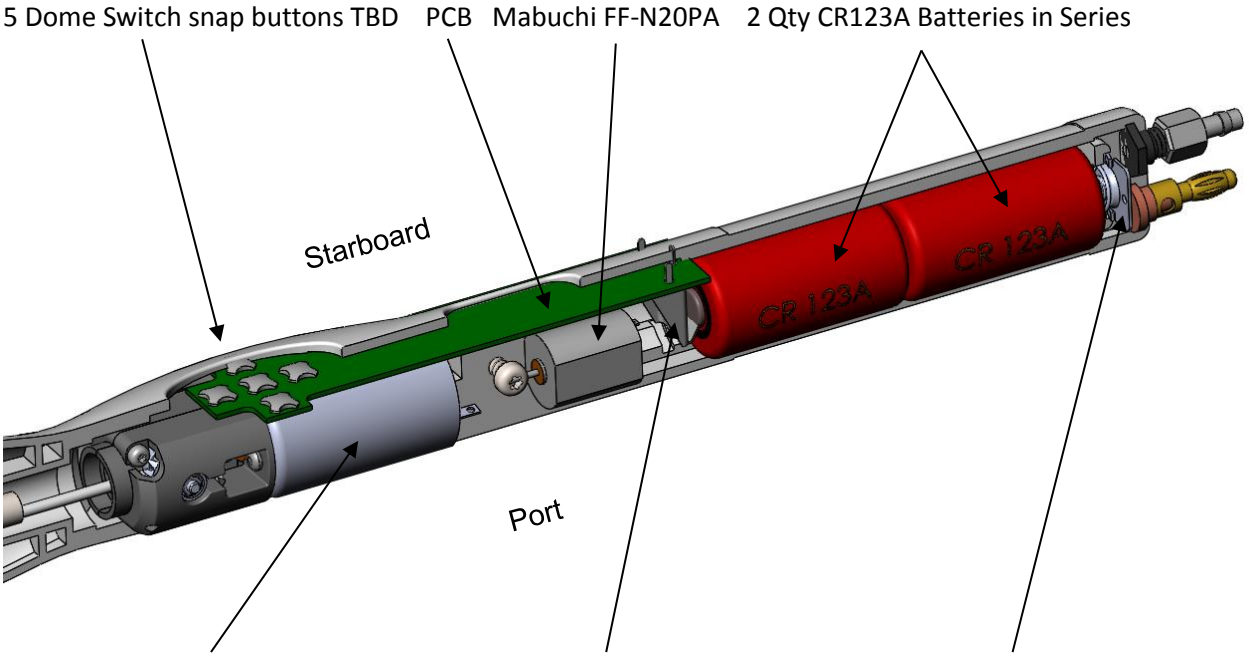
1.0 Laparoscopic Differential Dissector Version 3 Electronic Specification

