 1 end. The PCB silkscreen also has a notch near the pin 1 end, which is towards the upper edge of the PCB.

When installing the socket, solder two diagonally opposite corners, then inspect the board to be sure the socket is flush to the PCB and aligned correctly, and that all 28 pins are protruding through the PCB. Then, proceed to solder the remaining twenty-six pins. Be sure and trim the pins on the bottom of the board after soldering.

At location U1:

28-pin IC socket

Next is the real-time clock IC, U3. **It is static sensitive, and polarized.** Be sure the notch, dot or dimple is towards the Lithium cell holder (BT1) silkscreen legend.

Near the lower right-hand corner of the PCB:

U3 NJU6355ED IC (NJU6355)

Near U3 is a small, cylindrical crystal. The exposed lead length should be about 0.1" (2.5 mm). **Be careful with the crystal's leads, as they are very thin and may break if stressed. Do not attempt to push the crystal down flush to the PC board!**

Y1 32.768 kHz crystal

As long as we are on the right side of the PCB, this is a good time to install the LED. The LED is **polarized**. The **shorter** lead goes in the square hole on the PCB. This is **opposite** to the rule about electrolytic capacitors. The lead length is the only clue as to the part's polarity, so don't clip until you have verified it is installed correctly!

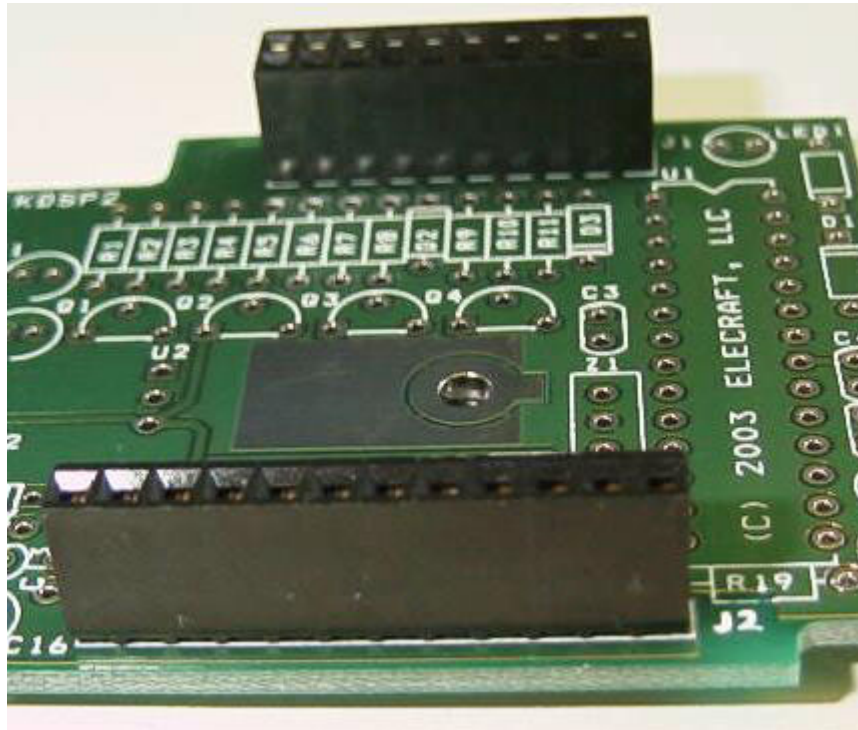
Near the upper right-hand corner of the PCB:

LED1 Red LED (no marking)

The 12-pin and 20-pin female connectors are next. These are the mating connectors for the DSPx module. You may find it easiest to tack the connectors in place at two opposite ends, verify the connectors are seated on the PCB and at right angles to it, then solder the remaining pins.



NOTE: The clearances are very tight in a K2/100, so the connectors must be flush to the PCB.



J1 20-pin female header (2 rows of 10 pins)

J2 12-pin female header (1 row of 12 pins)

When you install the IC in the next step, be very careful to not damage crystal Y1!

Install U1 (ATMEGA8L) into the 28-pin IC socket on the KDSP2 PCB. Be sure pin 1 (the end with a notch, dimple, or U-shaped pattern) is towards 20-pin connector J1 of the KDSP2.

Film capacitors are typically in a rectangular casing of a solid color. The part value is stamped directly on the part. These parts are not polarized.

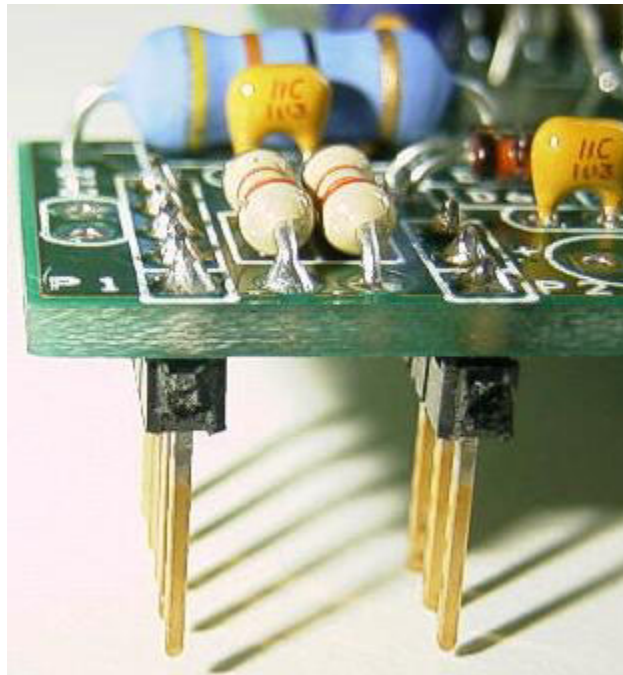
Near the center of the bottom edge of the PCB, adjacent to J2:

C15 0.33 uF (330n or 334)

C11 0.33 uF (330n or 334)

You should have **no** film capacitors remaining.

The next two connectors **mount on the bottom of the PCB**. They will mate with the control board in the K2. They must be mounted flush to the PCB and they must be perpendicular to it.





NOTE: The short end of the pins on the male headers are soldered into the KDSP2 PCB.

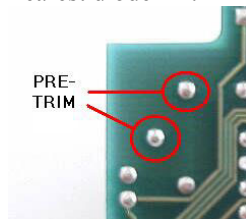
On the bottom of the PCB at the now-right hand side:

- P1 5-pin male header (1 row of 5 pins)
- P2 3-pin male header (1 row of 3 pins)

On the top of the board, install the final two capacitors. Remember, the electrolytic capacitor is polarized!

- C12 470 pF (471)
- C16 10 uF (10 uF or 106)

In the next step, you will install the three-pin Lithium cell holder on the right side of the PC board. You need to pre-trim two of the pins so they are flush with the bottom of the PCB. The two pins that need to be pre-trimmed are the center pin and the pin nearest diode D4.



- Pre-trim the leads on Lithium cell holder BT1.
- Install BT1, soldering all three pins. The Lithium cell will be installed later.
- Verify the middle pin and the pin nearest D4 do not protrude below the bottom of the PCB
- Carefully inspect the board for solder bridges (especially at the polarized capacitors and Y1), poor solder joints, etc.
- You should have only the following components remaining:
 - Lithium cell (CR-2032)
 - 3-pin female header;
 - 5-pin female header;
 - 0.5" male-female threaded spacer;
 - 4-40x1/4" screw
 - DSPx Module
 - Gray Foam
 - Black Foam

Control Board Preparation

The control board of the K2 may need to be modified to accept the KDSP2. If you already have a KAF2, no further changes are required and you may skip this section and proceed to **Installation**.

- Verify the firmware on the Control board is at least rev 2.01. If it is earlier, contact Elecraft and obtain current firmware. Install it and verify the radio operates properly before proceeding!
- Turn off the K2.
- Remove power from the K2 and disconnect antenna cables, keys, microphones and any other accessory that is plugged in to the radio.
- If you have the KBT2 option, place the switch on the rear panel of the K2 in the OFF position.
- Remove the top cover from the K2. Disconnect any internal cables from the top cover to the K2, including all cables to the Control Board. See the K2 manual for details.
- Remove the two screws that secure the Control Board to the Front Panel Board inside the K2. Extract the Control Board using the long-handled allen wrench as described in the K2 Owner's Manual. For K2s with S/N below S/N 3000, it is on page 40. The current manual, Rev D for kits S/N 3000 and above, has this information on page 40 as well.
- Place the Control Board on your work surface, component side up.
- If your Control Board is revision A, or revision X-something, the silkscreen information for the audio filter is on the back side of the board. **Do not install anything for the audio filter on the back side of the board. The two connectors to be added must go on the component side of the board.**



NOTE: Removal of R18 and R19 must be done with care. DO NOT overheat the solder pads on the PCB, tug on them with the joints hot, etc. If you lack good desoldering tools (wick, desoldering pump, etc.) then it is best to clip the leads individually at the body of the part. Then, using long-nose pliers, apply gentle pulling force while heating the joint with your soldering iron. The lead will come out easily. If you have the iron on the joint more than a few seconds and the lead won't come out, you are doing something wrong. The Elecraft email reflector is a good source of help for techniques, as is the Builder's Resources section of the Elecraft website (www.elecraft.com).

