

# Pic2Mag's Field Calculator Mobile Version 1.4



<https://play.google.com/store/apps/details?id=pic2mag.android.fieldcalc13>

<https://apps.apple.com/us/app/pic2mag/id1514504657>

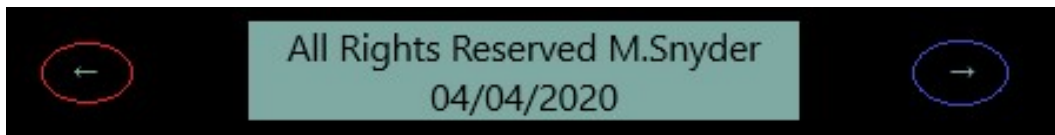
<https://www.microsoft.com/en-us/p/pic2mags-field-calculator/9mx7092smvm1>

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Pressing the left small arrow located at the bottom of the screen, next to the copyright notice, will pull up the initial settings screen.

You can press the left small arrow (shown circled in red) at any time to access and set the global settings like 'Magnetic' or 'Electric' mode.



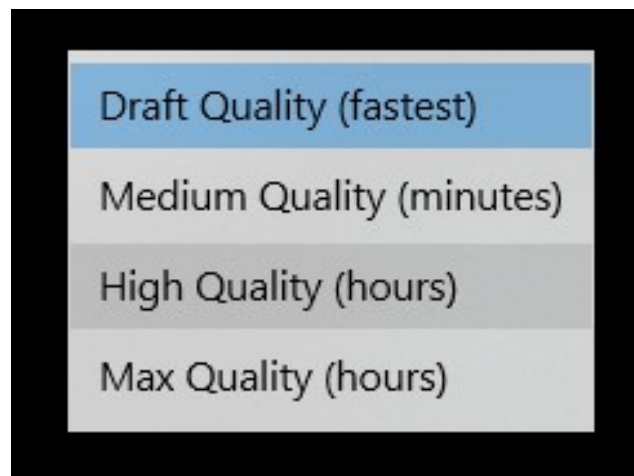
Pressing the right small arrow located at the bottom of the screen (shown circled in blue) next to the copyright notice, will pull up the processing screen. It also exits help mode.

The processing screen has all the options for setting the distance from the magnetic surface, and multiple isopotential and directional vector plotting options.

**You can press either of the screen mode selection arrows at any time.**



The user can select different quality levels which have different processing times. The default setting of 'Draft Quality' has a 640 pixel resolution along the longest image axis.

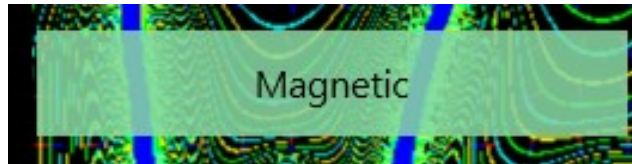


'Medium Quality' has a 800 pixel resolution

'High Quality' has a 1024 pixel resolution

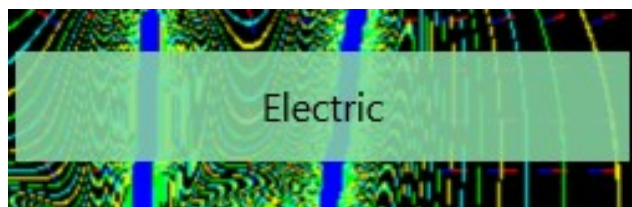
'Max Quality' has a 1280 pixel resolution

More pixels take more time, because each pixel interacts with every other pixel. The newest desktop processors can process images in a few minutes, Older processors and mobile processors can take hours to process an image at the highest resolution settings the first time.



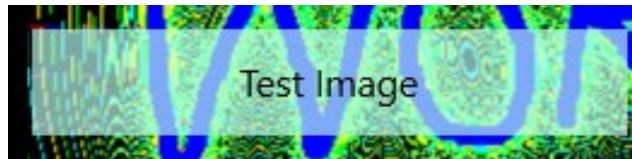
Clicking on 'Magnetic' mode sets the drawing mode to use the red and blue colors, and the directional vector plotting method to use red and blue arrows.

The Pic2Mag engine interprets Red (255,0,0) as a pixel with a magnetic moment in the positive Z direction, and Blue (0,0,255) as a pixel with a magnetic moment in the negative Z direction.



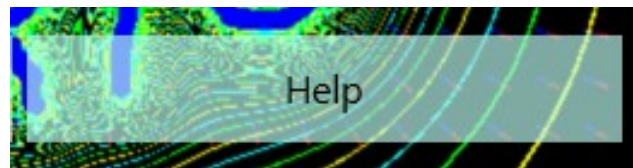
Clicking on 'Electric' mode sets the drawing mode to use the pink and dark purple colors, and the directional vector plotting method to use pink and dark purple arrows.

