

“Montreal Doppler II” - by Jacques, VE2EMM

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- The original URL was: <http://www.qsl.net/ve2emm/pic-projects/mtldopii/mtdop2-e.html>
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- The pictures and diagrams referenced by some of the embedded links in this document may be found at the end of this document.

The MONTREAL DOPPLER II

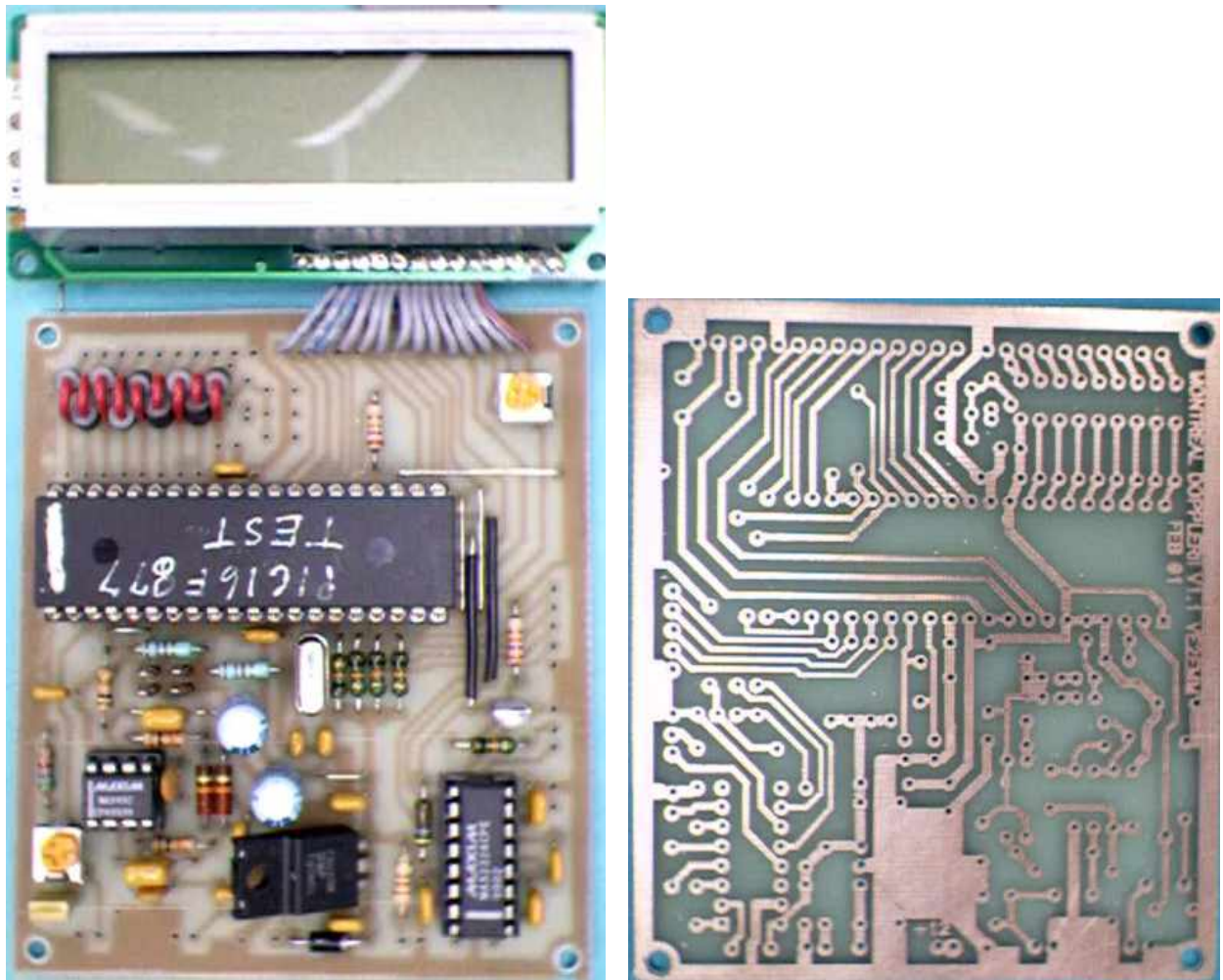
An all microcontroller doppler for home builders.
This is my most elaborate doppler, it should please the most avid Fox
Hunters.