Clearing the hole of solder is best done with solder wick or a simple desoldering pump.

IT IS CRITICAL THAT THE LEADS BE REMOVED AND THE HOLE BE FREE FROM SOLDER TO INSTALL THE CONNECTORS IN THE FOLLOWING STEPS.

- Remove R18 and R19. These may be actual resistors or wire jumpers. They are located near the right hand end of the 36-pin connector, J2.

- Using solder wick or a desoldering pump, carefully clean out the holes of solder where the leads of R18 and R19 were. **DO NOT overheat the pads.**
- Install the 5-pin female header (1 row of 5 terminals) at J1 **on the component side** of the Control Board. The connector must be seated flush to the PCB and perpendicular to it. Solder the center pin only.
- Install the 3-pin female header (1 row of 3 terminals) at J2 **on the component side** of the Control Board. The connector must be seated flush to the PCB and perpendicular to it. Solder the center pin only.
- Inspect the installation and verify the connectors are flush to the board and perpendicular to it.
- Solder the remaining pins of J1 and J2.
- Examine the electrolytic capacitors on the Control Board from the right hand side of the microcontroller (U6) to the right edge of the PCB. Ensure that these parts, and any other tall parts in the area, are firmly seated to the PCB and are straight. Clearance is tight between the KDSP2 and the Control Board, and you must take care to ensure no shorts will develop.
- Plug the Control Board into the K2 RF Board.

Installation

The Control Board is held in place with two 4-40 screws. The screw nearer J1 and J2 will be replaced with the male-female threaded spacer provided with the KDSP2 kit.

- If you have previously installed a KAF2 in your K2, remove it and skip the next **two** steps.
- Thread the ½” (12mm) threaded spacer through the mounting hole in the Control Board nearer J1 and J2. Tighten it snugly by hand. **Do not overtighten** - the spacer is made of aluminum and can be damaged by less torque than you might think.
- Verify the other mounting hole of the Control Board is secured with K2-supplied 4-40 hardware.
- Remove Frequency Counter cable (used for CAL operations) if present.
- Plug the KDSP2 board into the control board. Clearance between the KDSP2 and the cabinet side panel may be very tight.
- Ensure that the pins going into J1 and J2 are aligned properly. Misalignment (being off by one or more pins in either direction) may result in damage to the K2, the KDSP2, or both. If the mounting hole in the KDSP2 does **not** line up with the threaded hole in the spacer just installed, you may have the KDSP2 improperly mated with J1 and J2. Re-check.
- Check that the KDSP2 board doesn't interfere with the grounding wire on the PLL reference crystal(X1 on the RF board). The grounding wire for this crystal should be on the side of the crystal, not the top. If it is on the top, you should move it to the side of the crystal.

- Use the supplied 4-40 x 1/4" screw and the original lockwasher to secure the KDSP2 to the threaded spacer. Do not overtighten the screw - the spacer is made of aluminum and its threads can be stripped.
- If your K2 is Rev B (S/N 3000 or higher), inductor L1 on the Control Board will touch the bottom of the KDSP2. This is normal. The case of L1 is **not** conductive and will not cause an electrical short.
- Once again, verify there are no clearance problems between the KDSP2 and the tall components on the K2 Control Board. In particular, be sure there is clearance between the bottom of the KDSP2 PC board and the tops of the large electrolytic capacitors on the Control Board (C28 and C29).
- Using anti-static precautions, install the DSPx Module to the KDSP2. The clearances are very tight, and you may have to rotate the DSPx Module into the KDSP2 to clear tall components on the RF Board.
- Ensure the KDSP2 is completely seated on its connectors, and that it is properly aligned. Failure to align it properly could result in damage to the KDSP2, the DSPx, or both. When installed, there is a gap of about 1/16" (1 to 2 mm) between the KDSP2 and the bodies of the Control Board connectors. There are no mechanical fasteners to hold the DSPx in place. It is secured by the friction of its connectors. In the final assembly section, you will install an insulated retention system to ensure the DSPx Module does not come loose from vibration or reasonable shock.
- Turn on the K2. If you see or smell smoke or fire, turn it off immediately, find and fix the cause. Refer to **Troubleshooting**.

Initial Checkout

- Set the K2 AF GAIN control to minimum. This is good practice whenever you turn on the K2 as there may be a loud “POP” in the audio, a strong signal on the frequency to which it is tuned, etc.
- Turn on the K2. The LED should come on briefly, then extinguish.

The LED is turned on by the DSPx upon reset. It also comes on if there is an unrecognized command issued to it by the KDSP2 controller.

It is turned off when the DSPx receives a valid command from the KDSP2. This occurs within a second or so after power up, after the K2 announces its mode settings to the KDSP2.

- Tap the **MENU** button.
- If you are not in the secondary menus, tap **DISPLAY**. You should briefly see **SEC** in the K2 display.
- Rotate the K2 main tuning knob until you see **r t c** in the K2 display. Turn it ON if it is not already on, by pressing **EDIT** followed by **BAND+**.
- Tap **MENU** to exit the menus and return to the normal K2 frequency display.
- Turn up the AF GAIN control. You should hear audio.
- Select CW mode.
- Press, hold, then release the **AFIL** button. The display should briefly indicate

[F 2

- Tap the **DISPLAY** button. You should see something like this:

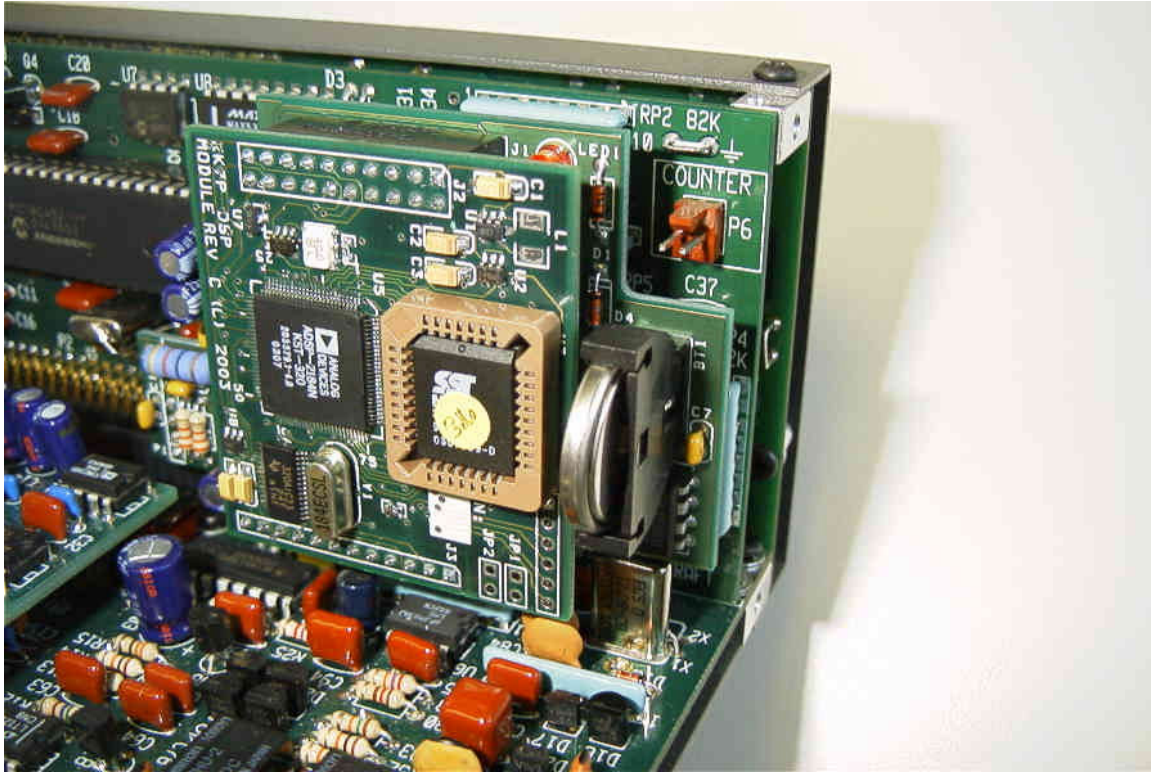
[2 n r

Congratulations! Your KDSP2 is functioning normally. Next up: Lithium cell installation.

3-Volt Lithium Cell Installation

- Turn the K2 off.

The (+) side of the 3-volt cell must be oriented towards the DSPx module. The (-) side must face the left side panel of the K2.



DO NOT use long-nose pliers to hold the Lithium cell! Doing so will short the + and - sides together.

In the following step, be careful to not stress the spring clip when inserting the cell, or it may not make good contact with the cell.

- Insert the Lithium cell into its socket, under the spring clip.

The *Operation* section of this manual describes the procedure to set the clock and calendar.