Pink (255,0,128) pixels are interpreted as a electric monopole sources, and dark purple (128,0,128) pixels as electric monopole sinks.



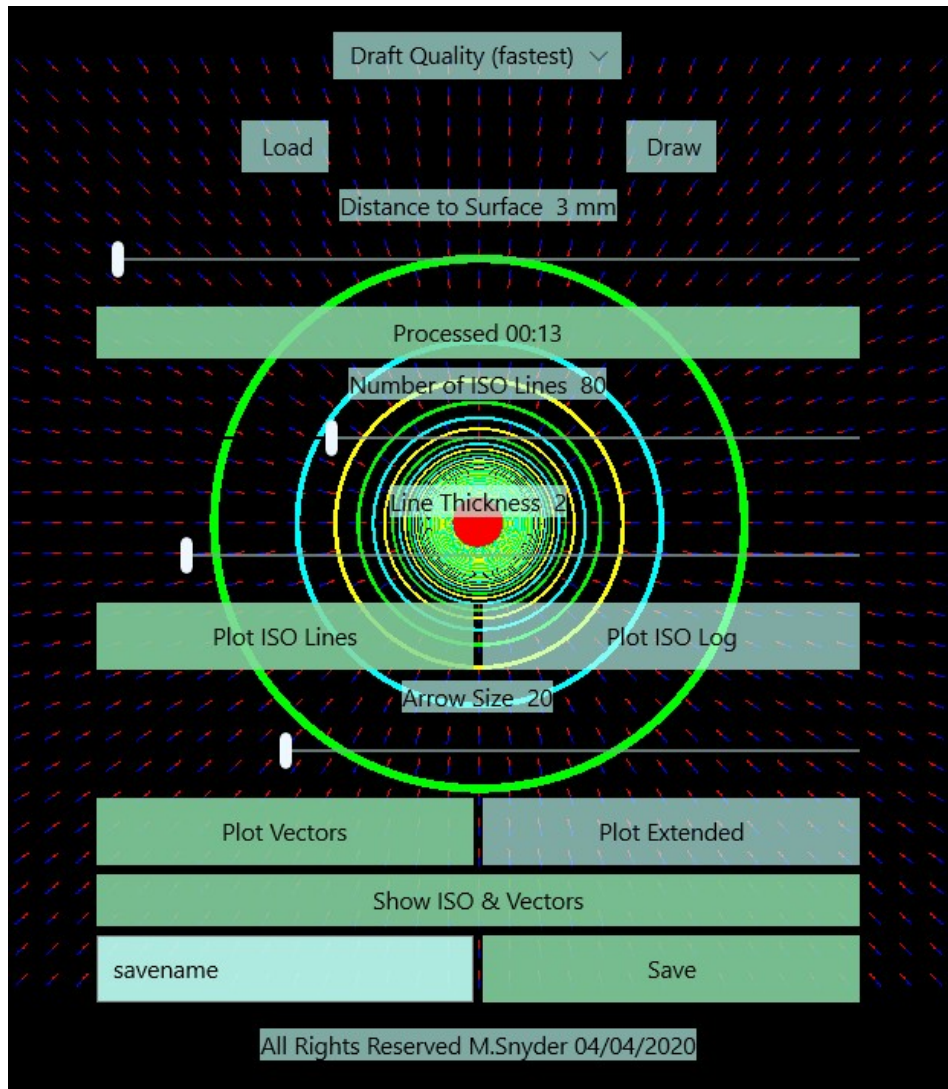
Pressing the 'Test Image' button will cycle through 23 different test images, and the user can set the desired resolution and press the 'Process' button to process the image.

Expect at least 10 minutes processing time on the first image that you process, and that the processing time will get shorter as you process more images and build more libraries.



Pressing the 'Help' button pulls up this series of help slides. Each time you press the 'Help' button, it will advance to the next help slide.

**Pressing either of the arrows located at the bottom of the screen, next to the copyright notice will exit help mode.**



The processing mode screen is designed to be used from top to bottom. First you either 'Load' or 'Draw' an image, then 'Process' the image, then pick either 'Plot IOS Lines' or 'Plot ISO Log' to plot the image, then pick either 'Plot Vectors' or 'Plot Extended' to plot field direction.

To finish, click on 'Show ISO & Vectors' to see both plots, then enter a name in the 'savename' field and press the 'Save' button.



The 'Load' button is used to load images into memory from your device. The Pic2Mag engine prefers 1280x1280 png format files, but you should be able to load any image file that your device supports, and the program will then resize it based on your 'Quality' settings.

The program looks for certain RGB color values in the image file and when it finds the exact match the program plots that pixel as a one millimeter cube permanent magnet with a defined magnetic moment angle.

