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406 MHz Distress Beacon decoder: New features with the "DECTRA" PCB

(Part 1 / 2)

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The beacon decoder circuit has been revised. A performance monitoring system LED has been added. It ensures that the FM receiver is correctly connected to the decoder. The input stage is now designed around a TLC2274 circuit (4 PDO "rail-to-rail") versus the original TLC272.

This decoder can display 4 lines of the information contained in the frames [1, 2, 3] (Photo 1). The time of receipt is recorded and displayed, and it is possible to recall the preceding frames. Associated with a receiver tuned to the frequency of the beacon, the decoder works completely autonomously. For good reception, it is best use the output from the "discriminator" in the associated receiver.

The new card has been called "DECTRA" for "DECodeur de TRAmes" (Photo 2) and a new circuit board was designed. Its size is only 99 mm by 36 mm. The length of 99 mm was retained to allow mounting it under the display. On the surface, this new card is less than half the size of the old card.

What remains unchanged is the microcontroller, a pre-programmed PIC 18F2685 and the display with 4 lines of 20 characters. The first version of the PIC program (V24 version of 2012) is available on the website www.F1LVT.com . Newer versions (the current version is VB2F) can be obtained in a pre-programmed PIC or free reprogramming of an older PIC. The new DECTRA card is fully compatible with the successive versions of PIC program. If you have an older version of the PIC, you can reuse it with this new card.

Photo 1 and 2: The frame decoder with its new DECTRA PCB and display. Above the display, you can see the lighted green LED 2 for monitoring system operation.

1 - New features introduced with the DECTRA PCB

The monitoring function is performed by 3 LEDs, two green LEDs and one red LED. This system was added because we realized that some problems with decoding either came from the state of the RX connection or between the RX and the decoder. Specifically, 3.5mm sockets can present some abnormalities leading to a non-operation of the decoder. Another example is the 9600 baud of certain dual-band TX not remaining always activated when you change bands. On some arrangements, a test of the receiver connection is possible at startup. We reworked this idea of equipping the new DECTRA circuit with a permanent verification system for the receiver connection. The system operates as follows:
- Upon powering the decoder, one of the 2 green LED's should light (one or the other green LED, they play a complementary role)
- When the receiver is on and correctly connected to the decoder, BOTH green LED's should stay on.
- When a frame is received, the red LED lights, and the decoded frame is displayed.

If the receiver is disconnected or turned off, only a single green LED remains on. Having both green LED's lit is a necessary condition for the proper functioning of the decoder. They indicate that the FM receiver signal is received.

But to have 2 green LEDs lit is not enough to decode correctly. It is also necessary to ensure that you are on the right frequency, the amplitude of the PSK modulation is sufficient, and that the decoder is set correctly to enable decoding.

As the connection monitoring system is permanent, it is possible to check at any time that the receiver is connected. A receiver off or a connecting cable problem can be detected immediately.

One note: when the decoder is tested with a frame generator (like described in the article "Generator 406 MHz beacon frames for verification operation frames decoders and for building exercise tag "[4]), the generator sends packets with no background noise from a FM demodulator. This makes only a single green LED light. Both are only lit at the time when the frame is sent, that is to say, for half a second.

The red LED is lit while the PIC is actively decoding data. The red LED concerns only the PIC. It is controlled by the activity of the PIC during decoding.

Regarding the PIC, a resistance of 10 k has been added between the pin 26 and ground. Pin 26 is used to program (PGM entry - The LVP function " Low Voltage Programming " and is ON by default - RB5 to be maintained in the low state during operation / Thanks F1BRO). In the absence of this resistance on pin 26, black squares appear from time to time on the display at startup. We must shut down and restart the decoder for the Home screen to redisplay. With the addition of this resistance on pin 26, the start of the PIC program is always correct.

Also regarding the PIC, the circuit around pin 1 of the PIC has been removed because it is used only in case of programming in situ. Reset is internal and cannot be accomplished by pin 1 of the PIC.