Final Assembly

Before re-assembling your K2 or K2/100, you need to add the self-adhesive foam retainers. These will help protect the DSPx module in the event your transceiver is subjected to high levels of shock (Oops! You dropped it!) or vibration (e.g., mobile installation in your off-road vehicle or helicopter).

K2

The black self-adhesive foam will be used to prevent the DSPx from disengaging from the KDSP2.

- Place the K2 top cover on a soft cloth or other clean surface to protect the painted finish on the cover.
- Orient the cover so that the speaker is towards you and the rear panel is away from you.
- Clean the inside surface of the top cover to the right of the speaker and towards the front. Ensure it is dry. Note that use of rubbing alcohol may leave a powdery residue that will hinder the adhesive.



The foam tape will be placed parallel to the front of the top cover. The distance from the front edge of the tape to the front edge of the cover should be 1.5" (3.8cm). The tape will extend from the speaker towards the right edge of the top cover. It should touch, or nearly touch, the edge of the speaker frame.

- Remove the backing from the foam.

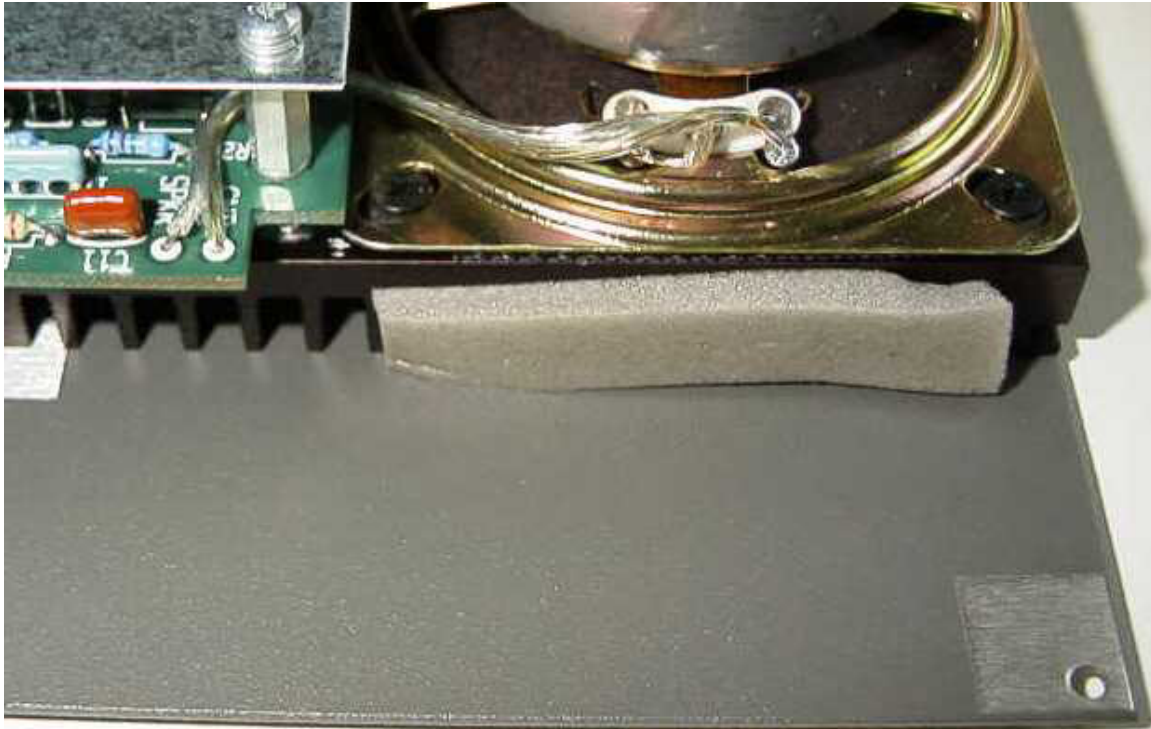
- Attach the foam to the top cover.
- If you normally have the counter cable installed in your K2, re-install it now.

When you re-install top cover assembly on your K2, we recommend you place it down, then slide it forward. Don't rotate it down into place as this may tend to compress or distort the foam.

When properly installed, the foam will be just behind the DSPx module, preventing it from disengaging from the KDSP2.

K2/100

On the forward edge of the heatsink, centered on the speaker, you will install the gray foam. This is ¼" wide. Do not use the black foam! It is for the regular K2 cover.



- Ensure the heatsink is clean.
- Ensure the heat sink is near room temperature. The adhesive doesn't work as well when it is cold.
- Remove the backing from the foam.

Attach the foam to the heatsink.

We recommend you not leave the frequency counter cable installed in your K2/100.

When you re-install KPA100 assembly on your K2/100, we recommend you place it down, then slide it forward. Don't rotate it down into place as this may tend to tear or wedge the foam.

When properly installed, the foam will be under slight compression, preventing the DSPx module from contacting the heatsink.

Operating the KDSP2

The KDSP2 is controlled by the K2's **DISPLAY**, **AFIL**, **BAND+**, **BAND-**, **RCL** and **STORE** buttons.

When a button is to be momentarily pressed (tapped) it is shown like this: **BAND+**. When a button is to be pressed and held for a ½ a second or so, and then released, it is shown like this: **RCL**

The KDSP2 recognizes three modes:

- ⌈ for CW;
- 5 for SSB (it does not distinguish between LSB and USB);
- ⌋ for RTTY.

The mode is determined by decoding auxbus traffic within the K2 transceiver.

For each mode, the KDSP2 maintains four filters, accessed using the **AFIL** button. Each time you press the **AFIL** button, you cycle to the next filter. After the fourth filter, the next is the first, always cycling through them in increasing order. If a filter is set to LPASS (low pass), then it becomes the last filter in that mode's sequence. You can use this to reduce the number of filters in a given mode's sequence.

On power up, the KDSP2 will default to the first filter for each mode. It will retain the current filter for each mode until power is again cycled.

The factory default filters are:

Mode	Filter	Center	Width	Notch	Denoise	Denoise Level
CW	1	LOW PASS	LOW PASS	Not avail	Off	1
	2	600 Hz	800 Hz	Not avail	Off	1
	3	600 Hz	250 Hz	Not avail	Off	1
	4	600 Hz	100 Hz	Not avail	Off	1

Mode	Filter	Low Cut	High Cut	Notch	Denoise	Denoise Level
SSB	1	LOW PASS	LOW PASS	Off	Off	1
	2	200 Hz	2.5 kHz	Off	Off	1
	3	300 Hz	1.9 kHz	Off	Off	1
	4	300 Hz	1.6 kHz	Off	Off	1

Mode	Filter	Center	Width	Notch	Denoise	Denoise Level
RTTY	1	LOW PASS	LOW PASS	Not avail	Not avail	Not avail
	2	2.5 kHz	1000 Hz	Not avail	Not avail	Not avail
	3	2.2 kHz	300 Hz	Not avail	Not avail	Not avail
	4	1.0 kHz	200 Hz	Not avail	Not avail	Not avail

Table 1 - Factory Default Filters

For CW and RTTY, the first column of numbers represent the bandpass filter center frequency and the second column the width. This is because these modes are commonly tuned and referred by their center frequency.

For SSB, the first column represents the lower frequency of the audio passband and the second column the upper frequency of the passband. This is generally more convenient than specifying a center frequency and width. You may think of the first column as “low cut” and the second as “high cut” in passband terms.

Filter Selection

When you select a DSP filter (by pressing the **AFIL** button) the mode and filter number momentarily appear in the K2 display. For example, when going from CW filter 1 to CW filter 2, the display will briefly show:

CF2

To display the KDSP2’s primary menu, tap the **DISPLAY** button.

KDSP2 Primary Menu

In SSB or CW modes, the primary menu is used for the auto-notch and noise reduction functions. In RTTY, the primary menu is the Filters menu, described below.

From the primary menu, you can toggle the noise reduction adaptive filter (generally referred to as a “denoiser” and, in the SSB mode, the auto-notch filter. You can also adjust the denoiser’s level from 1 (least aggressive) to 4 (most aggressive).

Let’s assume you were in SSB mode using filter 2. Tap the **DISPLAY** button to bring up the primary menu in the K2 display:

S2 nr nt

This indicates SSB mode, filter 2, denoiser and autonotch are off.

To toggle the denoiser, tap the **BAND+** button.

52 .n1 nt

appears for a second. The “1” signifies the current noise reduction level. This display will be followed by

52 .nr nt

The decimal point preceding the nr indicates the denoiser is active. You will likely hear the difference in the noise level coming from the K2.

When you activate the denoiser in SSB or CW modes, the denoiser remains active for all filters in that mode until you deactivate it. When off, it is off for all filters in that mode until you activate it. Thus, you can have the denoiser on in SSB and off in CW.

Tapping **BAND+** again will turn off the denoiser.

52 nr nt

The notch, available only in SSB mode, is toggled by tapping the **BAND-** button.

52 nr .nt

The decimal point preceding the nt indicates the auto-notch is active. If both autonotch and denoiser were active, you would see something like

52 .nr .nt

Like the denoiser, the notch setting applies to all SSB filters.