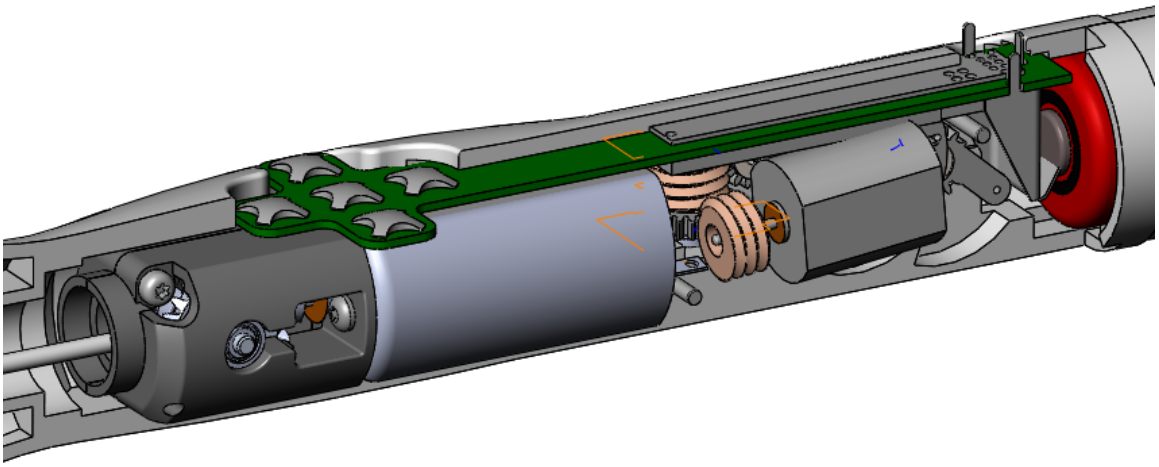


- PCB shall be powered by 2 qty, CR123A batteries in series, 7V maximum input
- PCB shall have a single polarity, PWM motor control circuit for the FK180SH-3240 motor.
- PCB shall have a reversible polarity (H-bridge) PWM motor control circuit for the FF-N20PA
- [Software] PCB shall have 5 dome switch snap buttons.
    - The distal most button shall increase DDM oscillation speed (control FK-180SH motor). If the user repeatedly presses this button, the oscillation speed will increase slowly. If the user holds this button down, the oscillation speed will increase rapidly. Number of discrete speed steps, PWM duty cycle, PWM frequency, and rate of increase TBD.
    - The proximal most button shall decrease DDM oscillation speed (control FK180SH motor). If the user repeatedly presses this button, the oscillation speed will decrease slowly. If the user holds this button down, the oscillation speed will decrease rapidly. Number of discrete speed steps, PWM duty cycle, PWM frequency, and rate of decrease TBD.
    - The Port most button shall cause the elbow to flex (control the FF-N20PA motor). Accommodate 6mm 2 position snap button.
    - The Starboard most button shall cause the elbow to straighten (control the FF-N20PA motor). Accommodate 6mm 2 position snap button.
    - The center button shall control power to the DDM oscillation (FK-180SH motor). Each successive button push shall change the oscillation state from on to off or off to on.

When the center button push changes the oscillation state from off to on, the DDM oscillation speed shall return to the speed that the user selected before the last button push to change the oscillation state from on to off.