2 - The printed circuit

To facilitate copying and printing the DECTRA card, traces no longer pass between the legs of the integrated circuits (Figure 1). However, to remain a single-sided circuit board, we had to add 4 jumpers (4 straps) that must not be forgotten during the construction. Three of these jumpers are placed under the integrated circuits. It is best to start with these jumpers at the beginning of the wiring. The layout diagram (Figure 2 of the second part of the article) shows these jumpers that are labeled STR1 to STR4.

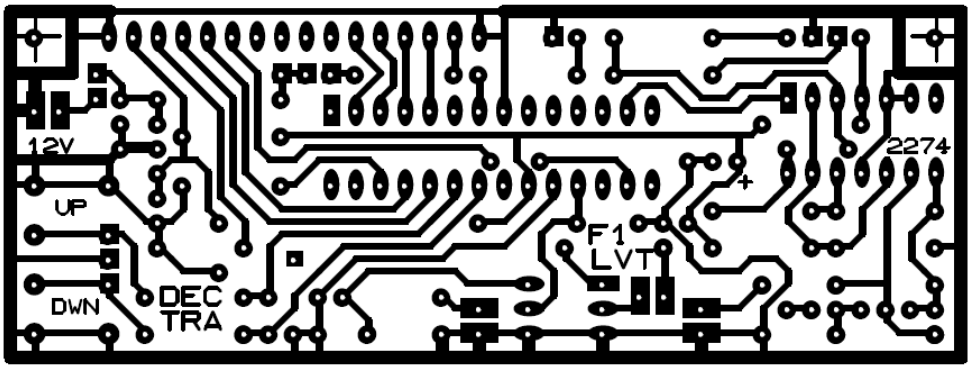

Figure 1: Printed Circuit DECTRA (trace side)

The size of the new card has been reduced to: 99 mm x 36 mm. Its size now allows now making 4 printed circuits on one Eurocard size (160 mm x 100 mm).

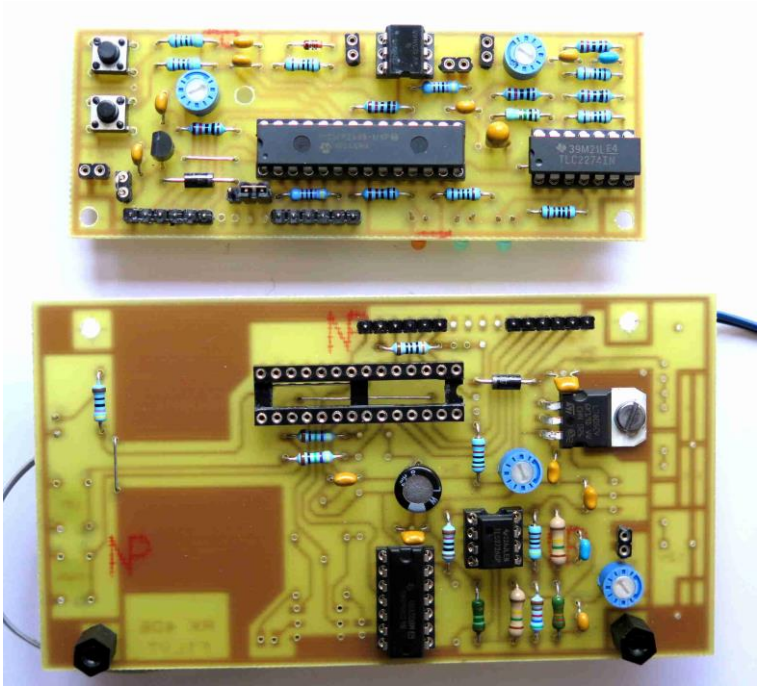

Photo 3: Comparison of the size of the DECTRA PCB (top) to that of the original PCB (bottom, partially wired)

The first circuit was designed as a support for accessories like signal input Jacks [1, 2, 3]. The circuit board exceeded size of the display on both sides. Its size of 125 x 62 mm resulted from these constraints. But now when you want to mount the receiver in anenclosure, it is the housing that will carry the Jack or pushbutton bases. The smaller size DECTRA card also makes it much easier to integrate into an enclosure housing (Photo 3).

