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Build a Four-Level FSK Data Decoder Interface

In this issue we present the promised Four-Level FSK Data Decoder Interface (4LFSKDDI) that, with a freeware program, can decode a few of those elusive and mysterious signals out there on the airwaves. The 4LFSKDDI can be built by most hobbyists, and the software is a no-brainer. Readers are cautioned that decoding certain Four-Level FSK signals could be illegal, depending on where you reside. Get informed before proceeding.

See my column last month for the necessary dual polarity power supply. Since then, I learned that power requirements aren't so critical, but ±15V is the max. Greater than ±11V should be regulated, but lower can be unregulated so long as it is reasonably stable. ±5V is an absolute minimum.

A pair of 9V DC adapters or 9V batteries can be perfect for the 4LFSKDDI. The important thing is to measure your intended power supplies before connecting them to the circuit. See my May-97, Jul-98, Aug-98, and Feb-99 *MT* columns for important (but not essential) background information, particularly on the simpler 2-Level FSK data decoder interfaces and processes.

You will need an 800-940 MHz scanner (cellular not required) with the NFM discriminator/baseband audio mod installed and known to be functional. See my Jul-98 column to do this modification to most any scanner. My Web site at: **http://ourworld.compuserve.com/homepages/bcheek/scandata.txt** always offers the latest on this baseband audio mod. See Table 1 for the Parts List.

Getting Started

Cut a piece of perfboard 18 complete holes long by 15 complete holes wide. This size supports the circuit perfectly and fits either of the suggested enclosures. If you choose the #270-283 project box, don't use the circuit board that comes with it. Save that board for another project.

Follow Figures 1 and 2 for the broad details of constructing the circuit. Begin by removing Pin 13 of the IC socket that will be used for U2. You can even cut Pin 13 away from the LM339 chip, too. It's not needed, but the empty space for it on the wiring side of the board comes in handy.

Install the IC sockets first, then solder bare 22-24 ga wire "traces" among the appropriate IC pins, for example: U1 pins 5, 10, 13 & 14; U2 pins 5, 7, & 9; U2 pins 10-11; and U1 Pin 5 to U2 pin 7. This secures the sockets to the board to keep them from falling out.

Install and solder jumpers JU1 and JU2. One end of JU1 has to be left open until later in the construction. JU3 and JU4 can be added later.

Now begin in earnest by installing and soldering R2, C1, R1, C2, C6, R5 and D2, in that order. First, bend the leads of resistors and diodes at right angles, as close to their bodies as possible. Use a flat-blade jeweler's screwdriver to bend component leads on the wiring side of the board.

Use protruding component leads as "traces" where possible (most of the time.) After a component is installed flush with the board, sharply bend its protruding leads on the wiring side in the general direction of the "trace" it should follow. Solder at least one end in place to hold the component before installing another one.

