Probes with LEDs and Opto Isolated BoBs
Calypso Ventures, Inc.
November 2011

The topic of interfacing a probe with a LED in it (like the Wildhorse probe) to a Break Out Board (BoB) that uses opto isolated inputs has come up a couple of times on the MSM support forum.

This little paper is a summary of the issue involved and may be of help to others….

Some abbreviations used in this paper:

MSM = MachStdMill
PP = Parallel Port
BoB = Break Out Board
LED = Light Emitting Diode; also visual objects on an MSM screen that Mach refers to as "LEDs".
NC = Normally Closed
NO = Normally Open
Opto Isolated = an input technique that uses optical devices to transfer a signal from one side to the other without making a direct electrical connection between the sides.

Probe Switch actions:
At the hardware level, many probes are basically a NC switch.
Most probes are naturally an "Active High" device to mach.

When the probe is not triggered, it's internal switch is closed and hence the input is shorted to ground; therefore the input pin is at a low (0v) state.
Conversely when the probe is triggered, the probe switch opens and this is supposed to let the input go to the "active state" = High. Alas, this does not always happen with all break out boards, with all probes….

Problem Symptoms:
The LED state on the Probe and the Screen LEDs in mach do not match, or the Probe action is intermittent.

Test Approach:
You can determine if you are having an electronic interface issue by comparing the actions of the probe to a pair of wires connected where the probe connects.

First test things using the pair of wires in place of the probe. Disconnect the probe and replace the probe with a simple pair of wires. Touch the wires to simulate the probe "not triggered", and open the wires to simulate "probe triggered" (note, this is a static test – no need to try to touch the wires in sync with a G31 motion).

Jumper/Wires Connected				
Jumper state	Voltage at Input Pin	MSM PP driver page Pin 13 LED	MSM Signal page Probe LED	Notes
Shorted/Closed	0v (or close)	OFF (low)	OFF (Inactive)	This is what we want
Disconnected/Open	V+ (or close)	ON (high)	ON (active)	This is what we want

Table 1

(note in the table above, V+ is typically +5v or sometimes +12v, check your boards specs to know what V+ level to look for)

Verifying the results in Table 1 will tell you that the chain from input terminal, thru the BoB, to the PP, then into Mach is working.

Now reconnect the probe and check things again. If you get the results in table 1 again, you are good shape.

If you get the results shown in Table 2 below, you probably have the technical issue this paper addresses.

Probe connected				
Probe state	Voltage at Input Pin	MSM PP driver page Pin 13 LED	MSM Signal page Probe LED	probable reasons
NOT Triggered	0v (or close)	OFF (low)	OFF	This is Correct
Triggered	Rises above 0v, but not near the BoB's V+ supply	OFF	OFF	Theory: Probe LED creates enough leakage current so that the BoB Opto stays on and thus so does switch the input pin signal to the PP and thus into Mach.

Table 2

<u>(Semi) Technical Explanation:</u>
For this I'm going to use the Gecko G540 as an example (only because it was the interface under discussion when this was written up).

The potential problem is that the probes with a LED in them, do not appear as just a switch to the input line of the Break out board.

What follows is a summary of the technical situation.

The input lines on the G540 (and many other BoBs) are opto isolated. This is generally a good thing, but can have some side effects.

In the G540 case, the input lines of the G540 look like this (excerpted from the G540 schematic posted on the Gecko Yahoo group):