On the printed circuit, the rectangular pads correspond to aux Input / Output connectors: 12V power supply, signal input, GPS inputs high and low impedance. The square pads match the marked points. For example to guide the LED's, the square pads correspond to their cathode. For Integrated circuits, the rectangular pad is pin 1. Three other points are marked off the location of the buttons "UP" and "DWN"; they are used to connect a cable for remoting these switches to a housing mounted switch. Similarly, two points are spotted near 12V connector in series with one. Wires can be added to this location to connect these points to an ON-OFF switch on housing. An isolated square patch is located above the capacitors C31 and C32; this point can be drilled with a 3 mm bit and secure a nylon screw to hold the printed circuit parallel to the display plane.

Since there are capacitors with 2.54 mm or 5.08 mm lead spacing, the pads allow the use of both types of components. The only exception is C31, pitch 5.08 mm only may be used due to trace locations.

The connectors (12 V power supply, input signal from the receiver, GPS input) were placed around the edge of the card, with the mass systematically outwards (Photo 4). The isolated input from a GPS receiver, connector GPS2, was set parallel to the edge of the card; entry signal is connected to resistor R43.

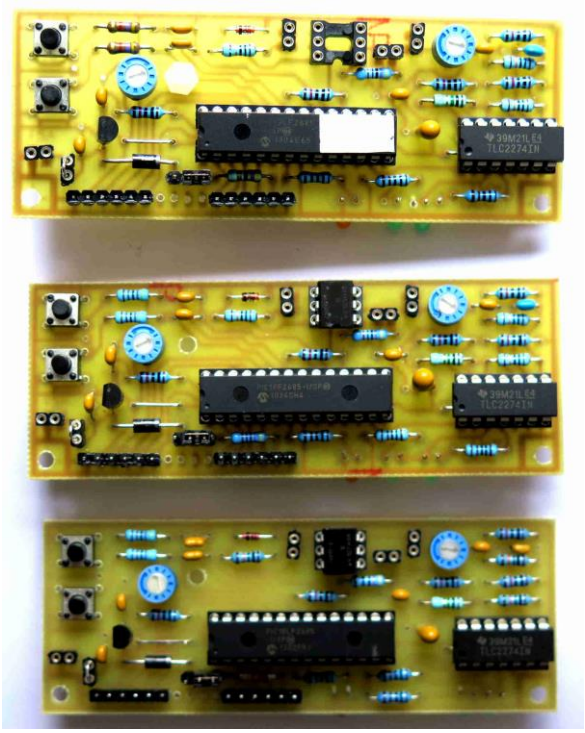

Photo 4: Three successive prototypes DECTRA PCB

3 - The choice of components

The input circuit is built around a TLC2274CN circuit (or TLC2274IN). It's a low noise Quad Operational Amplifier in a DIL14 housing, moderately fast (slew rate 3.6 V / us), "rail-to-rail" output, and it works very well in 5V single voltage. Its output current is limited, but sufficient with a 1k resistor in series with the green LEDs for monitoring the operation.

Using a "rail-to-rail" amplifier, we can fully use the dynamics of 5V output voltage, a 2.5V excursion around the midpoint. On the previous version we had used TLC272 amplifiers (corresponding to TLC274 in boxlike 4 amplifiers) that do not have this characteristic; supplied with 5V, their high voltageoutput does not exceed 4V, which limits the dynamic and can lead to decenter the mid-point of polarization.

As is standard pinout (Figure 2), this TLC2274CN circuit can be replaced by an equivalent circuit. For example the Texas Instruments TLV2374IN can be used. With Microchip, the equivalent circuits are limited in voltage but they can provide a higher current: the MCP6004-I/P can be used or the MCP604-I/P or MCP6024-I/P.

