IMPORTANT

Use of the GoldPic design, Semi-Kit and all related information is entirely at your own risk. In no event shall the supplier be liable for any damages whatsoever.

Introduction

These instructions describe how to build and operate your GoldPic 3. In addition to the Semi-Kit you will require the following:

- An intermediate level of electronic kit assembly experience
- Soldering Iron, Side-cutters
- The items listed in the Components List
- An Oscilloscope (not essential but makes fault finding and tweaking simpler)
- Basic plastic and metal working skills and tools (drilling, filing etc)

Components List

Semiconductors and Modules

IC1	78L05	TO92 +5V Voltage Regulator
IC2	7660	Voltage Converter
IC3	LM318	Fast Op Amp
IC4	4066	Quad Analog Gate
IC5	PIC16F84	Pre-programmed Micro (Supplied in Semi-Kit)
IC6	ADC0831	Analog to Digital Converter
D1 to D6	1N4148	Silicon Diodes
Q1	IRF740	High Voltage Power MOSFET
Q2	BC560C	High Gain PNP Transistor
Q3, Q4	BC550C	High Gain NPN Transistor
LCD1	16 Character 2 Line Alphanumeric LCD (eg Sharp LM16A21)	

Capacitors, with Lead Spacing in brackets. (**Note:** There is no C7.)

C1	4700uF 25V	Radial Electrolytic	(7.5mm)
C2, C3	470nF	Multi-layer Resin Dipped Ceramic	(5mm)
C4	10uF 25V	Radial Electrolytic	(2mm)
C5	10nF	Multi-layer Resin Dipped Ceramic	(5mm)
C6	47uF 25V	Radial Electrolytic	(2mm)
C20	6p8	Ceramic Disk	(5mm)
C8	100uF 25V	Radial Electrolytic	(2.5mm)
C9, C10	10nF	Multi-layer Resin Dipped Ceramic	(5mm)
C11	2u2 63V	Radial Electrolytic	(2mm)
C12	47uF 25V	Radial Electrolytic	(2mm)
C13	1uF 63V	Multi-layer Metallised Polyester	(5mm)
C14, C15	10pF	Ceramic Disk	(5mm)
C16, 17, 18	10nF	Multi-layer Resin Dipped Ceramic	(5mm)
C19	100uF 25V	Radial Electrolytic	(2.5mm)

Resistors

All resistors Maplin 0.6W Metal Film 1% recommended (same size as ¼ W)
Or ¼ W Metal Film 1% (Note: There is no longer an R5)

R1	300	
R2, R3, R4	100	
R6	100	
R7, R8	47k	
R9, R10	100	
R11, R12	220k	
R13	10k	
R14	1M	
R15	33	
R16	12k	
R17, R18	56	
R19	10k	
R20	39	
R21 to R24	10k	
R25	220	
R26	4k7	
R27	2k2	
R28	1k	
R29	10k	
R30	10k	
P1	250k	Square Multi-Turn Cermet Preset (In-line pins)
P2	10k	Square Multi-Turn Cermet Preset (In-line pins)
VR1	22k	Miniature Rotary Potentiometer

Miscellaneous

X1	4.00 MHz	Quartz Crystal (HC49U Can Style)

IC Sockets for all ICs	Turned Pin High Quality Type recommended.
Headphone Socket	3.5mm Headphone Socket or similar
On/Off Switch	SPST Sub-Miniature Toggle or similar
Zero Button	Sub-Miniature ‘Push to Make’ with ‘Click Effect’
Batteries, Holder, Connector	8 x AA (Re-chargeable Ni-cads recommended)
Printed Circuit Board	(Supplied in Semi-Kit)

Enameled Copper Wire Single Strand 0.5 mm diameter (24 or 25 SWG)
Link & Hookup Wire
Knob for VR1
Plastic Enclosure
25mm PVC electrical conduit or similar, Perspex, Polyester Resin etc
Nuts, Machine Screws and Washers, etc.