You may adjust the level of the denoiser by pressing and holding **STORE**. This will cycle through the levels. The available levels are 1,2, 3 and 4. The greater the level of the denoiser, the better it is at suppressing noise, but it also suppresses some speech. Lower levels permit voice signals to pass through the filter more readily, along with more noise. You should experiment with the available levels of the denoiser under various band conditions to get a better feel for the effect of this control.

If in the above example you used the **STORE** button, you would momentarily see

52 .n2 .nt

followed by

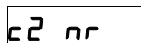
52 .nr .nt

Note that the denoiser has been activated. It makes little sense to adjust the denoiser if you can't hear the effect, so the KDSP2 automatically enables the denoiser whenever an adjustment is made to it.

The **.n2** which briefly appears informs you that the denoiser has been set to the fourth level. The display then reverts back to **.nr** for better functional clarity. If you continue to press the **STORE** button, you will see the filters cycle through 3, 4, 1, 2...

The denoiser levels for SSB and CW may be set independently.

If you press **BAND-** in CW mode, you will see something like



The lower-case **c** indicates that the alternate “soft” CW filters are in use. These filters have less skirt selectivity than the standard filters, but offer better ultimate rejection. They also have slightly less ringing, along with some attenuation, in the narrowest settings. Pressing **BAND-** again will toggle the CW filters back to the standard ones, indicated by an uppercase **C**.



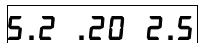
The next menu after the main menu is the Filter menu. The Filter menu is the primary menu for RTTY mode.

You can exit this menu, and all other KDSP2 menus, by turning the VFO knob, changing mode or filter, keying the radio, tapping **DISPLAY**, or holding **XFIL + AGC**. There are others, but these are the most common.

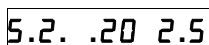
To access the next menu, press **RCL**. You can always get to the next menu by pressing this button.

KDSP2 Filter Display

You will see a display something like this:



This shows the mode, filter, lower and upper cutoff frequencies. In this case, it is SSB filter number 2, with a 200 Hz lower cutoff frequency and a 2.5 kHz upper cutoff. The decimal point after the **S** in **S2** indicates the denoiser is active. The notch is off in this example. If it were on, the decimal point after **S2** would be on, like this:



If a CW or RTTY filter were being displayed, the numbers represent center frequency and width, like this:

5.2 .60 .80

This shows standard CW filter 2, denoiser active, 600 Hz center frequency and 800 Hz width.



NOTE: the frequencies are always displayed as kHz with the decimal point in the appropriate place.



NOTE: when the KDSP2 is taking over the K2 display for its various menus, the display updates once per second. During the update process, you may hear a brief noise in the audio. This is due to auxbus traffic within the K2, and is normal. When you return to the normal K2 display, the noise will cease.

Changing Filter Frequencies

The most common operations to be performed on a filter are to alter its frequencies.

You will notice that the leading decimal point for the second set of numbers is blinking about once per second. This tells you that this filter value may be changed.

To change the filter value, tap the **BAND+** or **BAND-** buttons. If you tapped the **BAND+** button, you would see

5.2 .20 2.4

Tapping the **BAND-** button would return the filter to its previous state

5.2 .20 2.5

To change the other numbers, in this case the SSB low-cut frequency (center frequency in CW or RTTY), press and hold the **STORE** button. The blinking decimal point will move to the first set of numbers. You may increase or decrease the indicated value by tapping **BAND+** or **BAND-**. Tapping the **BAND-** button with the above displayed would yield

5.2 .15 2.5

Other modes operate in the same fashion.

There is a special filter for each mode, called LPASS (for low pass). This filter widens out the passband so you can more easily eavesdrop on neighboring frequencies. In CW, the filter is from a few tens of Hertz to 2.5 kHz; in SSB to 3.0 kHz; in RTTY to 3.5 kHz.

To invoke this filter in SSB, increase the high-cut frequency to its maximum limit (3.0 kHz) and reduce the low-cut to its minimum (.00 kHz). You will then see

```
5.2 LPASS
```

To change from this special filter, just tap **BAND-** or **BAND+**. As with the other displays in this menu, there will be a blinking decimal point.

In SSB mode, the LPASS filter is selected by increasing the high cut to its maximum value (3.0 kHz) and at the same time setting the low cut to its lowest value (.00 kHz).

In CW and RTTY modes, it is selected by setting the **highest** center frequency and the **widest** bandwidth.

Saving New Filters

What if you want to change a default filter and retain it through the next power cycle of your K2?

The KDSP2 includes EEPROM memory to allow you to do just that. In fact, every time you make a change to any KDSP2 setting, it is automatically saved into EEPROM. No special steps are required

Bypassing the KDSP2

Return to the DSP display by tapping **DISPLAY**. If the denoiser is active, tap **BAND+** to kill it. Press the **RCL** button. You will see the Filter menu display:

```
5.2 LPASS
```

Tap **BAND-** or **BAND+** to drop from the LPASS mode, and using the buttons you have learned, return the display to:

```
5.2 .20 2.5
```

Press the **RCL** button. You will be advanced to the Bypass Menu. It looks like this:

```
dSP On
```

You have the capability of bypassing the KDSP2 functions, which significantly reduces the power consumption of the KDSP2. If you tap **BAND-**, you will hear a change in audio and you will see

dSP bYP

When the DSP is in bypass mode, if you invoke the DSP display (by tapping the **DISPLAY** button) you will always be sent to this menu so you can quickly turn the DSP filters back on.

Simply tap **BAND+**, and you will return to DSP ON. The display will flash something like:

d2 .nr nt

The “d” indicates the DSP is being synchronized to the K2 current mode and filter selection. About one second later you’ll see

S2 .nr nt

or whatever the main menu display is for the current mode and filter you have selected.



NOTE: There may be brief drop, or “hole”, in the audio when you toggle between DSP ON and DSP BYPASS modes. This is normal. It is a result of muting the audio briefly to allow the audio levels to stabilize in the KDSP2. Otherwise, you might hear an annoying “pop.”

You may also reach the Bypass menu from the K2 RTTY mode. The RTTY mode is enabled by a K2 secondary menu in version 2.x firmware and later. It will be the next menu after the Main menu - the denoiser menu does not apply to the RTTY mode as it could add distortion to the signal, making data harder to decode.

Return to the Bypass menu:

dSP On

If you press the **STORE** button, you will be returned to the Main menu.

If you press the **RCL** button, you will be taken to a Denoiser menu (CW or SSB mode) or the Gain menu (RTTY mode).

Denoiser Menu

nr 89 71

In this menu, the **nr** characters indicate the denoiser, or noise reduction, menu. The first number indicates the Beta, or aggressiveness, of the filter and the second number affects the hold time, or decay rate of the filter. The value shown is the factory default.

As you have probably guessed, the flashing decimal point indicates the parameter (number) that will be changed by tapping either **BAND** button. To adjust the other set of numbers, use the **STORE** button

The beta number seems to have a mild effect, especially with the noise reduction level set to 1. The decay value seems to have greater effect, especially with smaller numbers. Experiment!

Each value has a range from 00 to 99. The value wraps around, so if you press **BAND+** while 99 is displayed, you will next see 00. Similarly, pressing **BAND-** with 00 displayed will take you to 99. You should definitely hear the effect of this change!

As with all menus, the **RCL** button will take you to the next menu in the sequence. This will be the Aut notch menu if the K2 is in SSB mode. If in CW mode, you will be taken to the Gain menu.

Aut notch Menu

If you are in SSB mode, and you press **RCL** from the Denoiser menu, you will see

nt 39 07

This is the Aut notch menu. Like the Denoiser menu, the first number represents Beta and the second number decay. The value shown is the factory default.

Like the Filter and Denoiser menus, the flashing decimal point indicates the parameter (number) that will be changed by tapping either **BAND** button. To adjust the other set of numbers, use the **STORE** button

Pressing **RCL** will take you to the Gain menus.

Gain Menus

There are five Gain Menus available in the KDSP2. Their purpose is to allow you to balance the gain of the system for the types of signals you most listen to. Three of the menus are based on mode (CW, SSB or RTTY) and two are related to the Denoiser function.

The SSB Denoiser Gain menu looks like this:

Sn G 7.0

while the CW Denoiser menu looks like this:

[Cn G 0.0]

The Filter Gain menus are prefixed:

[F] for CW Filter
[SF] for SSB Filter
[rF] for RTTY Filter

The numbers indicate the gain setting in dB. The setting may be changed in 0.5 dB steps, from -5.5 to +18.0.

To increase the setting, tap the **[BAND+]** button. To decrease it, tap the **[BAND-]** button.

If you press the **[RCL]** button, you will be taken to the next menu, either a Gain menu or the Main menu for the current mode. Pressing the **[STORE]** button will display the firmware versions of the KDSP2 (see below) followed by the main menu for the current mode.

The Gain menus available, by mode are:

Mode	Gain Sequence
RTTY	RTTY
CW	Denoiser, CW
SSB	Denoiser, SSB

You sequence to the next Gain menu, if any, by pressing **[RCL]**. If you are at the last Gain menu, you will go to the current mode's Main menu.

