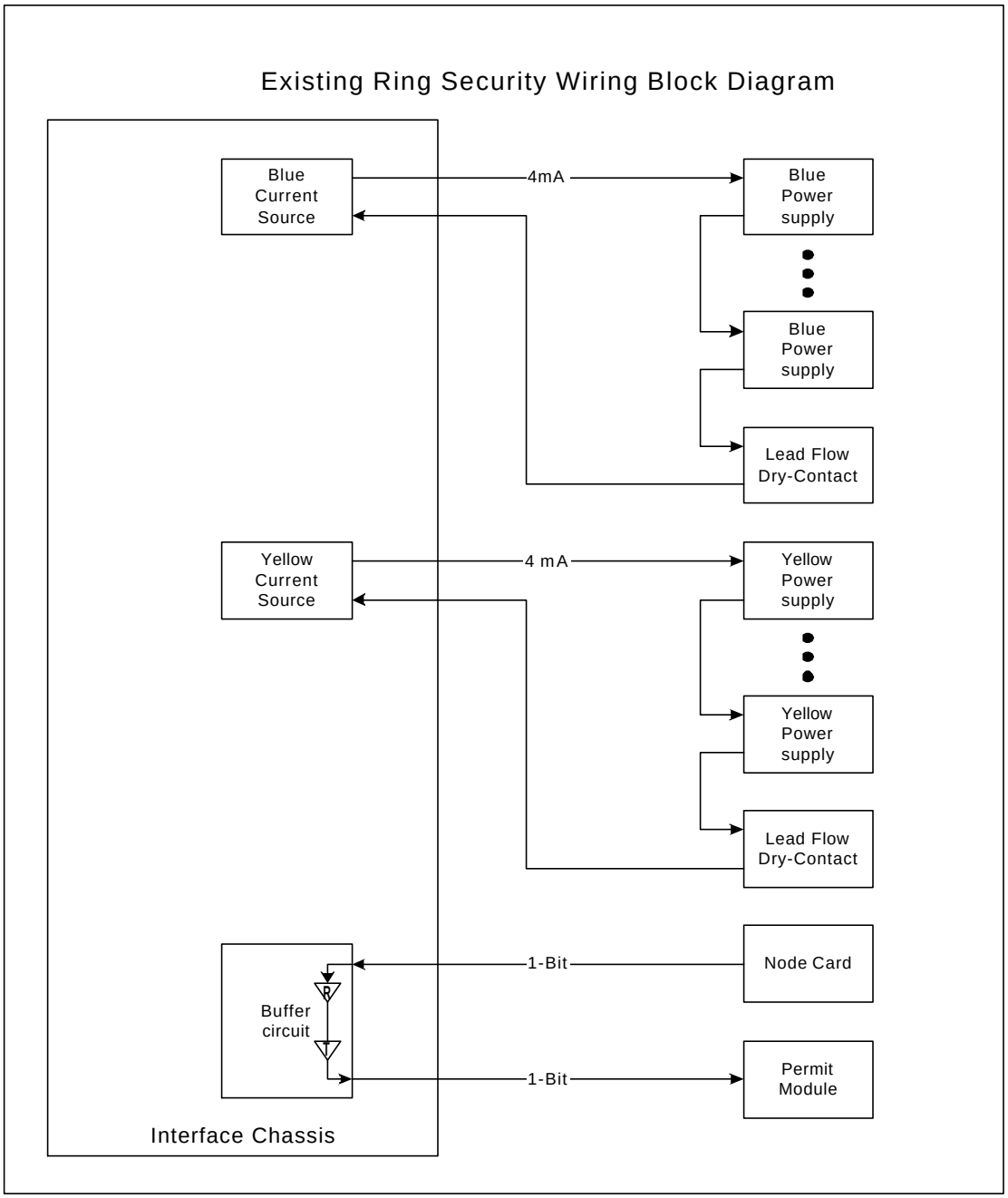
Ring Security Interface Chassis Upgrade

Introduction:

The present Ring Security Interface Chassis consists of two 4mA constant current sources to power the corrector power supply security circuits, one for blue ring and other one for the yellow ring. Each constant current source is connected in series with the cryo-lead-flow enable dry-contact. The dry-contact closes when the lead-flow is adequate and allowing the corrector power supplies to turn on. Power supplies are disabled when the dry-contact is open. The other part of the Interface Chassis circuitry accepts command from the node card, this command is routed to the Beam Permit module to enable or disable the Beam Permit System. Block diagram of the existing Ring Security Wiring Diagram as follows:

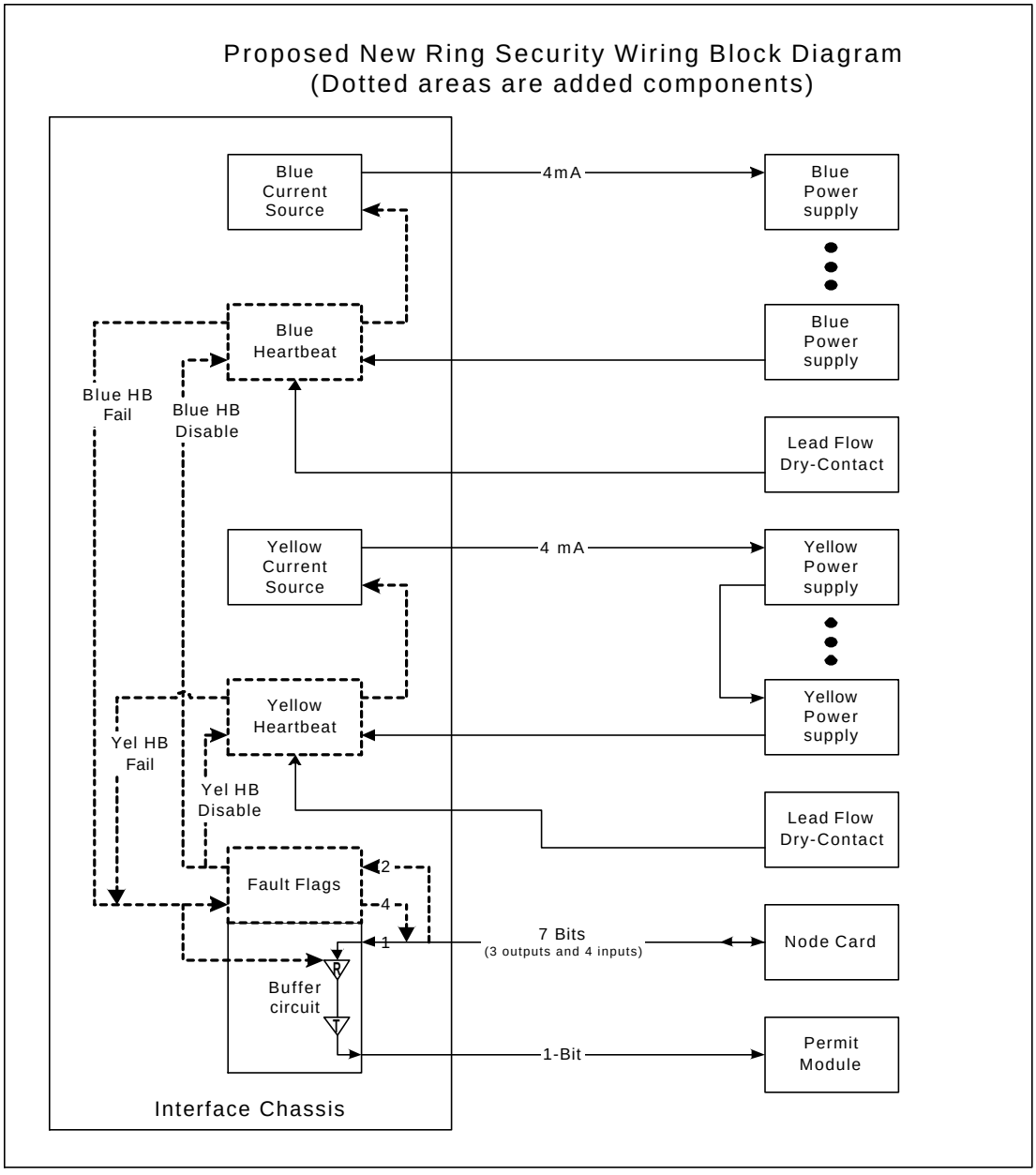


Problem encountered:

When the cryogenic system is reset, the dry-contact that connected to the Ring Security Interface chassis closes regardless of the flow rate. This condition allows the power supplies to turn on even though flow rate is insufficient. Magnets or leads might get damage if power supply is turned on and powered for more than a few minutes.