Febuary 3rd, 01.



Take a look at these features.

- Small PCB, 3" X 3.5".
- Antenna switching for 4, 6, or 8 antennas.
- Plus going or minus going pulses for turning on the antennas.
- Antenna rotation; CW or CCW.
- Individual antenna testing.
- Auto calibration to front of car.
- 2 lines X 16 character standard LCD display.
- A 36 LED like and a 0-359 number display at the same time.
- All menus selections shown clearly on the LCD display.
- Permanent memory to save all options.



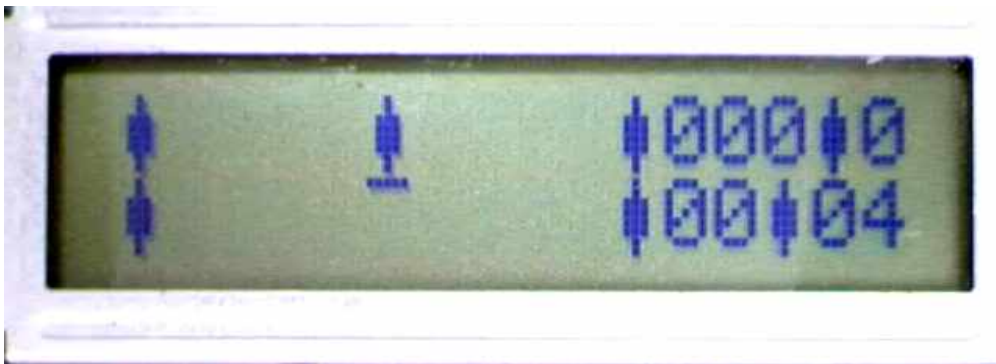
Montreal DopplerII prototype on PCB

More goodies.

- Signal processing mostly done in software
- Microchip PIC 16F877, Flash prog. Mem, EEDATA Mem, USART, ADC, Timers
- Calibration for 3 radios
- Output to APRS, GPS interface. Timed or provoked output.
- Built-in S-Meter display, the input is 0 to 2 < 5VFS for a display of 0 to 99.
- 7 selectable processing levels. Instant raw display selection.
- Maximum selectivity is +/- 0.1 Hz.
- Memorization of the last good return.
- Built in speaker.
- Backlighted display.

The 5 menus

Menu 1, the operating display.



- The left part is a 36 LED like display of the direction.
- Next on the first line is the direction is shown in degrees, 000 to 359.
- Last on the first line is the quality of the return, 0 to 8.
- Next to the direction, on the bottom line, is the input signal level, 00 to 99 and OL when in overload, or the S-Meter when activated, 00 to 99 and OL when the input signal level is in overload.
- At the extreme right, on the bottom line, is the selected processing level, 01 to 64.
 - PUSH BUTTONS FUNCTIONS
 - The left button forces a raw display and no processing.
- The center 2 buttons decrease or increase the processing level.
- Pressing the 2 center buttons at the same time instantly sends a transmission to APRS.
- The right red button stop processing and steps to the calibration menu.

Menu 2, direction calibration.



- Have a friend drive in front of you, his radio transmitting, then hit the 2 center buttons and the direction display will now be calibrated at 000 degree.
- To manually calibrate the direction, press the + or - buttons.
- Return to operation display by pushing on the left buttons (arrow).
- The right arrow or red button steps to the next menu.

Menu 3, antennas.



- Select the numbers of antennas and the switching polarity with the left button. 4,6,8, + or - switching.
- The Rotation button select CW or CCW rotation.
- The test button activate no antenna, or one of the antennas. The antenna array can then be tested.
- The right arrow steps to the next menu.

Menu 4, APRS options.



- The left button selects the baud rate to APRS. 2400 for Bob Simmons WB6EYV [DOPPLER D/F DISPLAY](#) on PC and also his [Palm display](#) , or 4800 for GPS and APRS.
- The next button selects what is sent to APRS. Nothing, DF, GPS, DF and GPS.
- Next is the time between transmission to APRS. OFF, ON every cycle or 5 seconds to 16 minutes.
- The right arrow steps to the next menu.