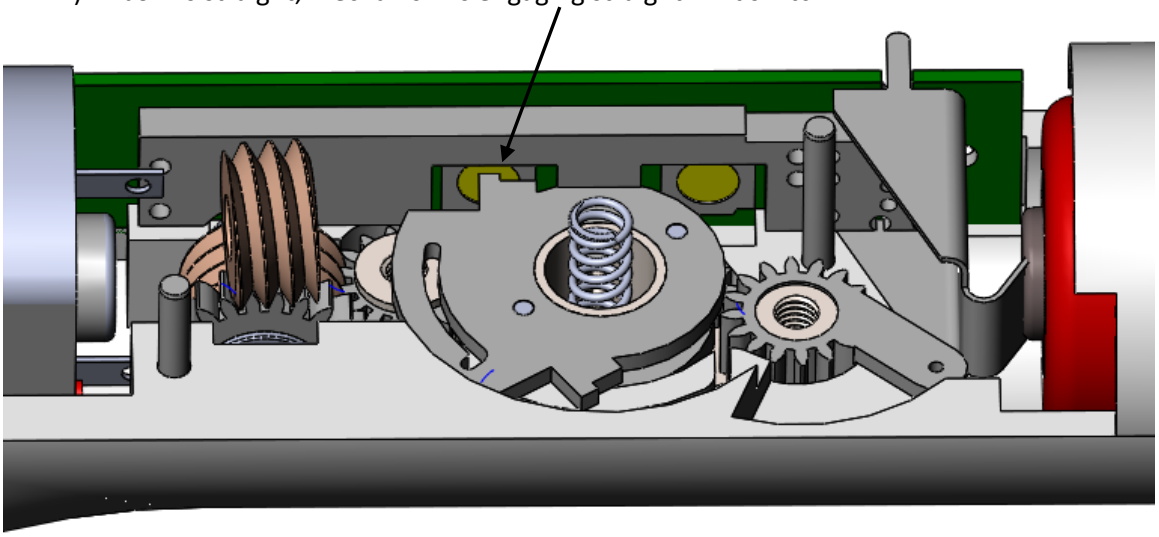
- The PCB shall interface a momentary-contact normally-open switch that will sense the end of travel limit in the elbow-flex direction.
    - [Software] Once this switch closes, the microprocessor shall disable the motor drive circuit for the FK-180SH motor, this disables the DDM oscillation in deference to electrosurgical functionality.
- The PCB shall interface a momentary-contact normally-open switch that will sense the end of travel limit in the elbow straight direction.
    - [Software] When this switch closes, the microprocessor shall stop driving the FF-N20PA in the elbow straight direction.
- The PCB shall interface a momentary-contact normally-open switch that will sense the end of travel limit for electrosurgical hook deployment.
    - [Software] Once this switch closes, the microprocessor shall stop driving the FF-N20PA in the elbow flexed direction. This will stop the deployment of the electrosurgical hook at the end of its travel limit. The microprocessor must also illuminate some yellow or amber LEDs to indicate that the electrosurgical hook is fully deployed and read to be energized.
- The PCB shall have some blue LEDs.
    - [Software] These indicate that the DDM oscillation functionality is on (i.e. its motor is running).
- The PCB shall have some yellow or amber LEDs.
    - [Software] These indicate that the electrosurgical hook has been deployed and is ready to be energized.
- The PCB shall have 2 additional LEDs connected to MCU outputs (to be used for debugging software).
- The PCB shall use Tag-Connect design for programing via JTAG. This shall be accessible when the PCB is in the handle.
- The PCB shall have test points for the 2 PWM outputs so waveforms can be monitored directly.
- The PCB shall have another 4 I/O pins available on through-hole vias for future expansion / modification.
- Emergency button to release electrode and elbow mechanism thereby retracting electrode and straightening elbow. This action shall turn the DDM motor and elbow adjust motor off.
    - Software – once emergency button is pressed, processor needs to set elbow actuation to off and DDM oscillation to off. This will be done by monitoring the Elbow electrode travel extent limit switch. If this switch opens without the FF-N20PA motor driving the mechanism away from the switch, then the software will know that the emergency button was activated.

Laparo Rigid PCB in Situ:

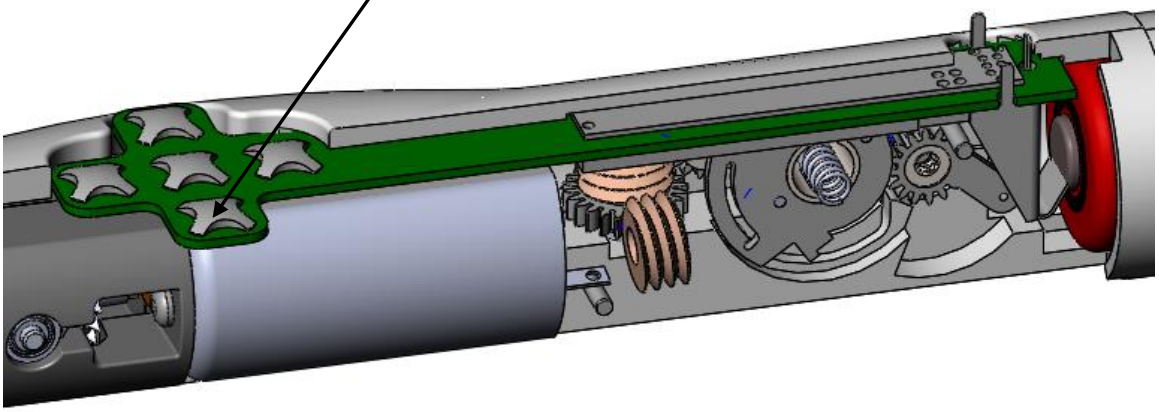


Actuation Order of Operations:

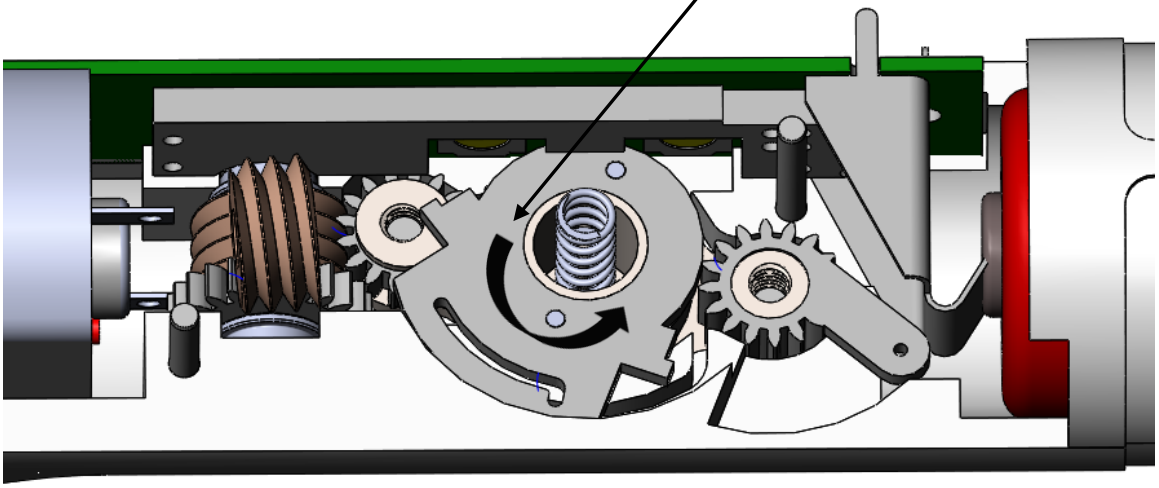
1.) Elbow is straight, mechanism is engaging straight limit switch



2.) User presses elbow flex button

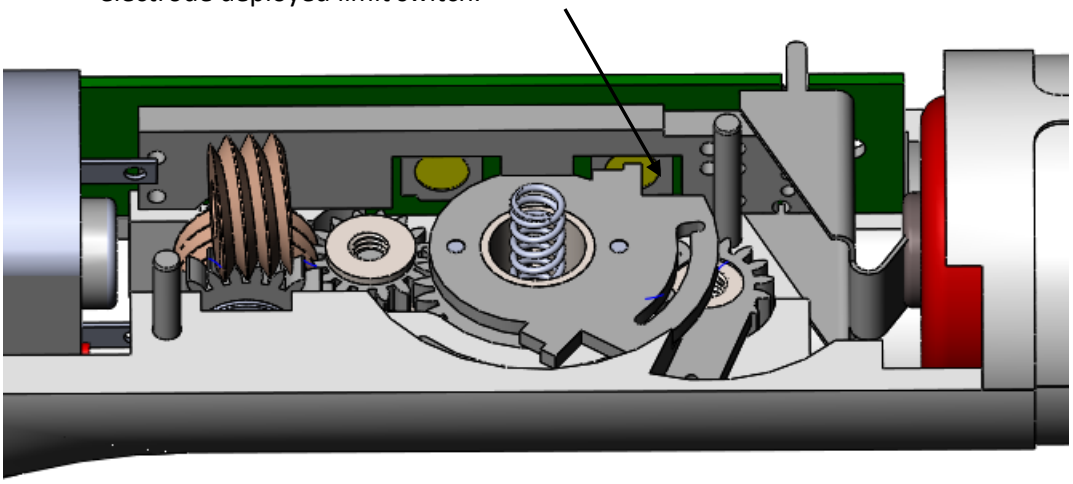


3.) Microprocessor disables DDM oscillation (maybe)
4.) Microprocessor starts driving FF-N20PA in the elbow flex direction (motor hidden to show mechanism.