Proposed solution:

Add Heartbeat circuit to monitor the state of the dry-contact. When the lead flow system is in working state, the dry-contact must opens and closes at rate of once every 2 to 30 seconds. This condition allows the power Supplies to operate. When the dry-contact is stopped toggling, the ring security's constant current source to the power supply opto-isolators will be interrupted in a minute, shutting down the power supplies and sending a fault flag. The Heartbeat circuit could be disabled by the node card, but the software-disable could be override by jumpers on the PCB. The block diagram for the proposed system is as follows:



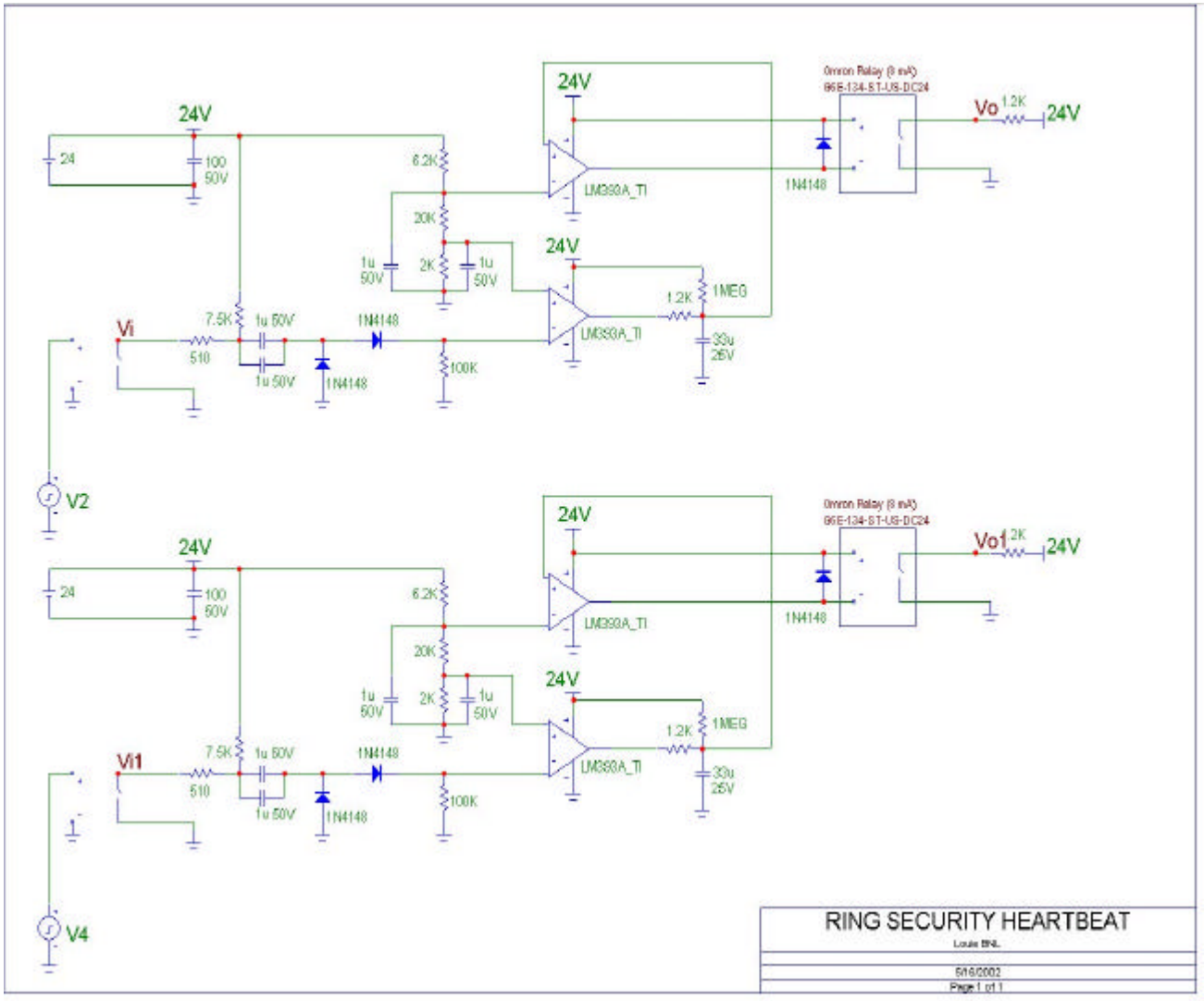
The added new components:

1. Two heartbeat circuits, node card connectors and terminal blocks should be able to fit on a 2.5”x4” printed circuit board. This daughter board will plug directly onto the existing Ring Security PCB. Ten additional wires from the daughter board terminal blocks are connected to the main board.
2. New Node card to Interface chassis cable is needed. This will be a five pairs twisted cable with a 25-pin D-Sub on the node card end and a 15-pin D-Sub on the Interface chassis end.