GoldPic Assembly

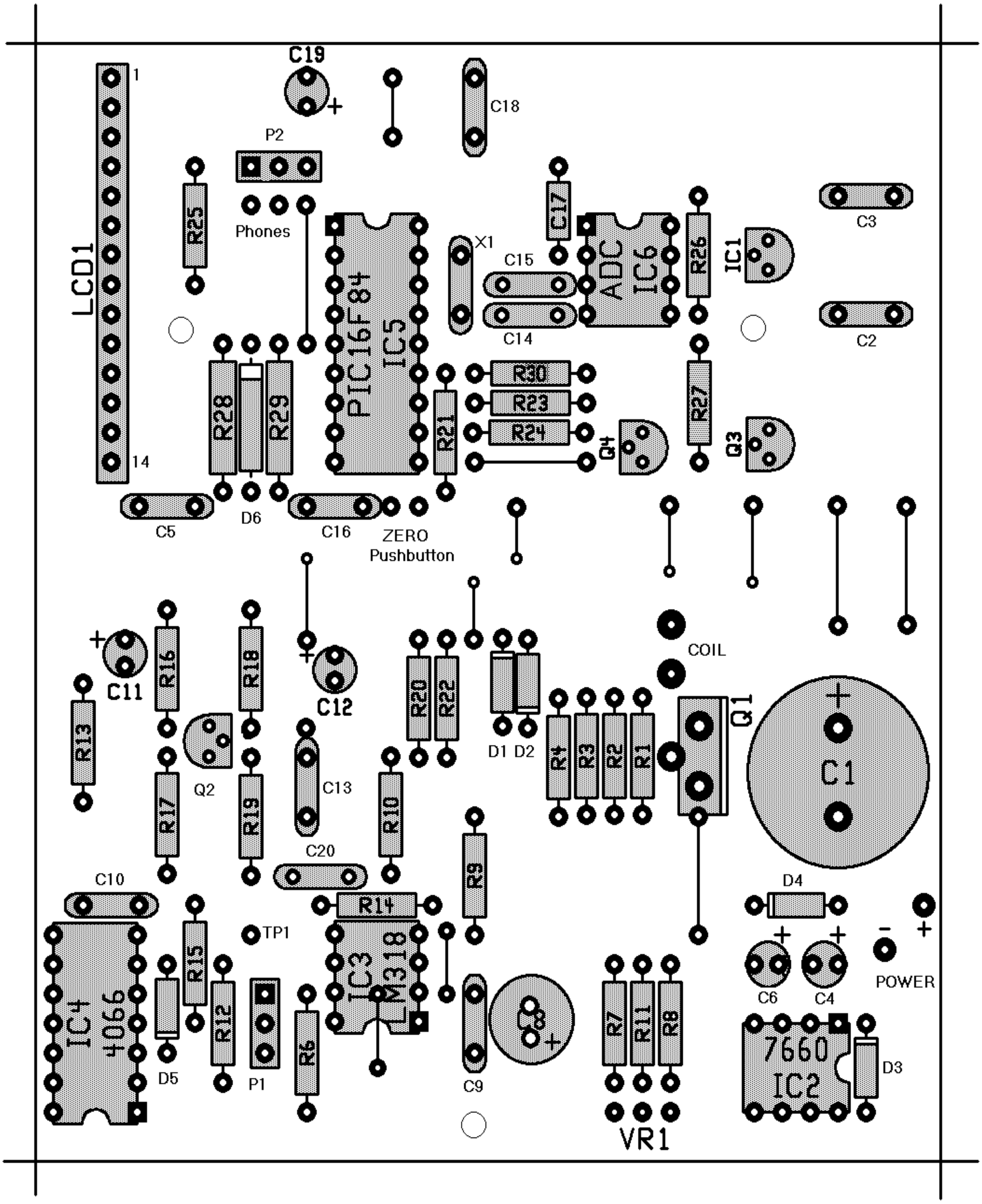

Figure 1 – Component Overlay

PCB Assembly

The component overlay is shown in Figure 1. All soldering should be done using a miniature (15-25W) soldering iron with a fine tip. After loading and soldering each individual component, crop the leads to within 1.5mm to 2.0mm of the track surface and then re-solder. Re-soldering produces a neat, smooth, sealed joint. Where appropriate mount the components flush with the board to reduce lead length. Mount the TO92 devices a few millimeters above the board.

The following is the recommended assembly sequence.