5.) Elbow continues to flex until the mechanism passes a mechanical limit. At this point, the elbow stops moving and the mechanism starts driving the electrode deployment.
6.) Once the elbow reaches the flexed extent of travel, a limit switch is engaged that notifies the microprocessor to disable the DDM oscillation functionality. This will be done with a switch that is housed in the plastic handle and wired back to the board via discrete conductors.

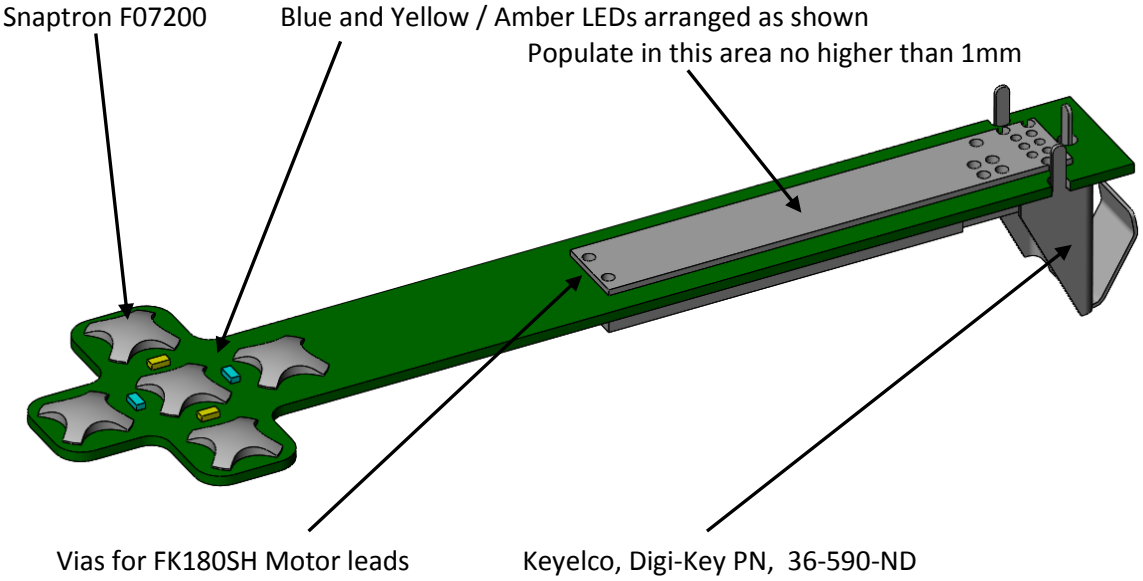
7.) The microprocessor continues to drive the FF-N20PA motor until the mechanism engages the electrode deployed limit switch.

