HEPI Update Nov. 2013

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1 Summary

We are making several updates to the HEPI master model. These are an accumulation of small to medium sized changes. They are primarily to add functionality to HEPI which is similar to the existing ISI systems and update the Watchdogs. The updates are:

1. Install calibrated cartesian bias offsets to the IPS path, and remove the DC offsets from the input to the Blend Filters.
2. Move the DC Offsets item on the MEDM Overview screen to reflect the new location of the offsets.
3. Make a new MEDM screen for the offsets.
4. Install a new IPSALIGN matrix in the IPS path after the Cartesian basis bias block. Add the indicator to the overview screen and link it to a new MEDM screen.
5. Remove the combined GAIN control from the MASTER block (but leave the overall GAIN control in the ISO block for now).
6. Update the ISO block with new cdsCtrlFilt2 parts.
7. Add a reset feature to ISO control filters so the Watchdog can reset the isolation loops.
8. Add monitoring to the ISO filters so we can monitor the filter state and gain level, report it to the MEDM screen, and correctly calculate the ODC bit for the isolation loops. This matches the monitors in the ISI models.
9. Replace the Watchdog c-code with new 4-state code HPIWD_GPS4S.c and additional output signaling so we can turn off the Isolation loops first and then later turn off all the model outputs.
10. The checker script functions have been included in the front-end model.
11. Add new trip signals to the Watchdog from the IOP Watchdog and the Hardware Watchdog. These are not yet connected to anything.
12. The Watchdog can ride through 10 cycles of saturation before tripping (about 5 msec).
13. Move the Watchdog STS-2 input to monitor the inputs from STS-2, unit B, rather than the output of the selection matrix.
14. The MEDM Watchdog screen has been updated to reflect the changes listed above, and it has been updated to include the new watchdog plotting tools.

15. The science channels are still present (first true in previous release).
16. The model is saved under Matlab 2012b (also true in previous release).

For this update we have decided to **not** update several things:

1. We have not added the saturated integrators to the loop to hold offsets when the isolation loops are switched off.
2. We have not implemented blend switching.

This technical note complements ECR E1300872, and integration issue 530.
The work here was developed in the HEPI_nov_2013 branch of userapps.
It was first committed to the trunk for testing at MIT in update -r6295.

2 Details

2.1 Cartesian Bias and Alignment

We have implemented the calibrated cartesian monitoring and biasing which was developed for the ISI, and described in detail in T1300559. The simulink diagram has been modified to remove the bias which was at the input to the blend filters, and add it immediately after the IPS2CART matrix, as shown below in figure 2. The local biases for the IPSINF Input Filters should now always be set to 0 and turned off.

We have also implemented a new alignment matrix called IPSALIGN which is used to minimize HEPI rotations when HEPI is translating. This serves exactly the same function as the CPSALIGN matrix in the ISI. Initially, this 8x8 matrix will be the identity matrix. We have found that small off-axis terms can be used to dramatically reduce the tilt of the HEPI system, for example see LHO alog entry 8291. As with the ISI, this matrix is placed directly after the cartesian basis monitor and bias block, as can be seen in figure 2.

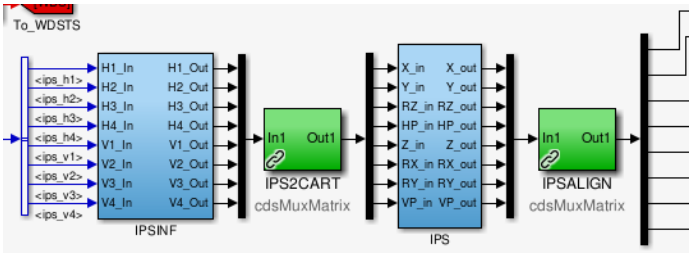

Figure 1: The location of the new cartesian basis bias block is just after the IPS2CART basis change. It is named IPS, which was chosen to give reasonable epic value names such as H1:HPI-HAM2_IPS_X_LOCATIONMON. The new IPSALIGN matrix follows the monitoring to be sure the monitors are watching just the sensors, and not the user defined cross coupling.

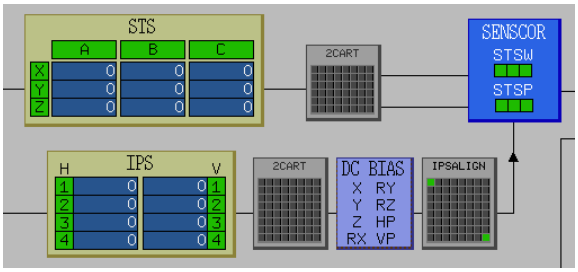

Figure 2: The MEDM Overview screen has been updated to show the new locations of the Bias and Alignment parts. The matrix values are not valid in this screen capture.