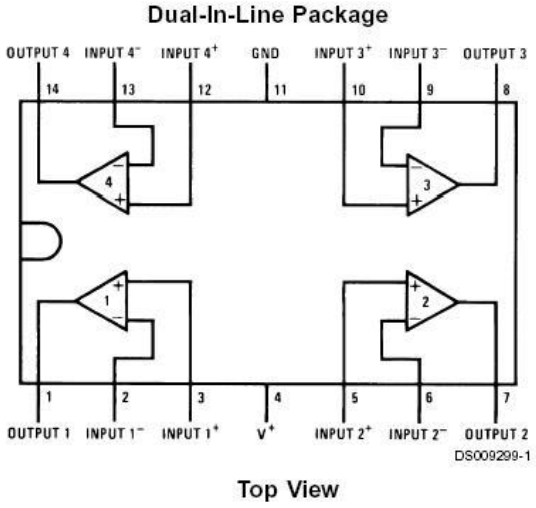

Figure 2: Pin assignment TLC2274 (classic pin for a quad op amp.)

For the power, given the current consumed by the circuit (28 mA at rest and 32 mA when decoding), a 78L05 regulator is sufficient. Its pinout is shown in Figure 3.

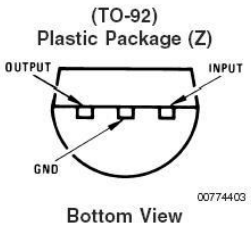

Figure 3: Pin assignment 78L05 5V 100mA regulator

The other active components are identical to those of the first version: the PIC 18F2685 microcontroller from Microchip, and CNY17-3 type optocoupler or equivalent. For LEDs, 2 green LEDs play a complementary role; they must be visible together. The third diode, red (or orange) should be mounted apart from the green LEDs to show when the circuit is decoding.

4 – The Schemas

4A – Power supply

The power section is very classic. The regulator is a 78L05 circuit (in case T092) framed by three 100 pF ceramic capacitors C11 to C13 (Figure 4). C12 should be an electrolytic capacitor of 100 µF, or tantalum capacitor of 10 µF.

The CN11 connector allows providing 12V (between 7 and 15V). Connector CN12 was added in series to be able to connect a front panel switch. If this function is not used, you can jumper this connector on the tracks. Connector CN13, is a two position jumper that allows selection of powering or not powering the display illumination. It is also can connect this with a front switch if desired.

The value of R11 series resistance is adapted according to the display. It allows sufficient power to read the display at night without turning it into a night lighting system. With the recent high-brightness displays, we can set this to 2.2 kΩ, which reduces the consumption of lighting less than 5 mA.

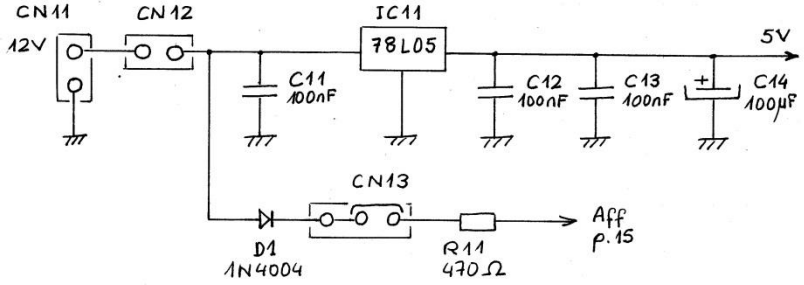

Figure 4: the supply portion of Scheme

List of components of the Power Circuit

R11	470Ω	To adapt it to the desired lighting: from 470 Ω to 2.2 kΩ
C11	100 nF	
C12	100 nF	
C13	100 nF	
C14	10 µF to 100 µF	polarized Capacitor
IC11	78L05	100 mA regulator
D11	1N4004	or equivalent diode
CN11	12V power connector	(8V to 15V)
CN12	Serial connector for Power switch	(can be bypassed)
CN13	Jumper connector for the display illumination	(can be bypassed)

4B - The input circuit and signal shaping

The signals are amplified and filtered by the first stage of the input circuit (Figure 5). The P21 potentiometer is used to adjust the input level and C21 removes the DC component. The divider bridge R27 - R28 provides the bias level to 2.5V for the input reference amplifiers.

The level of the output of the second stage flip-flop from 0 to 5V, making only one of two LED (LED21 and LED22) turn on. In operation, the noise output of the FM receiver produces a quick switch to the output, so that both LEDs appear to stay on. If only one LED is lit, the decoder does not hear the noise receiver bottom. The third amplifier is used for formatting signals before treatment by the PIC.