Menu 5, more options.



- The left button select one of 3 saved radio calibrations.
- The next button is the quality factor selection. The direction will freeze to the last good return when the returned QF is below the selected QF. 0 to 8.
- The 3rd button SMTR turns on or off the s-meter option.
- The right arrow returns to the operate menu.

View the [Operation and construction text](#).

Parts list.

Notes on the LCD Display;

I am using a 2 lines X 16 characters LCD display with a LED back light, I purchased it at a local electronic surplus store. I paid \$5 Can. for it. Do not hesitate to shop for surplus LCD, just make shure that it has the Hitachi HD44780 controller, also it must be of 2 lines X 16 caracters because the display locations are at secific addresses. Buy the largest display that you can find. You may look for sellers in the [NUTS & VOLTS](#) magazine, ask for a free sample issue.

What antenna to use;

May I suggest the use of Joe Moell K0OV wide [band antenna switcher](#).

View the [Schematic](#). (27K) The input filter was changed due to the unavailability of the MAX 294 switch capacitor low pass filter.

[The PCB](#). (300K)

[The Parts location](#). (114K)

[The complete top view](#). (184K)

The PCB, a programmed microcontroller, and the other ICs are available from [FAR CIRCUITS](#).

The programmed microcontroller is also [available from me](#).

Please note: The source program and the object code are not available for this project.

- **Thanks to my friends Yvan Roy and Claude Houde VA2HDD for their valuable help with this project.**
- I appreciate your comments and suggestions. [Please write](#).

Updated on March 25, 04.

Fine print:

All material on this page is distributed on a WYSIWYG basis and as such I can't take any responsibility for the use of this design and its results. However in saying this it must also be mentioned that every effort (1 1/2 year) has been taken to ensure that it as error free as possible.

[BACK TO HOME PAGE INDEX](#)

Many thanks to Al Waller K3TKJ for graciously hosting my web pages on QSL.NET.

Operation and construction text V1.1

THE MAIN DISPLAY

- *The left part is a 36 LED like display of the direction.
- *Next on the first line is the direction shown in degrees, 000 to 359.
- *Last at the extreme right on the first line, is the quality factor of the return, 0 to 8. NOTE: The quality factor is the amplitude of the 500 hz signal taken after the software filter.
- *Next to the direction, on the bottom line, is the input audio signal level measured before the software filter, 00 to 99 and OL when in overload, or the S-Meter when activated, 00 to 99 and OL when the input audio signal level is in overload. (It overrides the S-Meter)
- *At the extreme right, on the bottom line, is the selected processing level, 01 to 64. One processing level equals 24 antenna revolutions. One sample per revolution for a total of 24 samples.

MENU OPTIONS

- *Pushing the red MENU button steps the menus
- *Buttons are numbered from right to left.

- 1- OPERATE MENU ((1)/2/3/4/5) (MENU PB1)
 - * MORE PROCESSING, (1/2/(4)/8//16/32/64) (PB 2)
Each processing numbers represents 24 antenna rotations
 - * LESS PROCESSING, (PB 3)
 - * RAW DISPLAY, NO PROCESSING, (PB 4)
 - * INSTANT TRANSMISSION TO APRS, (PB2 AND 3)

2- CAL MENU

- * Auto calibration to 000 degree (PB2 AND 3)
- * (+) (PB 2)
- * (-) (PB 3)
- * (RETURN TO OPERATION) (PB 4)

3- ANTENNA MENU

- * TEST, ((NONE)/1/2/3/4/5/6/7/8) (PB 2)
- * ANTENNA ROT, ((CW)/CCW) (PB 3)
- * NUMB OF ANTENNAS&SWITCHING POL ((4+)/6+/8+/4-/6-/8-) (PB 4)

4- APRS MENU

- * TX RATE TO APRS, (PB 2)
(OFF/ON/(5)/10/15/20/30/40/50SEC./1/2/4/6/8/10/12/14/16MIN.)
- * TX TO APRS, ((NONE)/DF/GPS/GPS&DF) (PB 3)
- * Baud rate to APRS and (2400/(4800)) (PB4)
use 2400 for WB6EYV DOPPLER DISPLAY on a portable PC

or 4800 for APRS and GPS

5- OTHER OPTIONS MENU

- * S-METER, ((OFF)/ON) (PB 2)
- * DISPLAY above a QF of: (0/1/2/3/(4)/5/6/7/8) (PB 3)
- * RADIO, ((1)/2/3) (PB 4)

OPERATION

SET-UP

Run through all the menus and set them for your particular configuration.