Flow rate dry-contact specification:

1. The dry-contact must be rated for 24 VDC, able to pass 50 mA of current.
2. When the flow rate is adequate, the dry contact must toggle open and close. The duration for open or close must greater than 250 milliseconds. The heartbeat circuit discriminates pluses less than 200 milliseconds. The minimum time between toggles is 2 seconds, and the maximum allowable time between toggles is 40 seconds.
3. When the flow rate is insufficient, the dry contact can be in either open or close state.

Simplified Heartbeat circuit schematic is as follows:



Node card interface:
The Ring Security Chassis is connected to Port #12 on the Node Card Chassis via a 25-pin D-sub connector. Three output bits and four input bits are used for controls and communication. Their functions are described as follows:

1. Output bit assignment.
   a. OUT1 – Permit Enable.
      This bit could set to logic LOW when both the BLUE STATUS bit (IN1) and YELLOW STATUS bit (IN2) are LOW. When IN1 is low, it means the gas flow to the blue magnet leads is correct. When IN1 is high, it means the cryo system is not working correctly and all the blue power supplies are disabled by hardware. When IN2 is low, it means the gas flow to the yellow magnet leads is correct. When IN2 is high, it means the cryo system is not working correctly and all the yellow power supplies are disabled by hardware.
      This bit is ANDed with the blue and yellow lead flow circuits. When all three signals are ready, then the output to the Beam Permit Module goes high and allows the beam to operate.
   b. OUT2 – Blue Heartbeat Circuit Disable.
      Set this bit to logic LOW to disable the blue heartbeat circuit. When the heartbeat is disabled, the lead flow is sensed by the static condition of the lead flow dry contact. The dry contact closes when the flow rate is correct, and the dry contact opens when the flow rate is incorrect.
      Set this bit to logic HIGH to enable the blue heartbeat circuit. When the heartbeat is enabled, the dry contact must toggles at lease once every minute. If the toggling is stopped, regardless the static conditions of the dry contact (either open or closed), the blue power supplies will shut down and the BLUE STATUS bit (IN1) will set to logic high.
   c. OUT3 – Yellow Heartbeat Circuit Disable.
      Set this bit to logic LOW to disable the yellow heartbeat circuit. When the heartbeat is disabled, the lead flow is sensed by the static condition of the lead flow dry contact. The dry contact closes when the flow rate is correct, and the dry contact opens when the flow rate is incorrect.
      Set this bit to logic HIGH to enable the yellow heartbeat circuit. When the heartbeat is enabled, the dry contact must toggles at lease once every minute. If the toggling is stopped, regardless the static conditions of the dry contact (either open or closed), the yellow power supplies will shut down and the YELLOW STATUS bit (IN2) will set to logic high.
2. Input bit assignment.
   a. IN1 – Blue Status.
      Logic LOW indicates the lead flow is correct, and blue power supplies are safe to operate. Logic
      HIGH indicates blue power supplies are disabled due to incorrect cryo condition.
   b. IN2 – Yellow Status.
      Logic LOW indicates the lead flow is correct, and yellow power supplies are safe to operate. Logic
      HIGH indicates yellow power supplies are disabled due to incorrect cryo condition.
   c. IN3 – Blue Heart Beat Disabled.

Logic HIGH indicates the flow rate dry contact is in toggle sensing mode. The following conditions will cause this bit to go high:

i. No jumper is inserted to E8, E9 and E10. When no jumper is existed, then the Blue heartbeat circuit is always enabled.
ii. Jumper is inserted across E9-E10 and OUT2 is set to LOW by software.

Logic LOW indicates the flow rate dry contact sensing is in static mode. The following conditions will cause this bit to go low:

i. Jumper is inserted to E8-E9. This jumper causes the Blue heartbeat circuit to disable all the time.
ii. Jumper is inserted across E9-E10 and OUT2 is set to HIGH by software.

d. IN3 – Yellow Heart Beat Disabled.

Logic HIGH indicates the flow rate dry contact is in toggle sensing mode. The following conditions will cause this bit to go high:

i. No jumper is inserted to E5, E6 and E7. When no jumper is existed, then the Yellow heartbeat circuit is always enabled.
ii. Jumper is inserted across E6-E7 and OUT3 is set to LOW by software.

Logic LOW indicates the flow rate dry contact sensing is in static mode. The following conditions will cause this bit to go low:

i. Jumper is inserted to E5-E6. This jumper causes the Yellow heartbeat circuit to disable all the time.
ii. Jumper is inserted across E6-E7 and OUT3 is set to HIGH by software.