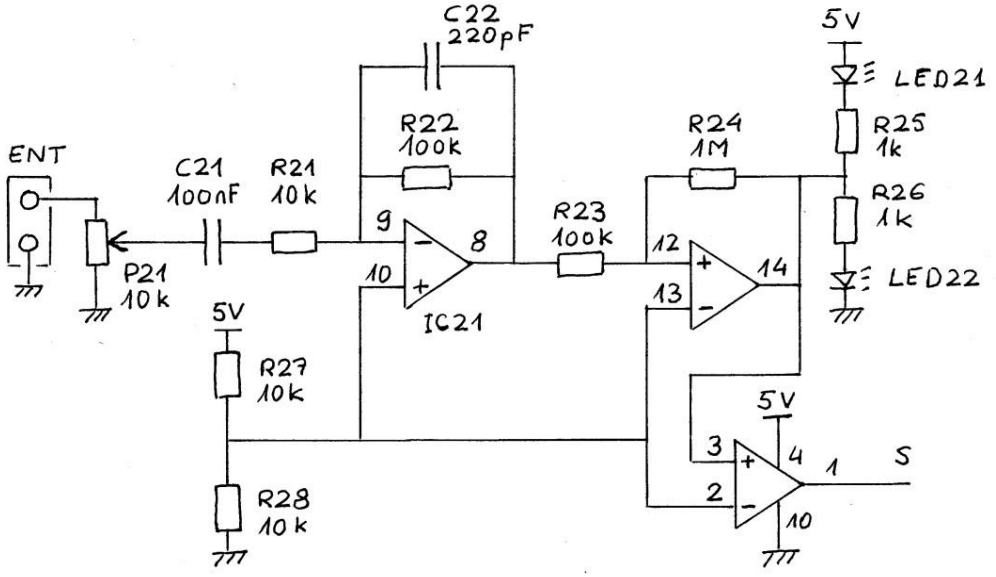

Figure 5: Diagram of input circuit

Components of the input circuit

R21	10 kΩ	
R22	100 kΩ	
R23	100 kΩ	
R24	1 MΩ	
R25	1 kΩ	
R26	1 kΩ	
R27	10 kΩ	
R28	10 kΩ	
P21	10 kΩ linear	Potentiometer circuit
C21	100 nF	
C22	220 pF	

IC21 TLC2274 or equivalent (4 op amp, Single-voltage power supply, rail-to-rail output)

LED21	green LED	Monitoring the input circuit
LED22	green LED	Monitoring the input circuit

ENT Input connector of the audio signal decoding
Support 14 br.

The R23 and R24 resistors are used to set the switching threshold of the second amp, which is 250 mV with the used values. With the gain of the first 10 amp, sensitivity of the mounting is 25mV. It is well suited for most receivers. In the case where would need to increase this sensitivity, R22 should be increased and C22 reduced in the same proportion to keep the same filter cutoff frequency.

4C - Microcontroller and Display

For the microcontroller, the resistor R31 was added to pin 26 (Figure 6). On the other hand, the resistors in series with the push-buttons have been increased to 4.7 kΩ.