CALIBRATION

Have a friend with a low power TX drive his car about 300 or more ft. in front of you, in the CAL menu hit the 2 middle buttons and the DOPPLER will be calibrated to 000 degree.

ROTATION INVERTION

During calibration, turn the vehicle 90 degrees to the left or counter clockwise. The display should read 90 degrees. If the display reads 270 degrees, change the rotation direction in the ANTENNA Menu.

S-METER

The receiver must generate 0 to 2 < 5 Volts DC as S-Meter output. Saturate the RX with a signal, adjust VR2 for a reading of 98-99 on the S-Meter display.

OPERATION

The input level on the second line should be kept at around 90, if the level goes too high it will show OL, if you have chosen to display the S-METER instead of the signal level, it will also display the OL. Reduce the volume control to remove the OL and to go back to a normal level.

When the shape of the 500 Hz is not good and the QF goes below the selected QF value (OTHER OPTIONS MENU) the display will freeze to the last good value.

Use the squelch on your radio, it prevents false display when there is no modulation.

To send a DF packet /and/or a GPS sentence to APRS, place the APRS TX menu to the desired transmission and the TIME menu to OFF. Press the 2 center buttons each time a transmission to APRS is desired.

Do not activate the transmissions to APRS unless you need it, it consumes up to 2 seconds of DF time at each transmission.

Switching a speaker in/out will change the displayed direction, make your choice before the calibration and do not change it during the hunt.

HOW IT WORKS

THE ANALOG SECTION

The audio in is first passed through a pair of peaking amplifier. Diodes D2 - D5 limit the amplitude of the 500 Hz signal, thus removing some of the noise and modulation that could be on the signal. The peaking amplifiers are set to 500Hz and pass only a band of +/- 35 Hz.

THE DIGITAL SECTION

Inside the PIC (software), the 500Hz input from analog input AN1 is sampled once per revolution of the antenna, it takes 24 revolutions to complete an acquisition cycle. By adjusting the processing level, the acquisition can be increased up to 1536

revolutions of the antenna(a processing level of 64 cycles).
The phase is extracted from the accumulated data at the end of
the processing.

APRS

If you have more than one GPS, either TTL or RS232 output from
a GPS can be jumper selected. A DPST switch could also be
installed to make the selection.

The PIC places the direction packet at the end of the GPS
transmission. Do not activate the GPS and/or DF output if they
are not used as they consume processing time from the PIC.

CONSTRUCTION HINTS

Box

Use a metal enclosure to contain the microprocessor noise.

Use 4-40 hardware for the PCB mounting and 2-56 for the display.

DISPLAY The display can be any LCD 2 lines X 16 characters module that is
compatible with the Hitachi HD44780 controller commands.

APRS

If you have no APRS or GPS, omit Q1, R14 to R16, IC4, C18 to
C22.

S-METER

If you will not use a S-Meter, VR2 and C15 can be left out,
R12 must stay to protect the analog input of the PIC, place a
jumper between the left side of R12 and the wiper location of VR2.

ANTENNA SWITCHING LIMITATIONS

Each antenna switching wire is limited to 25mA sink or source.

The maximum total simultaneous current sink or source by the PIC
to all the antennas is 200 mA.

KOOV WIDEBAND SWITCHER

There are some uncommitted component locations at the 5V for
the switcher. Use them to install Joe Moell KOOV wide band
switcher parts that are needed to reduce the 5V to 3V.

ANTENNA ARRAY

Make the antenna array out of stiff wire to enhance the stability
of the display, as flexible wire will jitter the display.