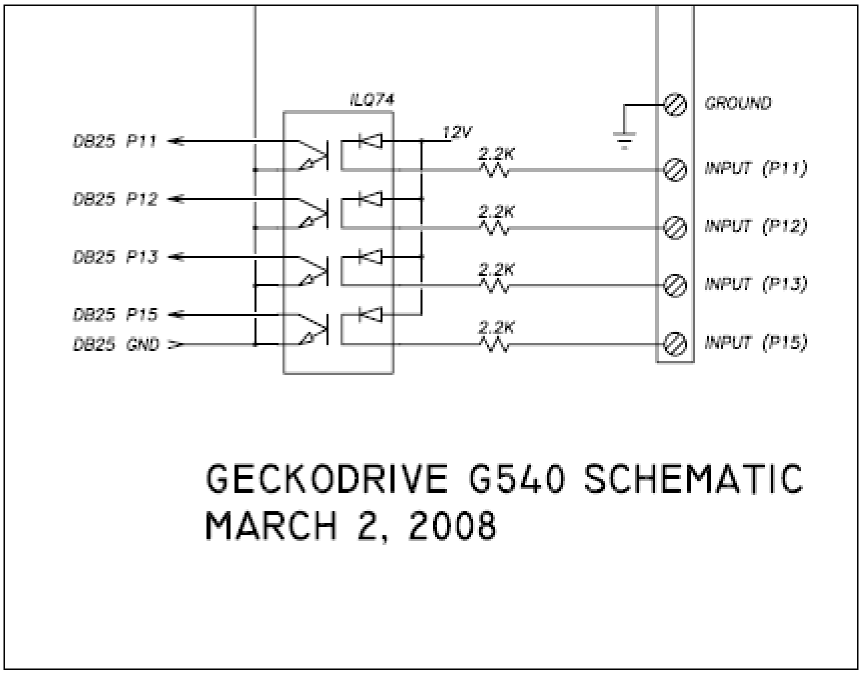

Figure 1: G540 Opto Inputs

The Jumpers or a simple switch are electrically this:

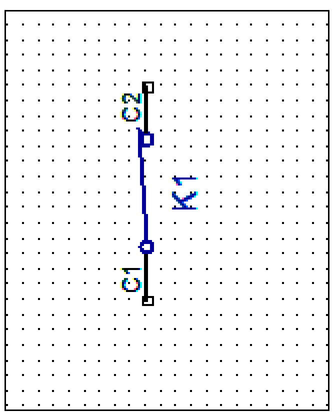

Figure 2: Switch/Jumper

So, rearranging and connecting the jumper/probe to the input line, and just showing externally exposed 1/2 of the opto isolator we would get:

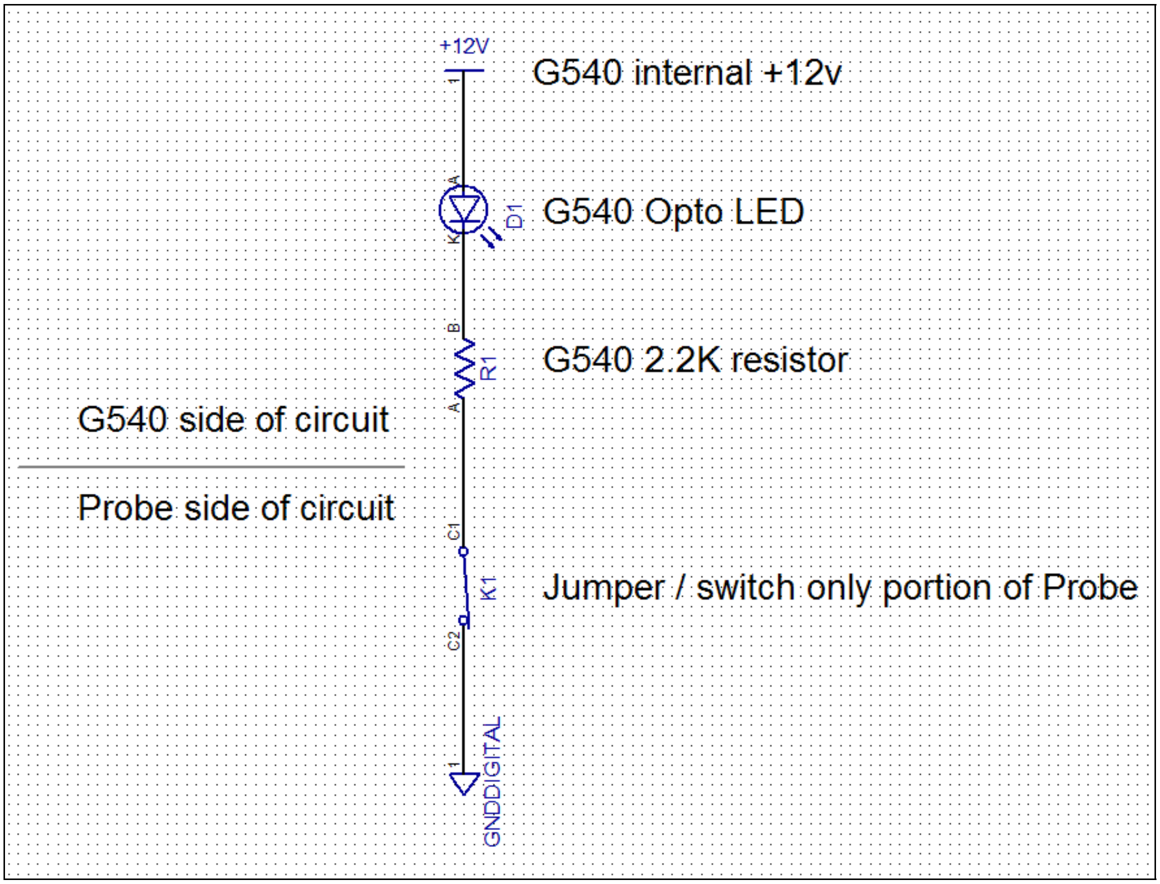

Figure 3: Composite Opto Input and Probe Switch

The above is what the jumper is doing and it generally works fine with Opto isolated inputs.

For the jumper case, when the switch is closed, current flows thru the LED and it gets bright, that turns on the Opto transistor that feed the G540 side (not shown above). When the switch is closed the current thru the opto will be 12/2.2k = 5.5 ma

When the switch is open, the G540 LED will be off, and so will the opto transistor it drives.

So the two states from the electronics point of view are:
Closed (probe inactive) = 5.5 ma current
Open (probe active) = 0 ma current

This is the behavior you want – so why can connecting the probe cause a problem? Because the probe is not just the switch, it also has the LED in it.

If we add the Wildhorse Probe's LED and resistor to the above circuit, we then get this schematic:

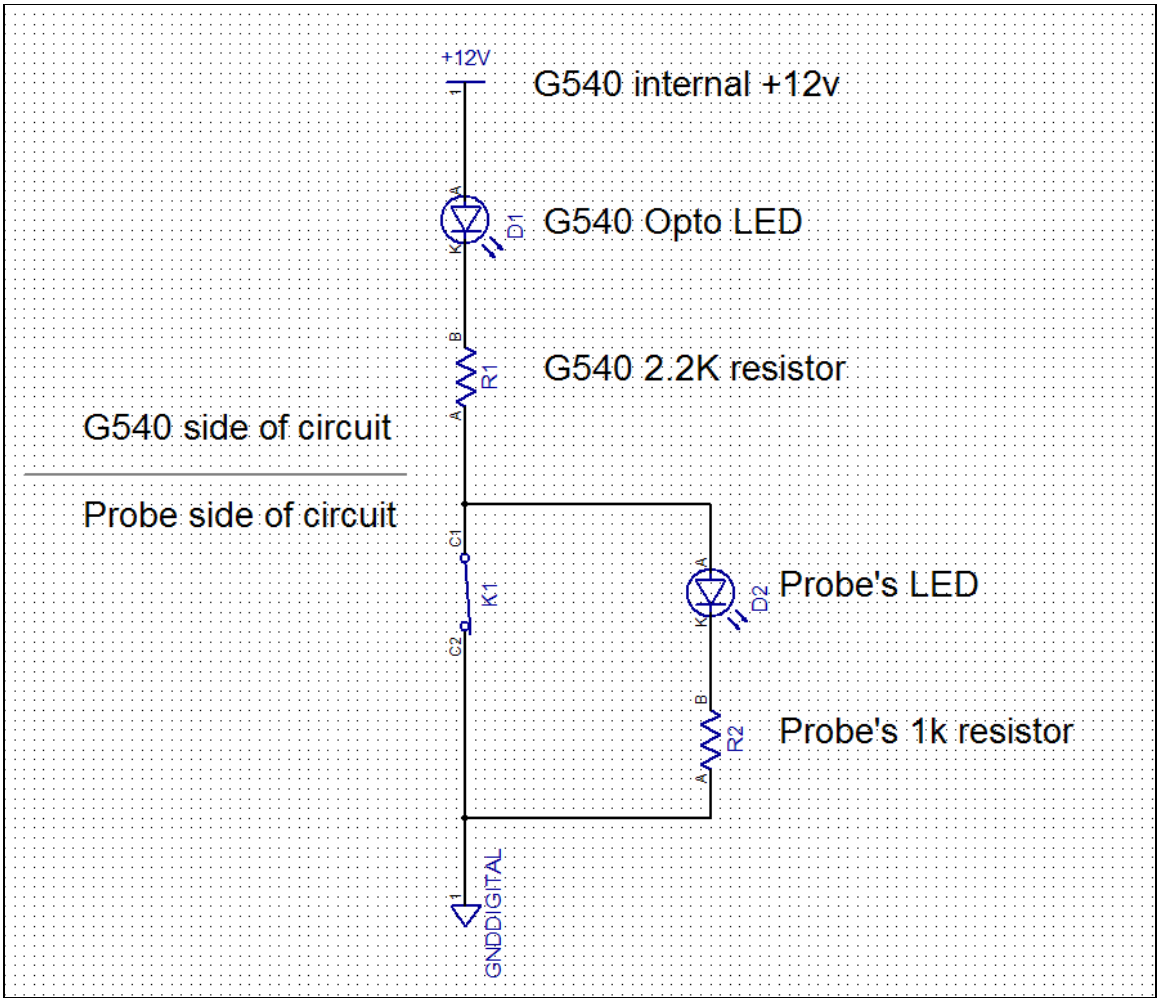

Figure 4: Typical Probe with LED

This is a different situation from Figure 3…

With the switch closed, we have the same situation as before: 5.5ma thru the G540 opto LED.

Now, let's assume the forward voltage drop across both LEDs are1.5v (when they are on; this voltage varies by LED but is close enough to illustrate the problem…)

Voltage = 12v – 1.5 – 1.5 = 9v
Resistance = 2.2k + 1k = 3.2k
Therefore ohms law gives the current thru the Opto LED as 9v/3.2k = 2.8 ma
That tells us the basic problem.

The probe LED is causing the probe's "ON" state to draw 2.8 ma thru the G540 Opto LED – that is enough that the opto's LED will still be lit and the opto transistor may still be ON….

In this circuit, the changing of the switch in the Probe is probably not causing a change in logic level at the PP input.

Instead of changing between 5.5 and 0 ma, the probe is making the delta 5.5 and 2.8 ma. The 2.8ma level is not low enough to get the Opt transistor to turn off.
You can think of the presence of the Probe LED as causing a current "leakage" path where the leakage is causing the problem.

This also matches the symptom that sometimes the probe works and sometimes it does not, Since the 2.8ma current is in the middle range (neither 5.5 ma not 0 ma) where it may or may not drive the Opto transistor to a definite on/off state.

Fix method:
The usual fix for this is to add a pull up resistor from the input line to +V, then the circuit would become:

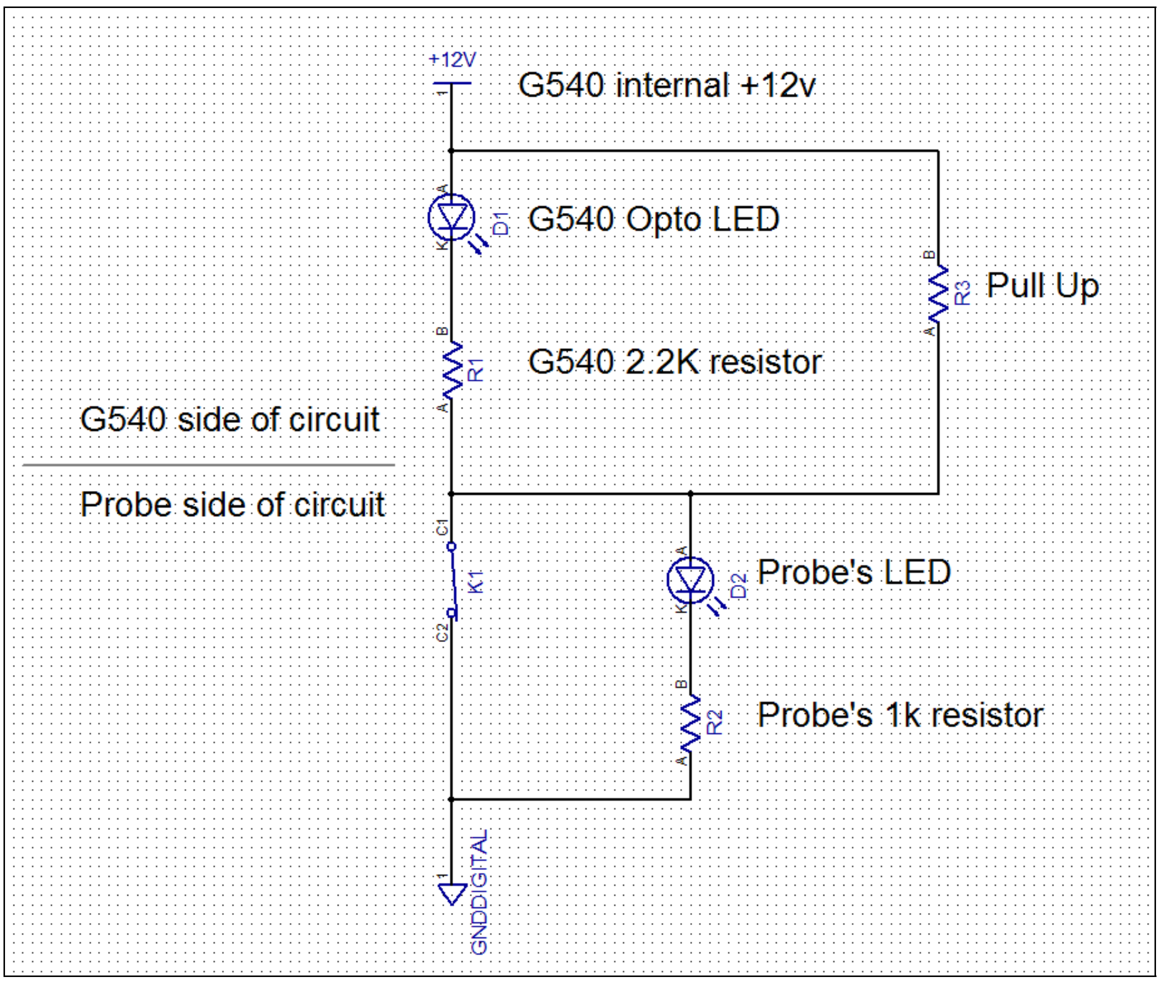

Figure 5: Addition of Pull Up Resistor

To calculate the value of the pull up resistor, one needs to know the internal circuit characteristics of the Opto used by the BoB.

Since CVI is not in the business of designing custom electronic interfaces to various BoBs for MSM users, we have to point you back to the BoB vendor for electronic interface issues.

If you are experiencing this situation, please contact your BoB vendor for advice on interfacing this type of probe to their product.

<u>Notes about some BoBs:</u>
Here is some informal info CVI has learned about some BoBs. No guarantees here, this is just offered as additional information in case it is of assistance to you as an MSM user.

PMDX 125 & 126:
This issue can occur with the PMDX-125/126 boards and the Wildhorse probe. The PMDX boards use +5v for their optos and PMDX has told CVI that a 470 ohm resistor from the input pin to +5 will solve this situation for those boards.

Additonally, we understand that the next rev (B) of the PMDX-126 BoB will have an onboard resistor (configured via jumper) to handle this situation.

Gecko G540:
Please contact Gecko to ask them for help - as this is an interface problem that results from the G540 opto input circuit in conjunction with the WILDHORSE Probe.

The challenge we see for the G540 is that Gecko did not bring the internal +12v out to the terminal strip…. So there is no place to connect one end of the pull up resistor…. Please ask Gecko how they would like you to interface the probe to the G540.

Other BoBs:
At the time this was written, CVI did not have specific pull up resistor info for other BoBs.   Please contact your BoB vendor for assistance.

<u>Probe Side Solutions:</u>

Wildhorse probe
If you don’t mind modifying your probe electrically, you can disable the LED in the probe.
This turns the probe back into just a switch and then it will act just like the jumper test case.

The down side is that you lose the LED in the probe. The up side is that this is simple to do… just open the WILDHORSE probe, cut one of the LED leads to open the LED circuit. If you want to do fix thing at the BoB later on, you can solder the cut lead back together.

A trick a user sent us is that (assuming that the Wildhorse circuit does not change) you can swap the probe wires. This will not effect the switch part of the Probe, while at the same time it reverses the Probe LED electrically so that the probe LED can never come on and hence can’t create a current leakage path.

Other probes:
Other probes (other than the Wildhorse) with a LED, may use either a different resistor value internally or a different internal circuit to drive the LED. You should contact the Probe vendor for technical information about your specific probe.