Displaying KDSP2 Firmware Revision

If you press the **[STORE]** button in any GAIN menu, you will see the firmware revisions of the DSP and KDSP2 controller. It will look like this:

[DSP 03.16]

which indicates the DSP Flash firmware version is 3.16, followed two seconds later by

[tL 03.00]

indicating the KDSP2 microcontroller firmware version. In this example, it is 3.00. If the MCU firmware is prior to version 3.00, you will be returned to the KDSP2 main menu two seconds later. If the MCU firmware version is 3.00 or later, then after another two seconds you will see a Flash memory checksum

FCS FFA d

followed by the EEPROM checksum

EEP BAC 1

Two seconds later, you will be returned to the KDSP2 main menu. The numbers you see may be different, as the firmware versions evolve.

Filter Status Display

The K2 provides a filter status display, invoked by holding **XFIL** + **AGC**. This displays the current XFIL and AFIL settings. For example, in CW mode, you might see

FL2 0.7c

followed by

AF 1

The second display is Audio Filter and number. This display does not distinguish between modes, showing the DSP filter as **AF** rather than **CF**, **SF**, or **RF**.



NOTE: The AF portion of the Filter Status Display will display **only** if you have pressed the **AFIL** button at least once since you turned the K2 on. If the **AFIL** button has not yet been pressed, the Filter Status Display will only provide XFIL information.



NOTE: When you change modes, the Filter Status Display will show the AF value of the last mode you used in which you pressed the **AFIL** button. Thus, when changing modes, the Filter Status Display loses synchronization with the KDSP2 and may display incorrect AF information..

Real-Time Clock Menus and Displays

In addition to the DSP functions, the KDSP2 includes a real-time clock (RTC) function. The clock provides time and date information, and includes a Lithium backup cell. The real-time clock chip monitors the status of the Lithium backup cell. If the voltage is below limits, the time and calendar displays will be filled with E

EE.EE.EE or **EE-EE-EE**

This means the cell voltage is low. **When you first construct the KDSP2, or after replacing the cell, this display will also be seen.** Simply follow the clock and calendar setting procedure to erase the E's. If the cell voltage is low, the cell needs to be replaced.

From any DSP menu, you may enter the clock menus by pressing and holding **STORE** + **RCL**. This brings up the time display in standard 24-hour format:

14.11.07



NOTE: If instead you see a display of five dashes, you weren't in a DSP menu.

To display the calendar, tap either **BAND** button:

04-22-03 (MM-DD-YY format) or **22-04-03** (DD-MM-YY format).

After about two seconds, the display will return to time.

Pressing **STORE** will return you to the primary DSP menu for the current mode.

If the DSP is not in bypass mode, you may change the calendar format. To do this, press **RCL**. You will see either:

nn-dd-yy or **dd-nn-yy**

Tap either **BAND** button to toggle between these modes. The selected mode is saved in EEPROM to remember your preferred format.

Press **STORE** to return to the calendar display for two seconds, followed by the time display.

Setting the Real-Time Clock

If you wish to change the time or calendar settings, make sure the DSP is not in bypass mode. Enter the calendar format menu as described above, then press **RCL**.

Yr 03

Adjust the year by tapping **BAND+** to increase or **BAND-** to decrease. The display will wrap around between 99 and 00.

To adjust the month, press **RCL**.

Mo 04

Adjust the month by tapping **BAND+** to increase or **BAND-** to decrease. The display will wrap around between 12 and 01.

To adjust the date, press **RCL**.

dt 22

Adjust the date by tapping **BAND+** to increase or **BAND-** to decrease. The display will wrap around between 31 and 01. Yes, you can set February to 31 days if you wish. The calendar doesn't check to see if the date is valid for a given month, but it does keep track accurately when it moves from month to month as time passes.

To adjust the time, press **RCL**.

Hr 14

Adjust the hour by tapping **BAND+** to increase or **BAND-** to decrease. The display will wrap around between 59 and 00. The time is always in 24-hour format. There is no option for AM or PM display on a 12-hour display.

To adjust the minute, press **RCL**.

mn 11

Adjust the minute by tapping **BAND+** to increase or **BAND-** to decrease. The display will wrap around between 59 and 00.

Whenever you adjust any of the time or date settings by tapping **BAND+** or **BAND-**, the clock will reset seconds to zero. This is handy for syncing to a time broadcast, such as WWV.

From any calendar or time setting menu, pressing **STORE** will take you to the time display. You may also press **RCL** from the minute menu to return to the time display.

Menus Summary

Mode	Current Menu	Next Menu
CW	Main	Filter
	Filter	Bypass
	Bypass	Main
SSB	Main	Filter
	Filter	Bypass
	Bypass	Main
RTTY	Filter	Bypass
	Bypass	Filter

Table 2 - Primary Menu Sequences

Menu	BAND+	BAND-	RCL	STORE
Main*	Toggle Denoiser	Toggle Autonotch**	Next Menu ***	Decrease Denoiser Level
Filter*	Increase Width or Center Frequency (Upper or lower cut in SSB)	Decrease Width or Center Frequency (Upper or lower cut in SSB)	Bypass Menu	Toggle functions of BAND buttons
Bypass	DSP On	DSP Bypass	Denoiser, or Gain***	Main Menu
Denoiser	Increase Decay or Beta	Decrease Decay or Beta	Next Menu ***	Toggle functions of BAND buttons
Autonotch	Increase Decay or Beta	Decrease Decay or Beta	Next Menu ***	Toggle functions of BAND buttons
Gain	Increase Gain	Decrease Gain	Next Menu ***	Firmware Version

* Filter is the primary menu in RTTY mode; Main in CW and SSB modes

** Only in SSB

*** Selection is mode dependent

Table 3 - Button Meaning by Menu

Mode	Current Menu	Next Menu
DSP	Time	Calendar Format
	Calendar Format	Year
	Year	Month
	Month	Date
	Date	Hour
	Hour	Minute
	Minute	Time
Bypass	Time	Time

Table 4 - Real-Time Clock Menu Sequence

Menu	BAND+	BAND-	RCL	STORE
Time	Calendar Menu	Calendar Menu	Calendar Format**	DSP Main Menu*
Calendar	Time Menu	Time Menu	Calendar Format**	DSP Main Menu*
Calendar Format	Toggle Format	Toggle Format	Year Menu	Calendar Menu
Year	Increment Year	Decrement Year	Month Menu	Time Menu
Month	Increment Month	Decrement Month	Date Menu	Time Menu
Date	Increment Date	Decrement Date	Hour Menu	Time Menu
Hour	Increment Hour	Decrement Hour	Minute Menu	Time Menu
Minute	Increment Minute	Decrement Minute	Time Menu	Time Menu

* Filter is the primary menu in RTTY mode; Main in CW and SSB modes

** Only when DSP is active; otherwise sends you to DSP BYPASS Menu

Table 5 - Real-Time Clock Button Meaning by Menu

Table 1 from the beginning of this section is repeated here for the factory default filter settings.

Mode	Filter	Center	Width	Notch	Denoise	Denoise Level
CW	1	LOW PASS	LOW PASS	Not avail	Off	1
	2	600 Hz	800 Hz	Not avail	Off	1
	3	600 Hz	250 Hz	Not avail	Off	1
	4	600 Hz	100 Hz	Not avail	Off	1

Mode	Filter	Low Cut	High Cut	Notch	Denoise	Denoise Level
SSB	1	LOW PASS	LOW PASS	Off	Off	1
	2	200 Hz	2.5 kHz	Off	Off	1
	3	300 Hz	1.9 kHz	Off	Off	1
	4	300 Hz	1.6 kHz	Off	Off	1

Mode	Filter	Center	Width	Notch	Denoise	Denoise Level
RTTY	1	LOW PASS	LOW PASS	Not avail	Not avail	Not avail
	2	2.5 kHz	1000 Hz	Not avail	Not avail	Not avail
	3	2.2 kHz	300 Hz	Not avail	Not avail	Not avail
	4	1.0 kHz	200 Hz	Not avail	Not avail	Not avail

Table 6 - Factory Default Filters

The other defaults are:

Denoiser	Beta	89
	Decay	71
	SSB Gain	7.0 dB
	CW Gain	0.0 dB
Autonotch	Beta	40
	Decay	07
SSB Filter	Gain	0.0 dB
CW Filter	Gain	0.0 dB
RTTY Filter	Gain	0.0 dB

Table 7 - Other Factory Defaults

Troubleshooting

General

If your symptoms are not covered below, check the orientation of all components, connectors and wiring. Look especially for cold or poor solder joints. Check all DC voltages (see DC voltage chart).

Receiver noise heard when Clock or DSP menus displayed.

This is normal. The main microcontroller in the K2 polls the KDSP2 for information to display about once per second, waking up all option module processors, which generates noise that is audible at some frequencies. The K2 does not mute the audio under this circumstance, because you may be listening to a signal, or wish to synchronize the clock with WWV or some other time standard broadcast. If you wish to leave the clock display on for long periods of time, simply turn down the receiver's AF GAIN control or use the squelch menu entry (**SLCH** in the K2 secondary menu).