ADJUSTING THE PEAKING FILTERS

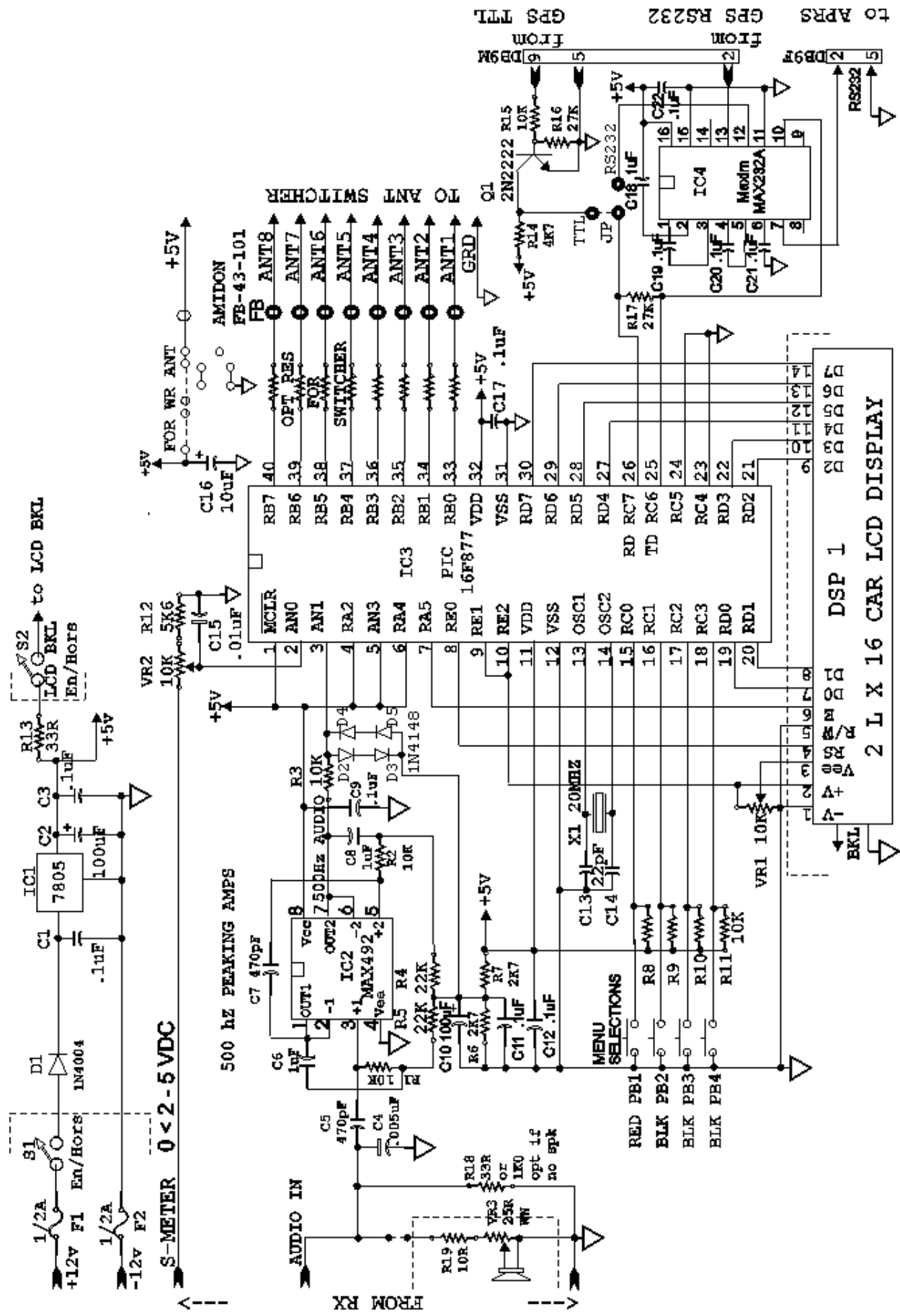
(An important step for best performance)

Do not install or if installed remove R4 and R5, feed antenna #1
switching signal with a 1K resistor in series to the audio input,
put a 50K potentiometer at the place of R5, adjust the pot until
a peak is reading is obtained on an AC voltmeter or a scope at
pin 1 of IC2. This will place the peak response of the peaking
amplifier number 1 at the frequency of the antenna switching.