1. Fit the 13 link wires using single strand 0.35mm (29 SWG) tinned copper wire. (**Note:** There is a link under IC3 that must be fitted before the IC socket)
2. Fit all the resistors.
3. Fit the 6 diodes, observing the correct polarity as shown by the cathode bands.
4. Fit the 5 DIL IC sockets. (All 5 ICs have Pin 1 nearest the edge of the PCB). (Do not insert the ICs themselves yet.)
5. Fit the ceramic and the multi-layer ceramic capacitors.
6. Fit IC1 (regulator) and the 3 bipolar transistors as shown. (**Note**: The orientation of the transistors is correctly shown on the component overlay. The pad layout is non-conventional, use the package outline shown to place the component)
7. Fit the 7 electrolytic capacitors, observing the correct polarity. The –ve lead is usually marked on the plastic sleave.
8. Fit preset pots P1, P2 and capacitor C13.
9. Fit the crystal and the MOSFET (Q1).
10. Wire the LCD display to the PCB. I use 0.5mm single-strand link wires. If keep short (<25mm) the stiffness of the wires is adequate to maintain the spacing between wires. Ribbon Cable or similar inter-connects can be used. Keep the length short by planning the enclosure layout before cutting to length.
11. Wire the headphone socket, the zeroing pushbutton and variable resistor VR1 to the PCB via insulated multi strand hookup wire.
12. Wire the battery connector to the PCB via the On/Off switch. Place the switch in the –ve lead to minimise cathodic corrosion. Observe the correct battery polarity.

Initial Digital Circuitry Test:

Insert IC 5 and IC6 correctly oriented. Apply power to the board. The LCD display should briefly display: **GoldPic V3.01 Zeroing ......** followed by: **S255 T255 M000** The actual numbers displayed may differ. Pressing the Zero pushbutton should cause the second line to display the message **Zeroing ...... (Note:** Adjust preset P2 to obtain the required visual contrast. (The displayed message may be invisible before this adjustment).

<u>Search Coil Construction</u>

The coil consists of 27 Turns of 0.5mm enameled single strand copper wire with a diameter of 190mm. (7.6 inches). The recommended method of winding the coil is:

1. Draw a 190 mm diameter circle on a piece of wood or board.
2. Knock in a small nail every 30mm around the circumference of the circle. The nails should slant out of the circle by a few degrees.
3. Wind exactly 27 turns around the nails, flush with the board. Leave +/- 10cm long flying leads for soldering to at the start and finish of the winding.
4. Pull out every other nail.
5. Using twine and a sewing needle, ‘sew’ a spiral of twine around the coil, tightly grouping the windings together. Fasten the ends by knotting.
6. Remove the remaining nails.
7. Add another tight spiral of twine and secure the flying leads in place.

Testing, Tweaking and Troubleshooting

Testing

Before testing, you need to know what the values displayed on the top line of the LCD represent. They are identified by a single character prefix, as follows:

S	**:**	The front end **Setpoint** value,	set via VR1.
T	**:**	The **Threshold** value,	set by zeroing.
M	**:**	The **Metal** signal,	due to a target.

Scrape off the enamel at the ends of the flying leads and solder to a length (approx. 1.2m) of twin core 5 Amp mains lead. (A circular cross section looks better than the flat lead variety). Solder the coil lead to the PCB.

Insert IC2, IC3, and IC4 correctly oriented. Set VR1 to mid position. Apply power to the PCB. After the initialization has completed adjust preset P1 to obtain an S reading of about 100.

Place the coil well away from any metal. (Large cardboard boxes are useful to work on, but look for metal staples first.) Press the Zero button. After zeroing, the Threshold reading should be a little higher than the Setpoint values observed. The Setpoint values displayed will cycle up and down a few counts; this is normal and no cause for concern.

Introduce a target into the vicinity of the search coil. The M reading should become non zero and a bar graph should be displayed on the second row of the LCD. If headphones are plugged in a tone should be heard.

Wait for a few minutes for the circuit to warm up before attempting range tests. The ranges obtained should be similar to those displayed on the GoldPic web site.