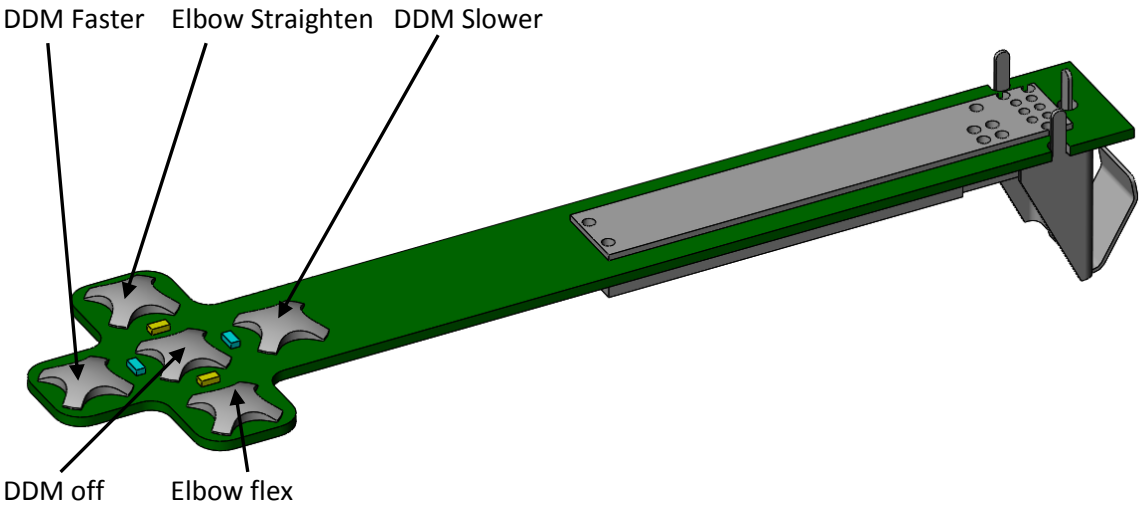


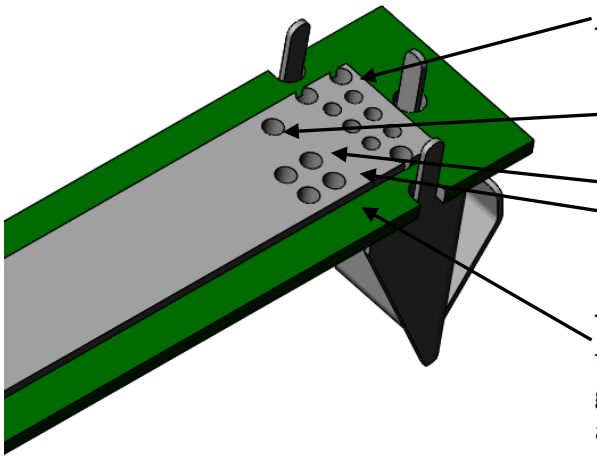
8.) Once this limit switch is engaged, the microprocessor stops driving the FF-N20PA, and illuminates an LED to signify that the electrode is fully deployed and ready to be energized.
9.) At the deployed extent of the electrode travel, the electrosurgical circuit is closed enabling electrosurgical current to flow through the device. This is also done in hardware in the handle plastic and does not interface with the PCB in any way.
10.) The DDM oscillation continues to be disabled when the mechanism is in this position.

Board Layout Details:

Reference the assembly model for specific dimensions.







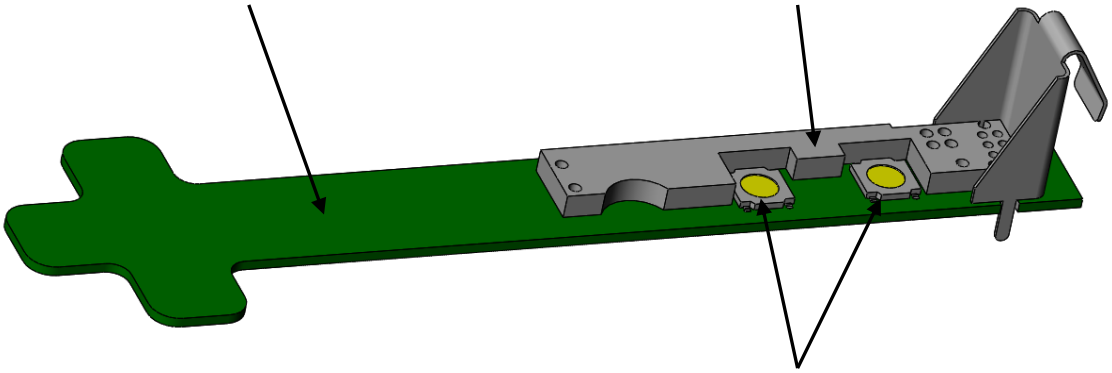
Via Sequence to accommodate Tag-Connect: TC2030IDC-NL

- Via to receive Negative battery terminal conductor
- Vias to receive FFN20PA conductors
- Vias to receive discrete conductors for a switch that monitors elbow travel extent.

The battery negative terminal via needs to go toward this end of the board, the others can go where they're convenient. Populate 1 Red and 1 Green LED at this end of the board for debug. Position at your convenience they will shine through the handle plastic.

Do not populate in this area

Populate in this area 2mm max height



Limit switches, Digi-Key stock item, TL3315NF100Q