Error messages.

If you see **not inst** in the K2 display when you press **AFIL** or tap **DISPLAY**, the KDSP2's microcontroller (U1) may not be functioning. Make sure it isn't installed backwards. Also check for bent pins, check voltages on all pins, etc. Remove and re-install U3 in case dirt, dust or other problems are interfering with good electrical contact between the IC and the socket. Try turning power off and back on.

AFIL works but I can't access DSP or clock menus when I press **DISPLAY**.

The auxbus has lost synchronization. Turn the K2 off and then on again and it should clear. Please let us know if this happens frequently in your radio.

Loud audio POP when K2 turned on.

If this is much louder than the normal turn-on transient when powering up the K2, set the AF GAIN control to minimum and cycle power again. If the POP is only present when the AF GAIN control is advanced, it may indicate the muting circuitry is not working properly on the KDSP2. Check R14, R19, Q5, Q6, Q7 and C8. Also check that U1 pin 14 is not bent or folded under the chip.

Weak or no audio at some filter settings.

If the KDSP2 filter is set to a frequency outside the XFIL range of the K2, it is normal for little or no audio to be heard. Be sure your XFIL setting and BFO frequency are such that audio will be present in the selected KDSP2 filter setting.

Filters don't seem to be at the right frequency or pitch.

If the KDSP2 seems to work OK but some filters don't seem to be at the correct pitch, try this test. Set the K2 to its widest filter setting in CW mode. Connect an antenna and find a noisy band or use a noise

generator. Set the KDSP2 to 400 Hz center frequency and 300 Hz width. Turn up the AF GAIN until you hear filtered background noise. Now, increase the center frequency of the filter. The noise pitch should increase. If the pitch does not increase with each increases in indicated center frequency, there may be a problem in the DSPx module. If the pitch increases, but then the noise suddenly becomes weak or absent, you are probably beyond the passband of your current XFIL setting.

If this test shows a problem with the DSPx module, you may carefully remove and then re-install the Flash memory chip in the socket on the DSPx board. Pay careful attention to the orientation of the Flash chip in the socket before you remove, and re-install it in the same orientation. This is a polarized part, and reversing it may damage the DSPx module or the Flash chip. If you are uncomfortable doing this, contact Elecraft.

LED remains on.

The KDSP2 LED will normally come on at power up, then extinguish after a second or two. If it stays on, it indicates that KDSP2 U1 and the DSPx module are not communicating properly.

Check U1, D3 and verify that the DSPx module is properly aligned and fully seated into its two connectors on the KDSP2 module. It is easy to be off by one pin in the alignment of these connectors. Also make sure that both rows of pins are inserted into J1.

Clock time doesn't increment.

U3 may be installed backwards or is defective. The 32.768 kHz oscillator may not be running- check Y1 and C6. If you have a frequency counter or oscilloscope, probe U3 pin 3 and look for a 32.768 kHz waveform.

Clock doesn't keep time with K2 power turned off.

Make sure the Lithium cell is installed correctly. (Nothing will be damaged if the Lithium cell is installed backwards, thanks to diode D4.) If you suspect the cell is bad, measure it with a voltmeter and replace it if the voltage is less than about 2.5 volts.

DC Voltage Chart

Voltages are approximate. Measurements were made under the following conditions: 13.8 VDC power supply. K2 turned ON, 3V Lithium cell installed, CW mode with default CF1 filter setting (800 Hz center, 600 Hz wide, noise reduction OFF), display showing frequency, DSPx module removed. KNB2 and KSB2 options installed.

Integrated Circuits

Pin	V	Pin	V	Pin	V	Pin	V	Pin	V
U1-1	3.6	U1-11	4.9	U1-21	5.0	U2-1	13.5	U3-1	0
2	4.9	12	0	22	0	2	0	2	0.5
3	5.0	13	0	23	0	3	5.0	3	0.6
4	4.9	14	5.0	24	0			4	0
5	0	15	0	25	0			5	0
6	4.9	16	0	26	0			6	0
7	5.0	17	0	27	0			7	0
8	0	18	0	28	0			8	4.9
9	0	19	0						
10	0	20	5.0						

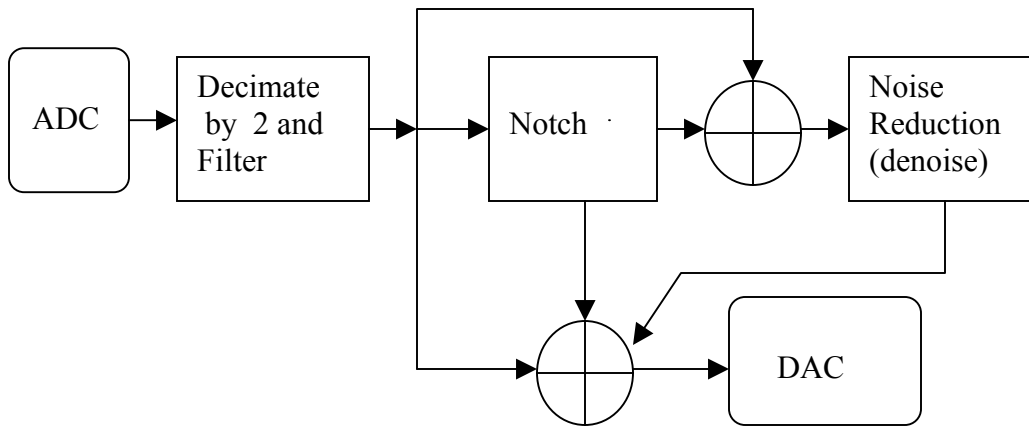
Diodes and Transistors

Pin	V	Pin	V	Pin	V	Pin	V
Q1-B	0	Q4-B	< 0.3	Q7-B	< 0.3	D3-A	0
E	0	E	0	E	0	D3-C	0
C	5.1	C	> 3	C	5.0	D4-A	**
Q2-B	5.1	Q5-G	5.0			D4-C	4.9
E	5.0	S	5.0	D1-A	5.0	D5-A	*
C	5.7	D	5.0	D1-C	4.9	D5-C	*
Q3-B	0	Q6-G	5.0	D2-A	4.9	D6-A	*
E	0	S	5.0	D2-C	5.7	D6-C	*
C	5.7	D	5.0				

*- This is a floating connection, not referenced to ground.

** - Varies with Lithium cell voltage

Theory of Operation



The DSP process flow is shown above. Incoming signals are digitized at a 16 kHz rate. The samples are then decimated, a process to provide higher performance filters with fewer coefficients. In the KDSP2, decimation by 2 is performed, limiting the highest frequency to a little under 4 kHz.

At the output of the decimator is a bandpass filter, selected by the user for the desired characteristic.

The output of the mode-selected decimator/filter is then passed to the notch filter. This uses an LMS (least-mean-squares) algorithm. A signal is always applied to the notch filter, even if it is not enabled, to minimize “popping” if it is selected after having been idle.

The denoiser accepts input from either the notch filter (if the notch filter is selected) or from the decimator (if the notch filter is not selected).

The output DAC receives its information from the appropriate decimator/filter, the denoiser, or the notch.

Circuit Description

The KDSP2 is an interface board that adapts the DSPx Module for internal operation in an Elecraft K2 Transceiver.

Please refer to the schematic for the following discussion.

KDSP2

Audio Path

Differential audio from the K2 Product Detector is supplied to the KDSP2 via 5-pin connector P1, pins 1 and 2. The audio is AC-coupled to the DSPx module inputs via capacitors C11 and C15. Resistors R15 and R16, along with capacitor C9, provide a simple low-pass filter to help suppress IF and RF feedthrough. Diodes D5 and D6 act as a limiter to prevent excessively strong signals from overloading the DSP section. These diodes will normally only provide limiting if the K2's AGC is OFF and a very strong signal is received. With AGC ON, the diodes should never conduct.

After processing, the differential audio is made available from the DSPx and is applied to capacitors C10 and C14. These couple the signal through muting transistors Q5 and Q6 to the K2 at P2, a 3-pin connector. R17 and R18 provide bias from filtered +5VDC to simulate the source normally seen by the K2 audio system.

+5V (VCC5), filtered by R13, C13 and C16, is used for the bias source.

Q5 and Q6 are N-channel JFETs with a low pinchoff voltage. Under normal operation, R14 biases the gates of these transistors to the 5-volt bias source, and the transistors are on, providing an audio path. The audio may be muted if transistor Q7 is turned on by applying a positive voltage to R19. When on, Q7 pulls the gates of Q5 and Q6 low, turning them off and muting the audio signal. When the voltage to R19 is returned to 0, Q7 is turned off and capacitor C8 charges through R14. This charging action turns on the JFETs over a period of several tens of milliseconds, to ensure there is no "pop" or other disturbing artifact as a result of un-muting.