Tweaking

To obtain the maximum detection range your GoldPic may require tweaking. The following changes can be experimented with:

- Substitute chips for IC3 and IC4 from different batches and manufactures. You can also try using a 4016 for IC4. Some chips are better than others. Experiment with different specimens for MOSFET Q1.
- Tweak the combined value of resistor R1, R2. Observe the decay curve of the pulse on Pin 6 of IC3 (test Point TP1) on an oscilloscope and adjust for critical damping. Too little damping and 'ringing' results, too much and the decay is slowed down. (Try 220, 270 or 330 Ohms for R1)
- The setting of P1 and to a lesser extent the setting of VR1.
- Good quality well charged batteries are needed to obtain optimum results.
- Avoid using plugs in the search coil leads, solder directly to the coil and the PCB

Troubleshooting

In addition to visual inspection for incorrect component placing and orientation, bad solder joints, bridges and breaks, the following voltages and signals can be monitored:

1. IC5 Pin14, IC6 Pin8 and LCD1 Pin2 should be close to 5 Volts relative to battery –ve. (If not then IC1 or associated components may be faulty)
2. IC3 Pin7 should be about 17 Volts relative to battery –ve.
3. IC4 Pin14 should be about 18 Volts relative to battery –ve. (If 2 and 3 not correct then IC2, D3, D4, C4, C6 may be faulty)
4. IC5 should have a sine wave (4MHz) across crystal and pulses on Pins 11 and 12 approximately every 4ms.
5. IC3 Pin2 should have positive and negative going pulses every 4ms, diode clipped at +/- 0.6V relative to battery +ve. (If not Q1, R1-R4, D1, D2 or Q3 may be defective)

6. IC3 Pin6 should have negative going pulses relative to battery +ve, that decay over about 100us. (If not then IC3, R10, R12 may be faulty)
7. C13 should have a voltage across it that increases when metal is near the coil. (If not then IC4, D5, Q2 may be faulty)

Mechanical Construction

This is largely a matter of your preference, the tools available to you and your skill. My detectors can be seen on the GoldPic web site.

I pot the search coil in polyester resin in a home made mold. The stem is constructed from 25mm PVC electrical conduit, internally reinforced with a wooden dowel where the enclosure is bolted on. The arm holder is made by heat bending a sheet of 'Perspex'. The stem is also heat bent to the required shape. I use an ABS box for enclosure.

The display needs to be fitted behind a waterproof window. I only use my GoldPic with the coil and the lower stem submerged; waterproofing the entire detector is rather difficult.

Do not use any metal in the coil and the lower 2/3 of the stem.

Using GoldPic 3

GoldPic 3 is easy to use as there are only a few controls and a single operating mode.

The top line of text on the LCD displays the following three values, each identified by a one character prefix, as follows:

S	:	The front end **Setpoint** value,	set via VR1.
T	:	The **Threshold** value,	set by zeroing.
M	:	The **Metal** signal,	due to a target.

The second line displays a bargraph whose length corresponds to the magnitude of the Metal Signal. In the presence of metal a audio tone is emitted by the headphones. (I do not ever use a loudspeaker as they are a source of noise pollution and inconsiderate to other beach-goers).

Switch on and wait a few minutes for the circuitry to thermally stabilize. Adjust the Setpoint via VR1 to a reading of about 100. (This is not a magic number, merely a guide)

Zero the instrument and check that the Threshold reading is a little higher than the current Setpoint. If not, you may have zeroed in the presence of a target.

This zeroing scheme enables silent searching in a non-motion mode.

Search fairly slowly to avoid missing very deep targets. On finding a target, information about the target and target pinpointing can be found by sweeping the coil from side to side and back and forth over the target and by raising and lower the search head. Large items like soda cans produce a large Metal reading (long bar graph) that persists even when the head is raised quite high. Coins / rings usually produce a more localized signal. Practice and familiarity are the keys to becoming skilled with any metal detector.

Every few minutes swing the detector back to an area that produced no signal and zero again. Frequent zeroing provides the best sensitivity. Zeroing at the same height above/on the sand (or in the water) as you are searching is also a good idea. I zero about once a minute when searching. Every 15 minutes or so you can set the Setpoint using VR1. The position of the knob at your favorite Setpoint gives an indication of the state of the batteries.