2.2 Updates to the Isolation control

The isolation control filters are all in the ISO block. ISO block has been updated considerably. The isolation loops per-se have not been modified, but new automation and monitoring have been added. The output of the isolation filters can now be blocked imme-

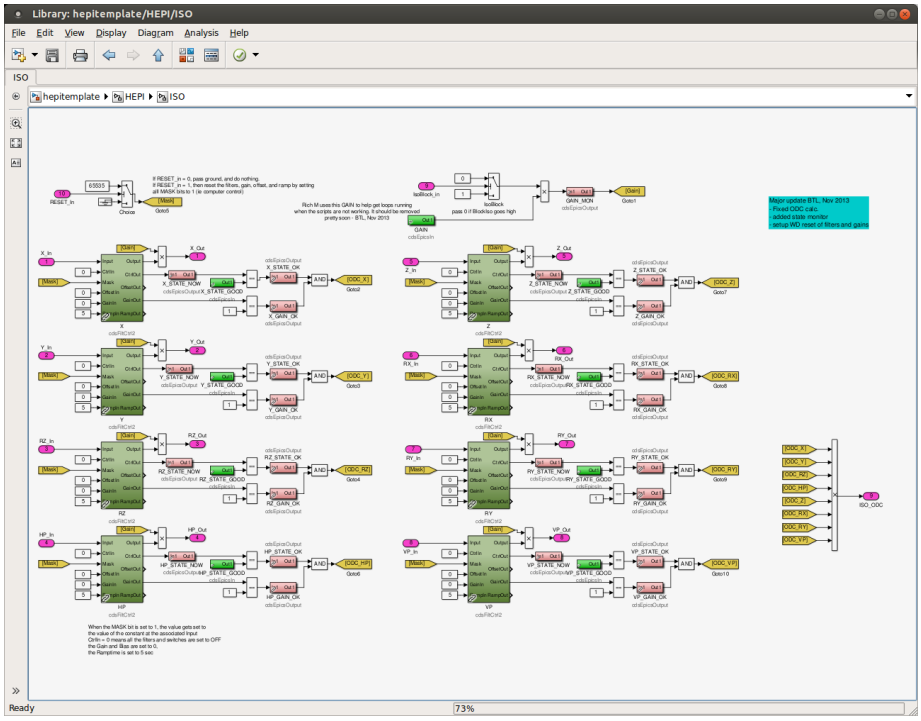

Figure 3: Revised contents of the ISO block

diately by the IsoBlock input from the Watchdog, via the GAIN goto/from tag, which will be true when the watchdog state is 2, 3, or 4. When the Watchdog state is 2, the IsoReset input will set all the filter modules to 'all off, ramp time of 5 seconds' so that when the watchdog is reset the loops will not instantly reengage with whatever large offsets then happen to have. The ODC now watches the gain and filter settings for each module, and it 'ands' the results together in the same way as is done for the ISI models.

The MEDM screen for the Isolation filters has been updated to show the gain and state information.

2.3 Updates to the Watchdog

We have updated the Watchdog to make the model-only changes as described G1301210 for the systems call on Nov. 6, 2013, which is to say the HEPI model has been updated,

but the connections to the IOP WD model and the Hardware WD have hooks, but no signals are being passed. The new c-code for the watchdog is now a 4-state system. The states are:

1. Run - The system is running normally and will go to state 2 if something trips.
2. Rampdown - The Isolation loops are blocked. Now they are blocked immediately. The system stays in this state for 5 seconds, and ignores ongoing trips. This allows it to finish the (not implemented) ramping down process. It then automatically transitions to state 3.
3. Bias Only - The isolation loops are blocked, but the main outputs are still enabled. If there were a bias at the outputs, it would remain in effect. The system stays here until there is another trip, and it goes to state 4, or the user resets the watchdog, and it goes up to state 1.
4. Full Shutdown - The final outputs are set to 0. The User Dac-kill is tripped. Currently, there is no bias signal, so we just shut off the outputs immediately.

The new watchdog code is HPIWD_GPS4S.c and is located in {userapps}/release/hpi/-common/src/. This replaces HPIWD_GPS.c which has been moved from .../hpi/common/src/ down to .../hpi/common/src/old_src/HPIWD_GPS.c

The checkerscript functionality has been imported to the HEPI model from the ISI model. This is described in T1300732 . This includes the automatic countdown for the current trip levels on the various monitors, and it also includes the reset function for the isolation loops described above.

The STS-2 signals now come from the raw ADC input for STS-2 unit B. This now matches the inputs for all the other sensors for the SEI watchdogs. Unit B is the port which is attached at the End stations, and which is nominally used for the controls at the corner station. It is a moot point, because the STS-2 trip level has been set to 50,000 counts (ECR E1300750) so as to not trip the watchdog.