Power System

Incoming +10 to +15 VDC is applied through R12 and C2 to U2, an LM340T linear regulator. This is a linear regulator so R14 shares the load with U2. A switching regulator might introduce noise into the K2 - the AGC IF is on the control board and is a wideband, untuned amplifier looking at a nominal 150 kHz signal. The maximum load current on the 5 volt regulator is about 70 mA. The output of U2 is filtered by C1 as well as various 0.1 uF capacitors distributed throughout the KDSP2.

VCC5 is further filtered for the audio bias, described above.

Auxbus Interface

The K2 auxbus operates at a nominal 5V, but may be as high as 6V with some accessories. This is incompatible with the 5V microcontroller used in the KDSP2. Level translation is accomplished by Q1-Q3 and associated circuitry.

Incoming auxbus data is filtered by C12 and applied via R8 and D2 to an input pin on the microcontroller, U1. R9 serves as a weak pull-up for this input. D2 is a Schottky diode, having very low voltage drop. It is used to couple the low-level (logic “0”) signals into U1. D2 and R9 combine to limit the input high levels (logic “1”) to +5V. This protects U1 from the potential +6V levels on the auxbus.

Q1 and Q3 are normally biased off by a LOW output from U1 to their respective bases through R3 and R4, respectively. Q1 being off allows R2 to bias Q2 off. As a result, the auxbus drivers from the KDSP2 are in the OFF, or high-impedance, state.

If the KDSP2 needs to assert an auxbus level of HIGH, it turns on Q1, which turns on Q2 and pulls R7 to +5 VDC. This high level is passed through R6 and R7 to the auxbus.

If the KDSP2 needs to assert an auxbus level of LOW, it turns on Q3, whose collector is tied to the auxbus through R6 and R8.

The microcontroller always turns OFF both Q1 and Q3 before turning either ON, to prevent contention. R6, R7 and R8 serve as current limiters in case of an auxbus fault.

Microcontroller

U1 includes a CPU, Flash program memory, EEPROM and RAM, along with I/O ports and timers. Flash stores the program, EEPROM the constants and filter settings.

Z1 controls the clock of U1, setting it to a nominal 4 MHz, the same as most other microcontrollers in the K2.

U1 monitors auxbus activity, interprets button presses, manages the menus and displays, and controls the DSPx Module.

Because the DSPx module operates internally at 3.3V (see below), it must be protected from the 5V output of U1. Schottky diode D3 provides this isolation, allowing U1 to pull J1 pins 11 and 12 to near ground, but preventing them from being driven to 5V. A pull-up resistor to +3.3V is included in the DSPx module to limit the applied level when U1 pin 3 goes high.

The LED is operated directly by the DSPx Module via Q4, and is used for status information.

Real-Time Clock

U3 is a real-time clock chip, incorporating clock and calendar functions. Y1 establishes the oscillator frequency of 32.768 kHz, with C6 to act as a fine adjustment.

U1 communicates with U3 over a 4-wire serial bus. This is used to set the time and date, and read them back.

The clock runs even when the K2 is powered off. Lithium cell BT1 provides a nominal 3V level to operate U3 via Shottky diode D4. When the K2 is operating, +5V is supplied to the clock via Shottky diode D1. Under this circumstance, the Lithium cell is idle. Shottky diodes are used to minimize voltage drop.

Capacitor C7 provides decoupling of the power supply to U3.

DSPx

The DSPx schematic is on a separate sheet.

Incoming +3.6 to +5.5 VDC is applied to voltage regulators U1 (supplies +3.3V for digital circuitry) and U8 (supplies +3.3VDC for analog circuitry). U2 provides +1.8 VDC for operating the DSP core and the CODEC core.

Incoming audio is applied to U6, a TLV320AIC23 CODEC (encoder-decoder), which contains a pair of 16-bit analog-to-digital (ADC) and digital-to-analog (DAC) converters, as well as gain controllable amplifiers and a pair of serial interfaces.

U5, an Analog Devices® ADSP-218xN series DSP chip, controls the CODEC (via U9, a Xilinx complex programmable logic device, or CPLD). It also has a serial interface that, with suitable modification through the CPLD, accepts ADC information and provides data to the DAC.

The program for the DSP is contained in the Flash memory, U3. At boot-up, the DSP fetches its program from the Flash, and then runs the program from internal memory. The Flash memory also contains numerous coefficient files for the various filters. These are fetched from the Flash on an as-needed basis.

The DSP is clocked by a 40 MHz oscillator, consisting of resonator RES1 and amplifier U4. This results in an internal instruction rate of 80 million instructions/second.

At power up, U7 provides a reset signal of sufficient duration to allow the DSP clock systems to operate and settle.

Glossary

The KDSP2 introduces DSP technology to the Elecraft K2 transceiver line. There are many terms used that are not familiar to many Amateur radio operators. This Glossary may be of help to you in understanding these terms in the context of the KDSP2.

Adaptive Filter

An adaptive filter is one which continuously adjusts its characteristics automatically. In the KDSP2, two types of adaptive filters are provided: autonotch and denoiser. These filters use an LMS algorithm to suppress heterodynes (notch) or random noise (denoiser). See coefficients.

ADC

Analog to Digital Converter. This is a device which accepts an analog signal and converts it to a digital value. In the KDSP2, the ADC accepts the signal from the K2 product detector and converts it to a 16-bit digital value. It does this 16,000 times per second.

Algorithm

The step-by-step process followed to perform a particular task. In the case of DSP, the task is handled by instructions to the DSP chip, known as software (if stored on a disk) or firmware (if stored in permanent or semi-permanent memory)

Autonotch

Automatic notch filter. This type of filter attempts to reduce the strength of a very narrow range of frequencies, typically caused by a carrier from a nearby station.

Beta

In the LMS algorithm, Beta defines how quickly the adaptive filter makes adjustments in its attempt to implement the algorithm. If you think in terms of an automatic gain control, it corresponds to the attack time.

A higher value means a more aggressive, or faster, attack.

CODEC

Coder-decoder. In DSP system, the CODEC contains an ADC and a DAC at a minimum. In the KDSP2, the CODEC contains two ADCs, two DACs, programmable gain amplifiers, interface logic and power management circuitry.

Coefficients

In mathematics, the coefficients of an equation are usually constant values. For example, in the phrase

$$Ax^2 + Bx + C$$

A, B and C are coefficients. x is the variable.

In DSP filters, the coefficients define the filter response, and are usually fixed (constants). The sampled signal is the variable, and the result of the equation is the filtered signal.

In the case of adaptive filters, the coefficients are changed by the DSP as a result of computations, so are not really constants.

DAC

Digital to Analog Converter. This is a device which accepts a digital value and converts it to an analog voltage. In the KDSP2, the DAC accepts the 16-bit digital information from the DSP chip and converts it to a differential analog voltage which is applied to the audio amplifier in the K2. It does this 16,000 times per second.

Decay

In the LMS algorithm, Decay defines how quickly the filter abandons adjustments made in its attempt to implement the algorithm. If you think in terms of an automatic gain control, it corresponds to the decay time.

A higher value means more rapid decay.

Decimation

It is sometimes advantageous to reduce the sampling rate of a signal that has already been sampled. The process of doing this is called decimation. In the KDSP2, the input sampling rate is 16 kHz. The filters operate better with a sampling rate of 8 kHz. A “decimation by two” operation takes place to change the sampling rate to 8 kHz from 16 kHz.

Denoiser

A process to remove random noise from a signal. This is usually meant to be thermal noise like the background hiss of an HF band. Denoisers usually don't do well against static crashes or impulse (ignition) noise.

DSP

Digital Signal Processing. This is a system that accepts signals that are digitized, and performs operations on them, such as filtering. In the context of most Amateur radio equipment, the term DSP often applies to the whole accessory, like the KDSP2, and is taken to include the analog-to-digital and digital-to-analog conversions as well.

FIR

Finite impulse response. This is a basic filter structure which does not use feedback. As a result, it cannot oscillate. FIR filters are common in DSP work, but very rare in analog design. FIR filters usually need much greater length to get similar results to an IIR filter, but FIR filters are often much better behaved. They have controlled phase characteristics, less ringing, and so forth.

In the KDSP2, all filters are FIR filters.

See also IIR.

Gain

This indicates the amount of amplification, or attenuation, of a signal. In the KDSP2, various GAIN menus are available. Their purpose is **not** to increase the gain of the overall K2 system. Rather, they are provided to balance the gain between the various modes and functions. For example, assume you have SSB Gain set to 4.5, CW gain to 3.0 and RTTY gain to 5.0. They should all be reduced by 3.0. This will result in settings of 1.5, 0.0 and 2.0, respectively. When doing gain balancing, one of the gains should be 0.0. The Sn and Cn menus are to accommodate a possible loss of signal strength when the denoiser is active.

IIR

Infinite impulse response. This is a basic filter structure which uses feedback. As a result, it can oscillate and ring. Nearly all op-amp and switched-capacitor filters in common use are IIR. Some DSP filters are IIR, as these filters require far less computation for a given response. IIR filters often cannot provide desired phase and amplitude response characteristics, and are only used in DSP systems in certain special cases.