Measure the resistance value of the pot and install a fixed or
combination of resistors equivalent to the pot at location fo R5.

Do the same for peaking amplifier #2, put a 10K resistor instead
of the 1K in series with the antenna switching signal, place the
pot at R4 location, measure at pin 7 of IC2 and likewise replace
R4 with a fixed resistor of the value of the pot.

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VE2EMM
 MONTREAL DOPPLER II DF
 JACQUES BRODEUR
 V1.1
 FEB 22, 01

RADIO GONIOMÈTRE
 VE2EMM

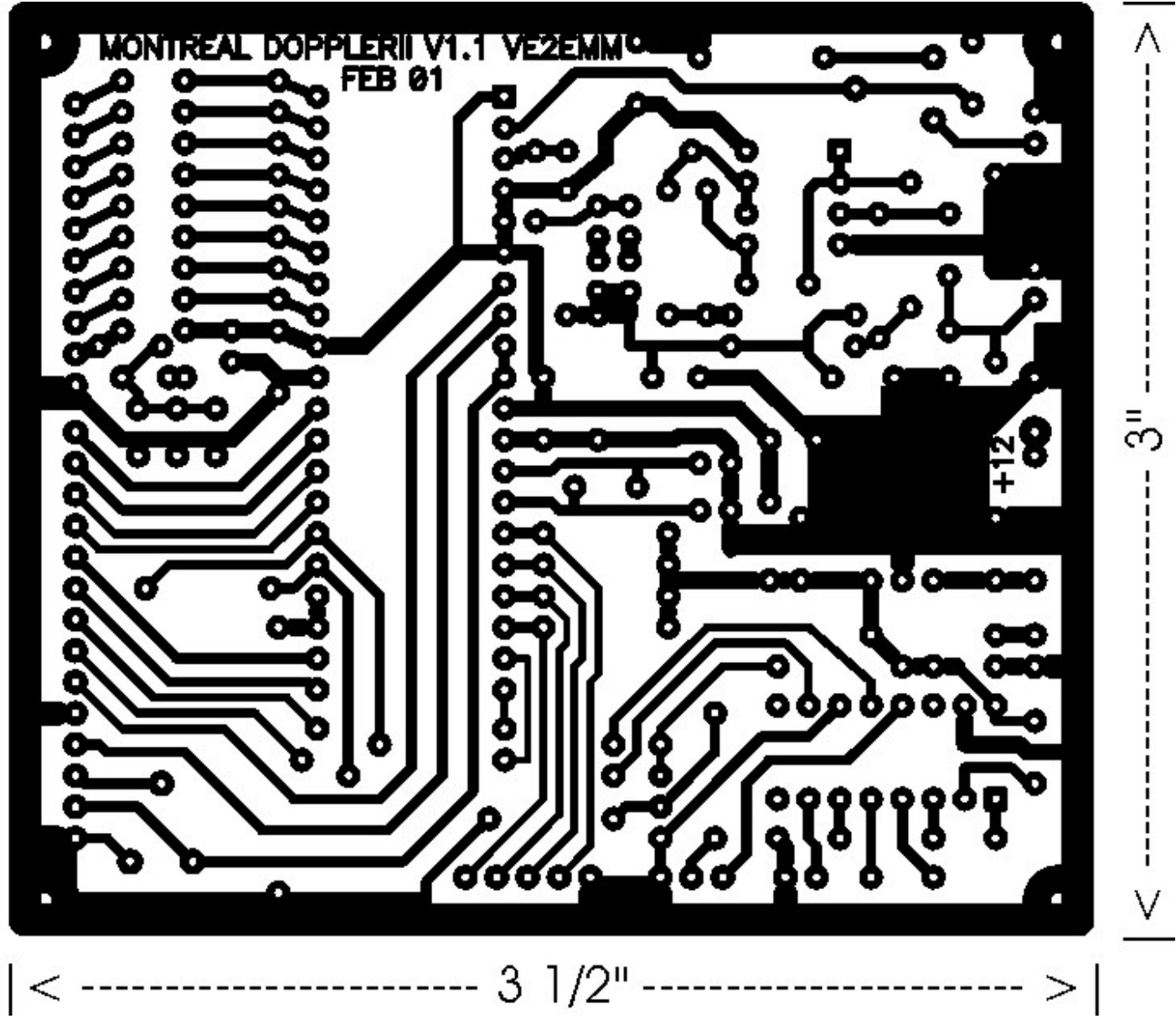
MONTREAL DOPPLERII V1.1 VE2EMM

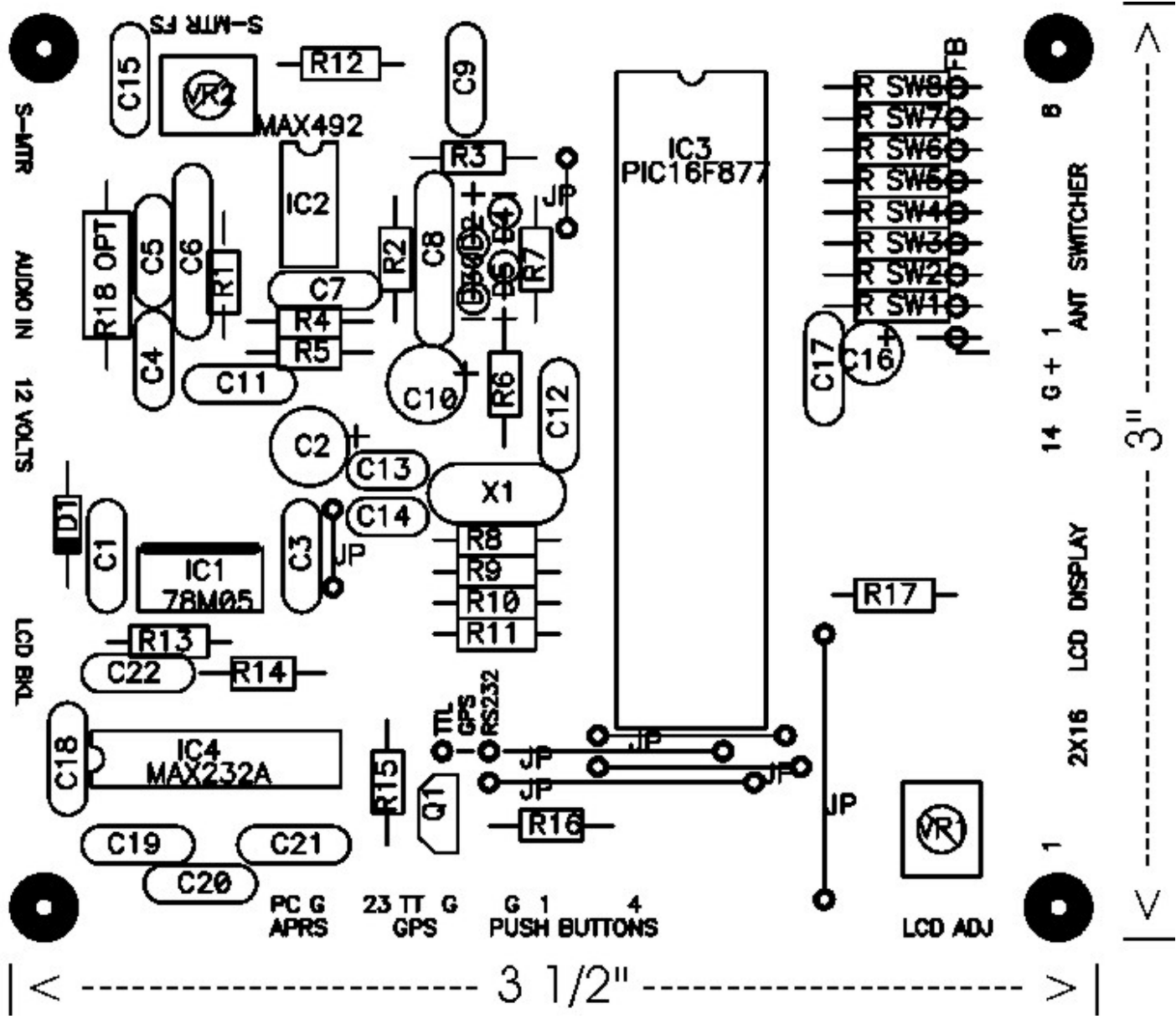
FEB 01

+12

3"