FIG-1: 4-LEVEL FSK DATA DECODER INTERFACE SCHEMATIC

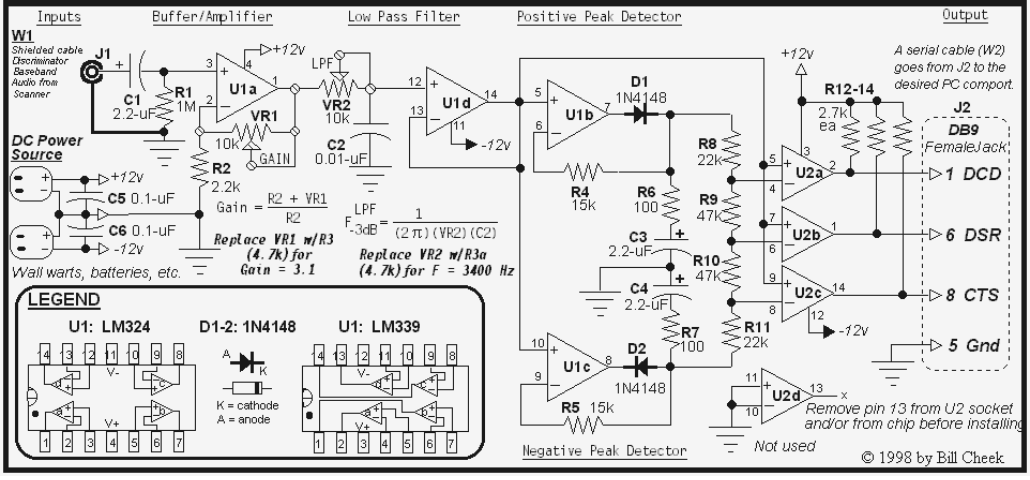
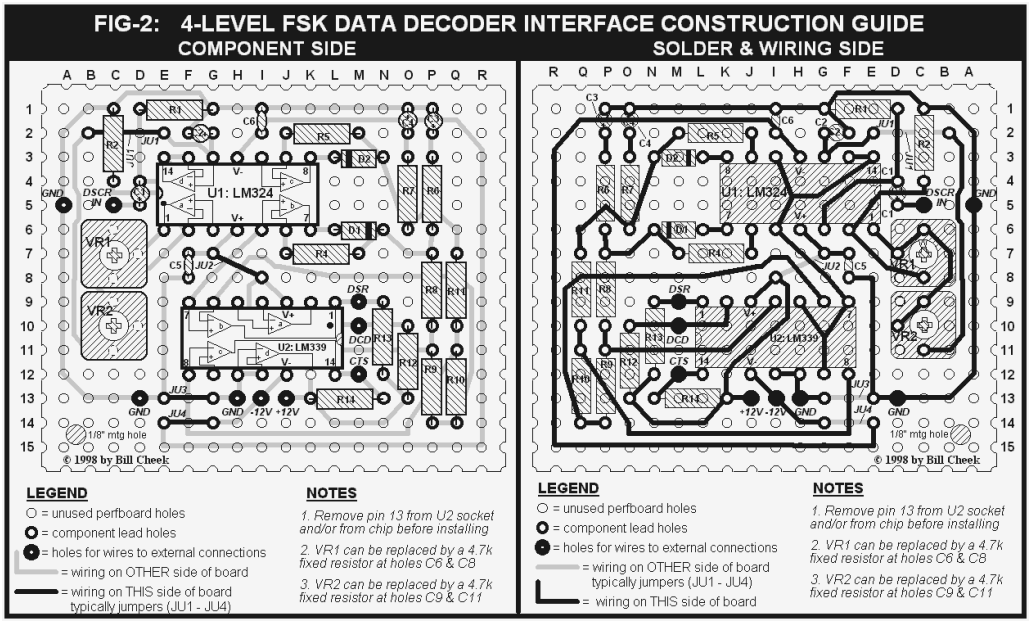


FIG-2: 4-LEVEL FSK DATA DECODER INTERFACE CONSTRUCTION GUIDE



Starting with R2, C1, R1, C2, C6, R5 and D2 as instructed above, install components, one at a time, working in and completing one area at a time. Work in a clockwise direction around the board. Where possible, tightly bend the leads on the solder side and route them as traces, instead of clipping them.

Follow the wiring and parts-placement patterns shown in Figure 2. Shorter traces will "rigidize" after soldering. Don't make anything permanent until after the board is tested and proved up. Observe polarity of diodes and electrolytic capacitors. Ensure IC's are correctly installed, per Pin 1 references.

Preset the adjustments of the two trim pots (VR1 & VR2) to midway between the ends. NOTE: the trim pots aren't absolutely essential. They can be replaced with 4.7k fixed resistors. (See Notes 2 and 3 in Fig-2.) VR1 sets the gain of U1a while VR2 is a Low Pass Filter adjustment for U1d.

Connect the 4LFSKDDI

Wire the outputs of the 4LFSKDDI to a female DB9 jack. Wire an RCA jack to feed the input to the 4LFSKDDI. Connect an ordinary shielded audio patch cable from the RCA jack to the NFM baseband audio output on your scanner. If needed, add a plug or adapter on this end of the cable to mate with the scanner's baseband audio jack.

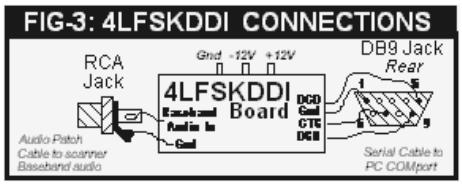
Connect a shielded straight-thru serial cable with a male DB9 plug to the 4LFSKDDI's female DB-9 jack. The other end of this serial cable should have a female DB9 (or DB25) plug (or adapter) to mate to the desired COMport on the PC.

The ± power supply can be connected in any number of ways, from the old fashioned hard-wired method to perhaps a stereo jack and plug with the shell grounded; -V on the ring and +V on the tip. A pair of monaural jacks with common grounds will work; +V on one center and -V on the other. Just don't reverse the +/- power polarities; the IC's will blow. Figure 3 illustrates the necessary connections.