In 'Electric Mode' each pixel represents an one millimeter cube of a ideal charged conductor.

Different colors are defined to have different magnetic moment directions. Imagine the viewing screen is a XY plane and that you are observing from the +Z direction. The magnetic or the charged surface, that you are viewing is located at ( $Z=0$ ) with the observer at ( $Z=3$ ).



Pressing the 'Draw' button switches you to a drawing screen where you can pick different sized circles to draw on the screen. Red represents a 'North' pole surface and Blue represents a 'South' pole surface. In 'Electric' mode pink represents a positive charge and dark purple represents a negative charge.



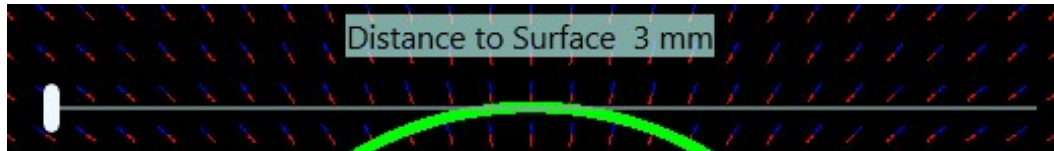
Once you enter into drawing mode you will see four buttons at the bottom of the screen. The 'Save' button is used to save your drawing and return back to the processing mode. The second button toggles the colors that you are drawing. You can also pick the background color in order to cut out special shapes like a ring magnet.

The third button sets the size of the circles or the lines that you are drawing on the screen.

The fourth button 'Undo' allows you to remove the last thing you drew, or to clear the screen.



The 'Distance to Surface' slider sets the distance in millimeters between the magnetic surface ( $Z=0$ ) and observing plane which defaults to ( $Z=3$ ). The farther away from a magnetic surface, the weaker the magnetic field.

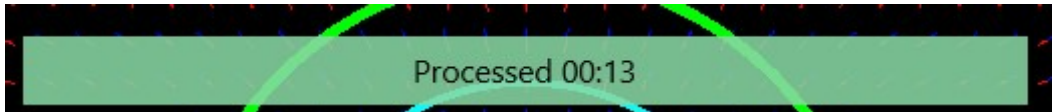


For example, imagine you have a cube magnet sitting on a table with the south pole surface touching the table. That means that the north pole surface is facing the viewer in the  $+Z$  direction and we should use a red color to represent the cube magnet. Then we add some more cube magnets with the blue south pole surfaces facing the observer.

Next we put a sheet of glass over the cube magnets and use a gauss meter to take gauss readings at the top of the glass surface.

How thick is the glass? Let's say it is 3mm thick. In other words, Pic2Mag is like an Ising model under a glass window :)

Once you have an image loaded by using one of the test images, or loading an image from storage, or drawing an image using the drawing mode, then you can press the 'Process' button.



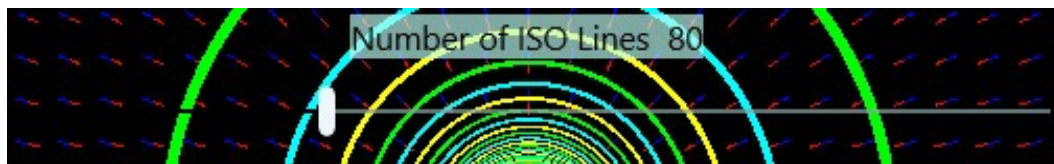
The Pic2Mag engine will divide your image up and start multiple processing threads using all your device's cores.

The engine will also make and save library files of the intermediate results which will save time the next time a similar drawing is processed.

The processing mode can be stopped by pressing the 'Cancel' button that appears after you press the 'Process' button. It takes some time to end all the processing threads.

Expect initial processing to take at least 10 minutes on most devices. The more that you use the program, the faster it gets.

Magnetic fields and Electric fields can be mapped using isopotential plots. Pic2Mag computes the vector field for each  $(x,y,z)$  point and then a scalar field is calculated using the norm of each vector or it's Euclidean distance.



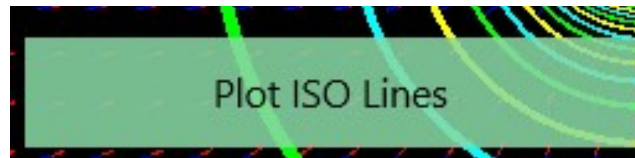
The algorithm that plots the isopotential lines searches for equal or similar values adjacent to each other. Once two equal values are found adjacent to each other, it turns on the display pixels for those  $(x,y,z)$  locations.

Electric fields have isopotential lines of equal voltage and Magnetic fields have lines of equal magnetic potential.

In general Magnetostatic or Electrostatic isopotential lines are parallel to each other and perpendicular to the field gradient.