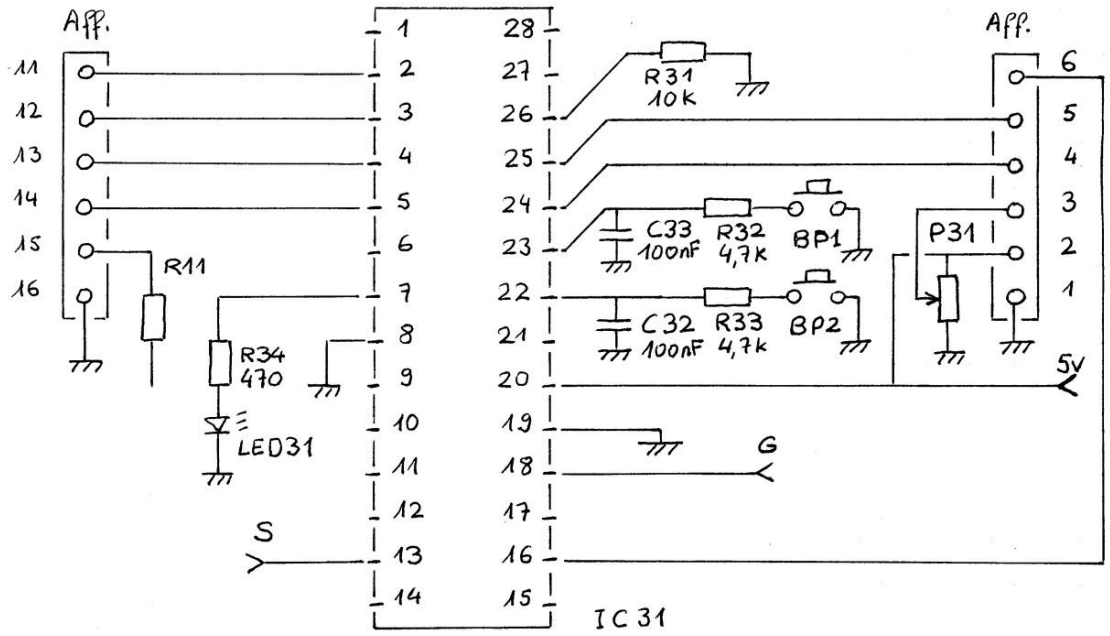

Figure 6: Diagram of the PIC part

Circuit of the display microcontroller

R31	10 kΩ	
R32	4K7	
R33	4K7	
R34	1 kΩ	
P31	10 kΩ linear	Potentiometer
C31	100 nF	
C32	100 nF	
IC31	PIC 18F2685	preprogrammed microcontroller
LED31	red LED	Indication of decoding by the microcontroller
Display	4 lines of 20 characters	Format 100 mm x 60 mm
BP1	Pushbutton	
BP2	Pushbutton	

Support 28 br.
Male connector X2 6 Points Display connector
Female connector X2 6 Points Display connector

4D - GPS Input

For GPS receiver circuit, there is no change from the previous card (Figure 7). GPS1 is the connector to the high impedance input and GPS2 to the isolated input. The CNY17-3 optocoupler may be replaced by an equivalent circuit.

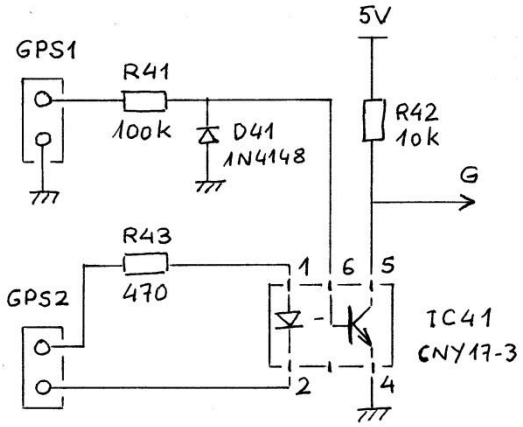

Figure 7: Schematic of the GPS input

Components of the GPS input

R41 100 kΩ
R42 10 kΩ
R43 470 Ω

IC41 CNY 17-3 optocoupler
D41 1N4148

Support 6 br.

GPS1 GPS high impedance input connector
GPS2 GPS isolated input connector and low impedance

The construction of the mounting will be described in the second part of this article

5 - References

[1] « Décodage des balises 406 MHz - Affichage sur 4 lignes des informations contenues dans les trames »
http://www.f1lvt.com/files/321-Decodeur406-Part1.81.pdf

[2] « Affichage sur 4 lignes des informations contenues dans les tramesdes balises 406 MHz : construction du décodeur »
http://www.f1lvt.com/files/322-Decodeur406-Part2-V2.123.pdf

[3] « Construction d'un décodeur « 4 lignes »pour la lecture des informations contenues dans latramedes balises 406 »
http://f1lvt.com/files/325-ConstructionDecodeur4Lignes-V3.133.pdf

[4] « Générateur de trames de balise 406 MHzpour la vérification du fonctionnement de décodeursde trames,et pour la construction de balise d'exercice »
http://www.f1lvt.com/files/311-ArtGeneTrames406.78.pdf