TABLE 1: 4LFSK PARTS LIST

Ckt Sym	Qty	Description	Radio Shack #
U1	1	LM324 Quad Op-amp	276-1711
U2	1	LM339 Quad Comparator	276-1712
C1,3,4	3	capacitor; 2.2-uF/35v, tant	RSU11295888
C2	1	capacitor; 0.01-uF	272-1065
C5,6	2	capacitor; 0.1-uF	276-109
D1-2	2	diode; 1N914/1N4148	276-1620
R1	1	resistor; 1-M	271-1356
R2	1	resistor; 2.2k	271-1325
R4-5	2	resistor ; 15K	271-1337
R6-7	2	resistor; 100	271-1311
R8,11	2	resistor; 22K	271-1339
R9,10	2	resistor; 47K	271-1342
R12-14	3	resistor; 2.7K	RSU11344942
J1	1	RCA Jack	274-346
J2	1	DB9 Jack (female)	276-1538
	1	Perfboard:18 x 15 holes	276-1394-6
VR1-2	2	Trimmer pot; 10K, mini *(See R3 & R3a below)*	271-282.
		Optional and Peripheral Items	
*R3,3a	2	resistor; 4.7k	* 271-1330
A1	1	Enclosure	270-1802, 270-283A
W1	3ft	Shielded audio cable	42-2370
W2	6ft	Shielded serial cable (6' DB9 female/DB9 male cable)	26-117
	2	IC socket; 14 pin DIP	276-1999

* Can be used in place of VR1 & VR2



Wrap-up and Loose Ends

The circuit has been extensively field-tested and proved, so be patient. Use a bright light and a strong magnifier to examine your work as you go! Common errors include missing traces and jumpers, reverse polarity of capacitors and diodes; cold solder joints; and solder-blobs or short-circuits in tight places. Despite the high-density design, cramped quarters are few, largely in the vicinity of U2 pins 3-5, U1 pin 12, C1, R2, and some of the area between U1 and U2.

Most "traces" are rigid once soldered at each end, but a few might be "wiggly" unless anchored in some manner. Pay special attention to traces E14-I2, F12-Q11, E13-P1, and H9-Q14. Anchoring can be with super-glue, hot glue, or even loops of wire passed through holes on either side of a trace, for instance at holes B12 and A13 to anchor the corner of trace E13-P1.

For detailed information on hobby circuit building, including pcb-making, see my four-part series, "Cool Ways to Design Circuits," Apr-96 through Jul-96. *MT* offers low-cost reprints if you don't have those issues.

Test the 4LFSKDDI

Download POCFLEX.ZIP from the following site:

http://www.geocities.com/CapeCanaveral/Launchpad/4039/PINFO.HTM

Docs and insider information at this site make this program an excellent test platform for the 4LFSKDDI, if legal in your area. Unzip the POCFLEX.ZIP archive into a new directory, say: \4LFSK

Review the contents, especially the *.htm files, which are the docs for this program. For a quick-start, follow the next five steps exactly:

1. Set the scanner to searching the 928.0-932.0 MHz band segment.
   A. Connect the baseband audio output of the scanner to the RCA jack on the 4LFSKDDI
   B. Don't power up the 4LFSKDDI at this time.
2. Edit the POCFLEX.INI file in the \4LFSKDDI directory as follows:
   TWOLEVELINT = 0
   SPORT = 2 (*See NOTE 1 below*)
   RCVPOLARITY = 0
   SHOWNUMERIC = 1
   SHOWMISC = 1
   TIMESTAMP = 1
   KILL_LF = 0
   prn_echo = 0
   lpt_port = 0
   screenmode = 2

NOTE 1: Make all settings exactly as shown above except for the SPORT = 2 line. Change the "2" to match the COMport (1-4) used by your 4LFSKDDI.

3. Edit the file called FILTER.INI as follows:
   textscan = 1
   scannumeric = 1
   scanaddr = 1
   filtfile = 1
   WINSIZE = 50
   beepfreq = 11000
   beeplen = 3

NOTE 2: Make all settings exactly as shown above.

NOTE 3: The POCFLEX.INI and FILTER.INI files are the configuration settings for the POCFLEX program. If you don't understand config files or don't know how to edit this type of file, you'll need to seek outside help. Make sure each of these two files contains the settings exactly as shown or discussed above. You can change them later to suit.

4. Power up the 4LFSKDDI.
5. Run pocflex.exe from a DOS command prompt, or from Win95/98 in a DOS window.

Make sure the scanner has stopped on an appropriate data signal (the 928-932 MHz band is loaded with appropriate data signals). If all is well, data should appear on the screen in a few seconds. If not, don't panic. Is the scanner on a data signal, and is the signal carrying data? Sometimes, these signals are "silent" between data bursts with clear tones. You can tell when data is present; check to be sure.

If all is well with the signal, but no data appears, then check the settings of the *.INI configuration files. Check all electrical connections and check for errors in the wiring of the connections, especially the DB9 wiring and the ± power polarity. Obviously, check the 4LFSKDDI board, too.

Support for this and all my columns is freely available by e-mail. If you're not computerized, please include an SASE with postal requests.

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