The user can pick the number of isopotential lines and the thickness of the lines and then press the 'Plot ISO Lines' button to plot the image.



The isopotential algorithm uses repeating sets of teal, green, and yellow lines similar to lines in a topographic map. The three colors become more greenish when they are spaced closer together. The strongest areas of the field appear the most green.



Pressing the 'Plot ISO Log' uses the same ISO algorithm but replaces each scalar field value with the logarithm value.  $\text{Plot}(\text{Log}(\text{value}))$  instead of  $\text{Plot}(\text{value})$ .

This improves the algorithm's search function and makes the width of each plotted isopotential line wider.

The 'Arrow Size' slider sets the size of the plotted directional arrows. Smaller 'Arrow Size' values plot more arrows and larger values plot fewer arrows.


The plotted arrows show field direction but do not show field magnitude.



In 'Magnetic' mode the red part of the arrow points to the nearest blue south pole surface and the blue part of the arrow points to the nearest north pole surface. This is the same behavior as a physical compass needle.

In 'Electric' mode the dark purple part of the arrow points to the nearest positive charge and the pink points to the nearest negative charge.

The directional arrow plotting algorithm reads the vector  $(i,j,k)$  float values for a field  $(x,y,z)$  grid location and plots the  $i,j$  vector components as a colored line.



Plot Vectors

Pressing the 'Plot Vectors' button plots the directional arrows. You can press the back arrow to return back to the processing screen.



Plot Extended

The 'Plot Extended' vectors algorithm is nearly the same as the directional arrow plotting algorithm. The arrow plotting algorithm reads a set of  $(i,j,k)$  vectors at a  $(x,y,z)$  grid location and plots a colored line based on the vector.

The extended plotting algorithm starts out the same way but only places a colored dot at the first location, and uses the first set of  $(i,j,k)$  vectors to make a pixel sized unit vector in order to hop forward six pixels and read the next  $(i,j,k)$  vector at a new  $(x,y,z)$  location.

Then the extended algorithm plots a colored dot at the new location and repeats the process. This creates a path of colored dots based on the vector values. This path of dots is similar to a mathematical streamline.

The 'Show ISO & Vectors' button takes the isopotential plot and directional vector plot and makes a composite image. The isopotential lines show relative field strength and the vector arrows show the field direction.



After the system computes the isopotential plot and the directional vector plot and the combined isopotential directional plot then you can save the images to your image directory by entering a text 'savename' and pressing the 'Save' button. The button should have blue color flashes as it saves.



Most likely, based on the security defaults of your device, you will need to allow the Pic2Mag application to access your image storage location and to save files.

Click on your device's settings tab, then click on applications, then click Pic2Mag, then click 'enable' on storage permissions.

You can edit images up to a maximum size of 1280x1280 pixels in a png file in any graphics editor. You must set the correct RGB colors for each magnet that you draw. The author uses AutoCAD to draw precise magnet shapes and then MSpaint's paint-bucket command to color the shapes before loading and processing the drawn magnet arrays with the Pic2Mag application.

Color Spin Vectors™ on a Black Background (0 0 0)

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Screen Direction - Degrees - Clock - Color - RGB Colors

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(Up) - 0 Degrees - 12:00 Clock - Light Yellow - (255 255 128)

(Upper Right) - 45 Degrees - 1:30 Clock - Orange - (255 128 000)

(Right) - 90 Degrees - 3:00 Clock - Aqua - (000 255 255)

(Lower right) - 135 Degrees - 4:30 Clock - Purple - (128 000 255)

(Down) - 180 Degrees - 6:00 Clock - Dark Green - (000 128 064)

(Lower Left) - 225 Degrees - 7:30 Clock - Brown - (128 064 000)

(Left) - 270 Degrees - 9:00 Clock - Green - (000 255 000)

(Upper Left) - 315 Degrees - 10:30 Clock - Lavender - (255 128 255)

(Towards Viewer) - North - (+Z) axis - Red - (255 000 000)

(Away Viewer) - South - (-Z) axis - Blue - (000 000 255)

(Towards) - Positive Electric Charge - Pink - (255 000 128)

(Away) - Negative Electric Charge - Dark Purple - (128 000 128)

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# Pic2Mag's Software Privacy Statement

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Pic2Mag software does not collect any intentional information from its users. The program is designed to either allow a user to draw an image, or to load an image file from a local file system and process the image, then ask for a filename and save a set of images to the pictures directory.

While it is possible future versions of Pic2Mag software will send images (of user drawn magnet arrays) to a central location for faster processing; the present software has no internet usage of any kind. The program is literally a graphical user interface tied to an image processing library. Neither part of the program uses internet resources.

In other words, when Pic2Mag software runs, from the software's viewpoint all resources are local on the device and there is no remote communication of any kind.