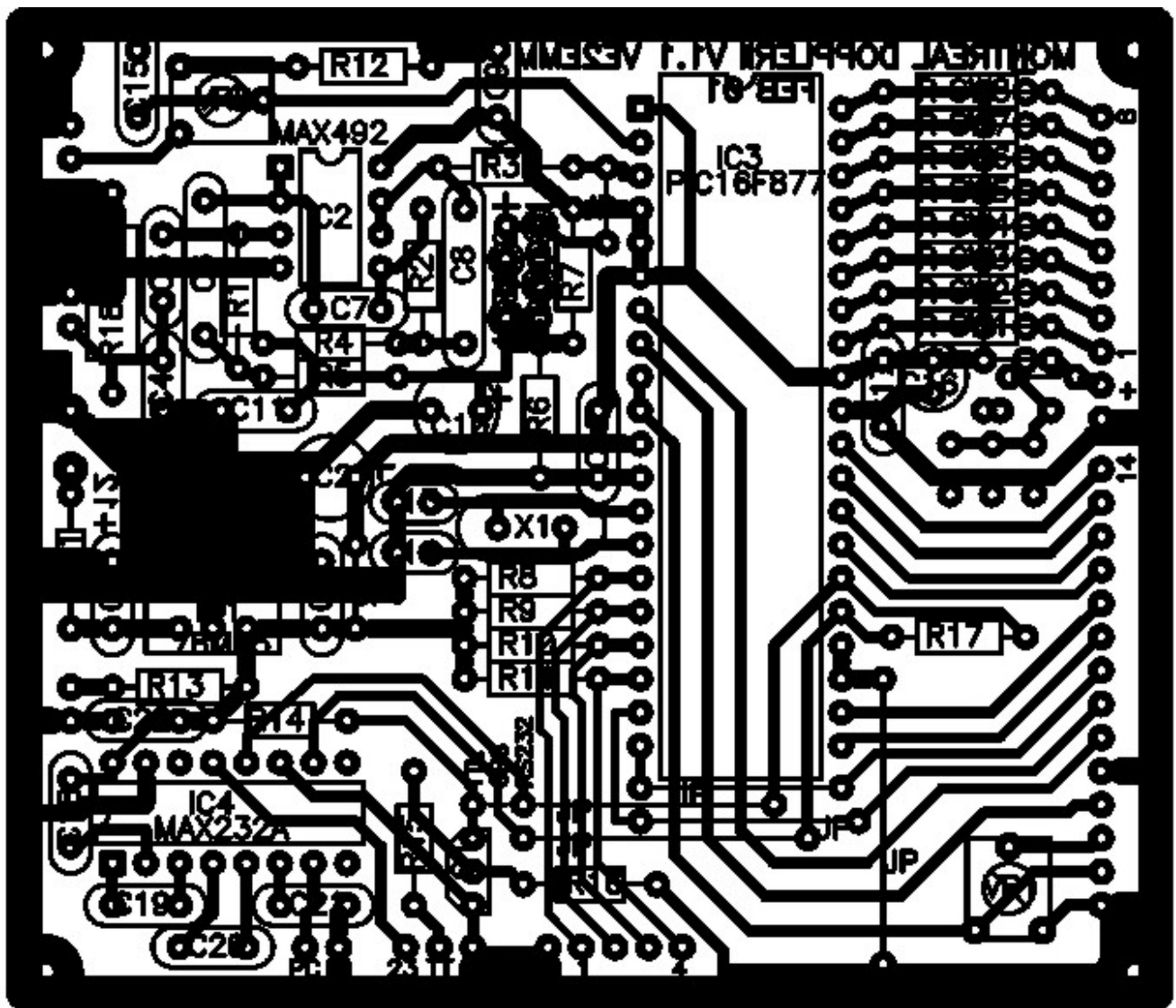
3 1/2"





3 1/2"

3"



<----- 3 1/2" ----->

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