The KDSP2 does not use IIR filters.

See also FIR.

Interpolation

This is a process where a signal that was sampled at a lower rate is made to appear as if it were sampled at a higher rate. In the KDSP2, the autonotch and denoiser operate at a 16 kHz rate, but the filter that precedes them is running at 8 kHz. An “interpolate by two” operation is used to convert the lower sampling rate to the higher one.

Length

In DSP, filters consist of two blocks of memory. One holds the coefficients, and the other the sampled signals. The size of these two memory blocks are the same, and are usually referred to by their length, measured in taps. The longer the filter, the more taps it has, and the more precise it can be. Thus, longer filters usually have steeper sides, less ripple, or more attenuation – or some combination of all three.

Longer filters also have greater delay, and require more processing power to implement.

LMS

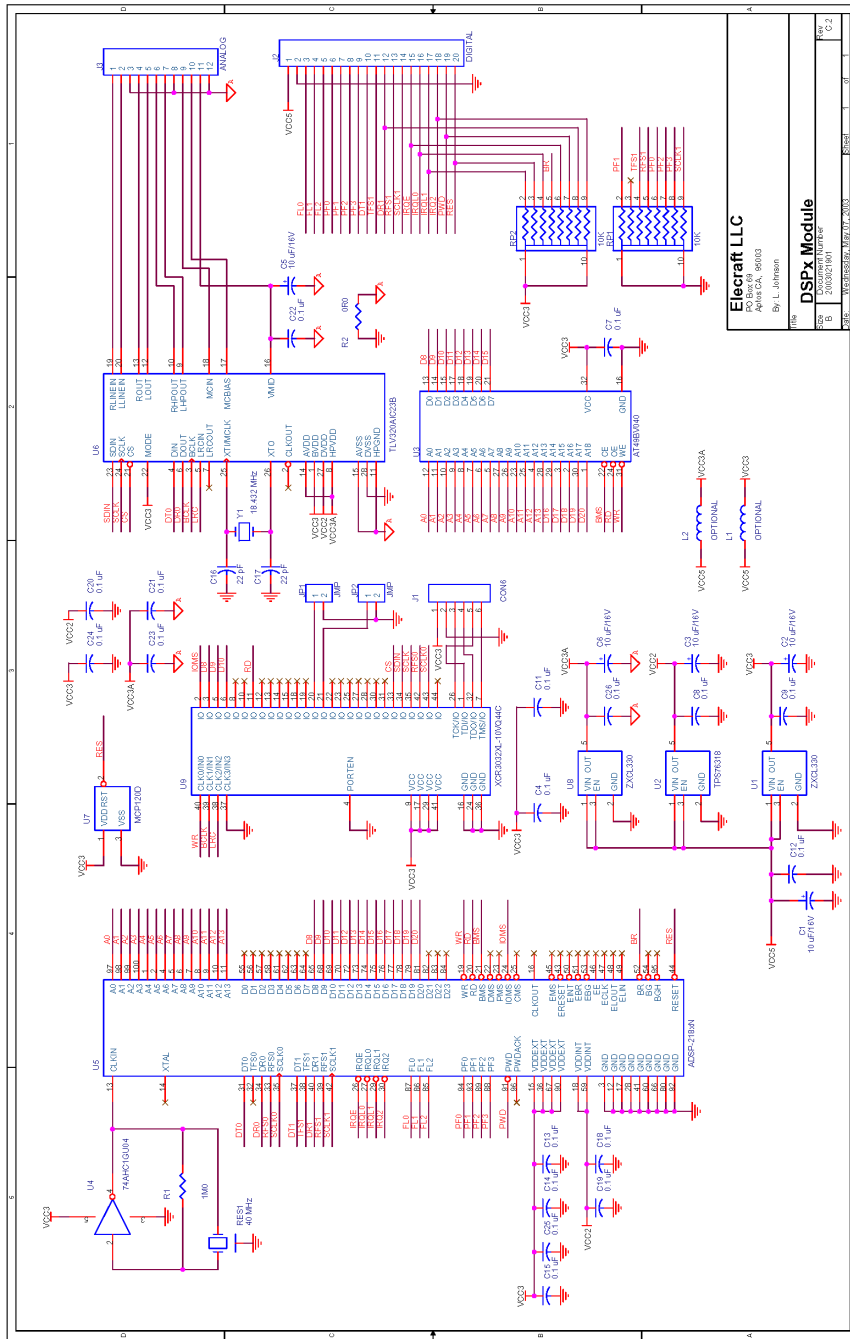
Least Mean Squares. This is an algorithm that is widely used in adaptive filters. The two adaptive filters in the KDSP2 are the autonotch and the denoiser.

Sampling

When signals are digitized, they are said to be sampled. In the KDSP2, analog signals from the K2 product detector are sampled at a 16 kHz rate. This means that 16,000 times per second, the output voltage from the product detector is converted to a 16-bit digital value by the ADC and fed to the DSP.

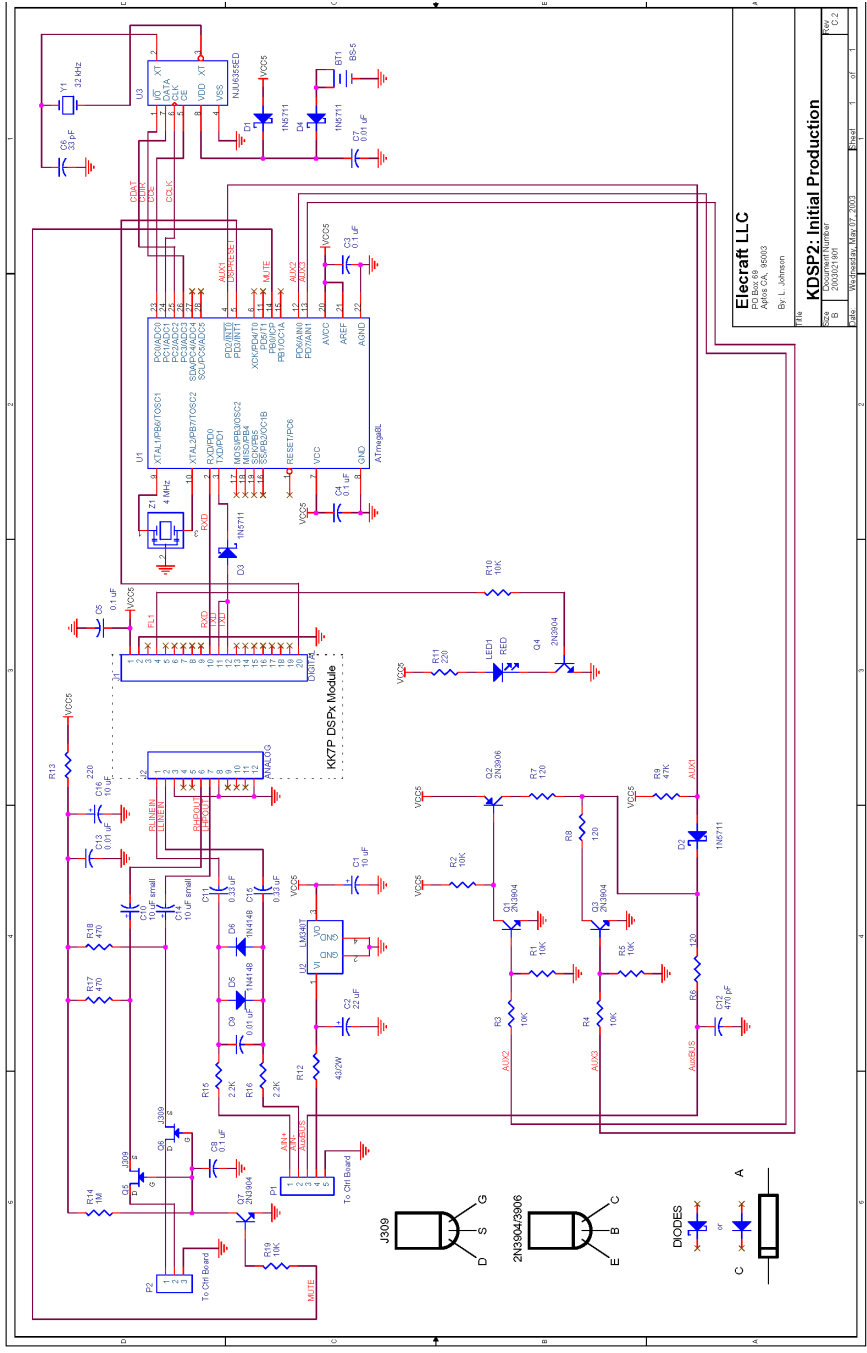
Taps

Each memory location used by a DSP filter is usually referred to as a tap. Thus, a filter using 100 memory locations for its signal samples would be said to have 100 taps. The term is historic and comes from the concept of a delay line, which was an L-C network that literally had “taps” along its “length.”



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DSPx Module
 Part Number: 20163021 (Rev. 1)
 Date: 06/27/2016



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