We have included new signals to the HEPI Watchdog which are designed to come from the IOP-WD and the Hardware WD. These are new inputs to the master model, and for the moment these will be grounded. As part of the system-level integration of the watchdogs, these should be connected so that the HEPI isolation loops will be reset when one of these other watchdogs are tripped. The hardware Watchdog will only be implemented for the quads, so the HEPI on other chambers will just ground these inputs.

The signals from the various sensors and actuators have been bussed to make the diagrams easier to understand. The top level of the Watchdog is shown below in figure 4.

We have updated the model to allow the watchdog to 'ride-though' 10 clock cycles with saturations before tripping (about 5 msec). The IPS block with the counting is shown below in figure 5. This is cumulative for each sensor set. e.g. if the IPS gets funny glitch which saturated the sensor for 1 count, and this happens twice per day, the watchdog will not trip for the first 5 days. An indicator is shown to the operator, and can be reset by the

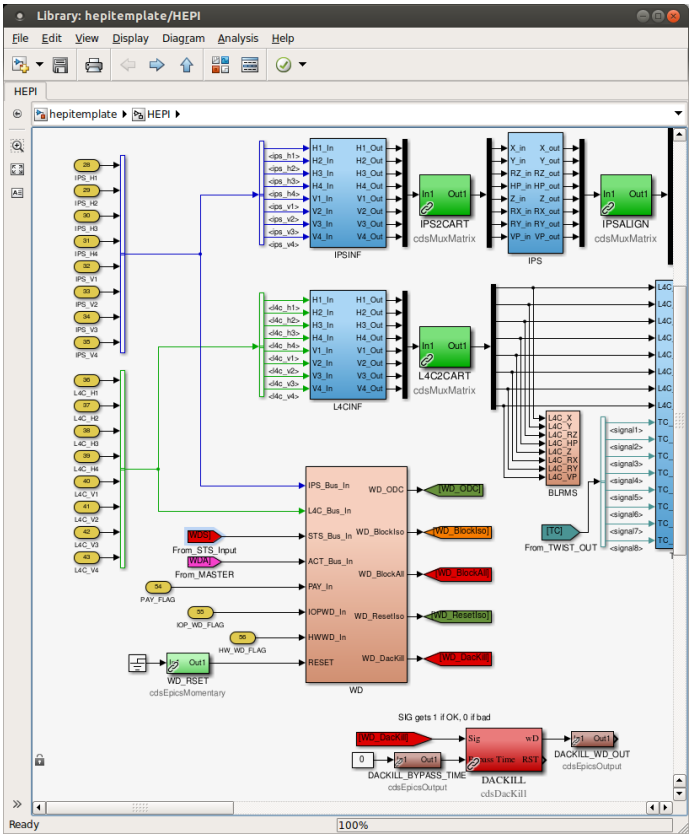

Figure 4: Top level of the Watchdog block (WD). Sensor and Actuator signal are now bussed. There are new inputs from the IOP-WD and the Hardware WD. There are several new outputs required by the 4-state system.

operator without tripping the watchdog. Ten counts or 5 msec is somewhat arbitrary. The unity gain frequency for the loops is not 5 Hz. In the past we have used loops with unity gain frequencies of just over 10 Hz, and we would expect any measurable gain peaking to be at frequencies less than 30 Hz. The characteristic time for a 30 Hz signal is roughly 1/(2*pi*30 Hz) = 5 msec, so if something bad starts to happen, the servo should be shut off in a time shorter than a peak of an oscillation.

The Watchdog MEDM screen has been updated to support the new features. It looks pretty much the same, but now has a set and reset button for the levels, a button to reset all the levels (which calls the script resetWatchdogThresholds in the hpi/common/scripts/ directory). We are currently adding the buttons for the Watchdog trip plotting software used by ISI (ECR E1300774).

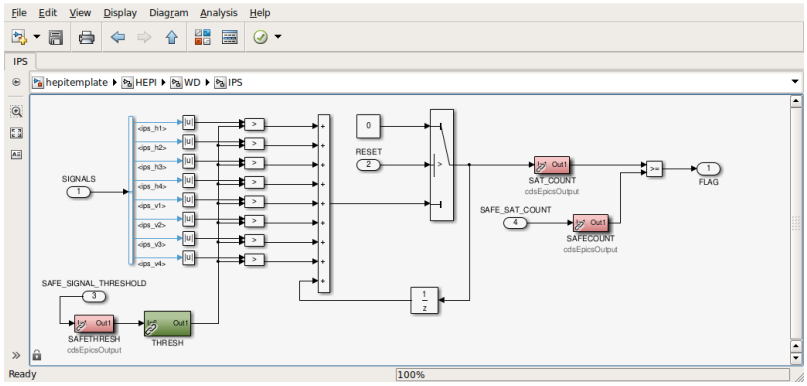

Figure 5: IPS watchdog block showing the new cumulative counting feature.