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| **ECR Title: ECR: Topology Changes to SUS models as a result of ISC Informed Interaction** | DCC No: E1300578-v1 |
| Date: 7/2/2013 |
| **Requester:** Jeff Kissel | **Impacted Subsystem(s):** SUS |  |
| **Description of Proposed Change(s):** (1) Drive DecouplingThe DRIVEALIGN matrix, a frequency-dependent 6x6 or 3x3 matrix that is currentjust after all Euler Basis control signals are summed  - LOCK [Global Interferometric Control],  - OPTICALIGN [Static Alignment of Optic; only at the TOP stage],  - TEST [For out-of-loop excitations] - DAMP [For local damping; only at the TOP stage] was initially conceived to provide a sanctioned location for any, potentiallyfrequency-dependent decoupling of Euler Basis control signal that causesunwanted displacement in auxiliary degrees of freedom. The first few attempts at using this matrix for L-Force-to-P-Displacement drivedecoupling, both with the L1IMC <<https://alog.ligo-la.caltech.edu/aLOG/index.php?callRep=4823>> and H1HIFO-Y <<https://alog.ligo-wa.caltech.edu/aLOG/index.php?callRep=6742>>have separately come to the same conclusion: we should move the DRIVEALIGNmatrix \*before\* the sum of the Euler control signals, such that it only affectsthe ISC paths- It is not necessary to decouple local damping loop control signals (and, infact, they often \*rely\* on the MIMO nature of the plant), nor is it necessaryto decouple the TEST or OPTICALIGN signals- With the DRIVEALIGN containing signals both the ISC and DAMP, one must usethe undamped open loop plant for the design decoupling filters -- i.e. onerequires filters with very, if not impossibly, sharp Qs. If the DRIVEALIGN ispulled out of the DAMP loops, we only need to compensate the residual dampedplant cross-coupling, and compensation filters become much more reasonable toimplement.(2) Alignment Control Distribution:Because it is as yet unclear which topology we prefer, there is a switch in thesuspensions that controls whether ISC signals are hierarchically distributed,either - Offloaded (where ISC signals are injected at the lowest stage, andsubsequent, filtered, control signals are fed to the input of the above stage),or - Distributed (where ISC signals are fed directly to each stage, band-passed,and filtered accordingly).Though mathematically equivalent, an offloaded design is more simple toimplement when it comes to single-DOF decoupled cavity systems. However, oncemulti-DOF, coupled cavities are up and running (for example, in the DRMI), weenvision using the distributed architecture to create a "fixed plant" superactuator such that to the ISC loops, the multi-stage suspensions look like a"simple" pendulum. See, e.g. <<https://dcc.ligo.org/LIGO-G1200692-v3>>.Thus far, for Length control, commissioners have moved forward using theoffloaded topology and done so successfully (and would like to continue doingso). However, for alignment control, only very-low-frequency drift control --fed only to the top stage -- has been needed. With the current topologyoptions, having both an offloaded LSC signal and ASC distributed only to thetop, requires using the offload topology and turning off lower stage ASCsignals in non-obvious places.This portion of the proposal serves to ask for a new ON/OFF switch \*after\*where the offload pick-off is fed to higher stages, such that a signal can beoffloaded to an upper stage, and obviously blocked to other stages.Less important things to remove in order to reduce model complication / framesize if the TRB is interested in a "do all your changes at once scenario:"(1) Remove the OFFLOAD path- Originally implemented as an option for globally controlled optics- Would require top-level changes so many models would be affected, andimplementation would be site-specific and tough (though it would be to \*remove\*some of these top-level dependencies)- Each suspension (even if not a globally controlled suspension) has the fullpath (a 6x6 matrix, and set of 6 filter banks), only to be terminated at thetop level if not used. LOTS of "unused" EPICs channels, and as a down-samplingfilter in each bank.(2) Remove the lower-stage damping path from the QUAD models- Implemented early in the H2OAT test to reduce 0.4-0.5 Hz RMS motion beforeISIs were functioning up to aLIGO specificiations- No longer used / needed- If implemented, would complicate loop design and modeling- 3 filter banks, a 3x3 matrix |
| **Reason for Change(s):** As we begin to really start using the global, interferometric feedback pathswith the IMC, HIFO-Y, and DRMI, we have discovered the need for twoimprovements to how the control signals are distributed throughout the variousstages of the suspension. |
| **Estimated Cost:** no hardware cost; no additional labor time/cost |
| **Schedule Impact Estimate:** none |
| **Nature of Change (check all that apply):****[ ]** **Safety****[ ]  Correct Hardware****[ ]  Correct Documentation** | **[x]  Improve Hardware/SOFTWARE****[ ]  Improve/Clarify Documentation****[ ]  Change Interface****[ ]  Change Requirement** |
| **Importance:****[x]  Desirable for ease of use, maintenance, safety****[x]  Desirable for improved performance, reliability****[ ]  Essential for performance, reliability****[ ]  Essential for function****[ ]  Essential for safety** | **Urgency:****[ ]  No urgency****[x]  Desirable by date/event: \_\_\_soon\_\_\_\_\_\_\_\_\_****[ ]  Essential by date/event: \_\_\_\_\_\_\_\_\_\_\_\_****[ ]  Immediately (ASAP)** |
| **Impacted Hardware/SOFTWARE (select all that apply):****[ ]  Repair/Modify. List part & SNs: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****[ ]  Scrap & Replace. List part & SNs:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****[x]  Installed units? List IFO, part & SNs: \_\_\_\_ALL\_\_\_\_\_\_\_\_\_\_\_\_\_****[ ]  Future units to be built** | **Impacted Documentation** (list all dwgs, design reports, test reports, specifications, etc.):None – software changes only |
| **Disposition of the proposed change(s):**The disposition of this proposed engineering change request is to be completed by Systems Engineering and indicated in the “Notes and Changes” metadata field in the DCC entry for this ECR. The typical dispositions are as follows:* **Additional Information Required**: in which case the additional information requested is defined. The ECR requester then re-submits the ECR with the new information using the same DCC number for the ECR but with the next version number.
* **Rejected**: in which case the reason(s) for the rejection are to be given
* **Approved**
* **Approved with Caveat(s)**: in which case the caveat(s) are listed
* **TRB**: the ECR is referred to an ad-hoc Technical Review Board for further evaluation and recommendation. It is the System Engineer’s (or designee’s) responsibility to organize the TRB. The System Engineer (or designee) then makes a technical decision based on the TRB’s recommendation. Links to the TRB’s documentation (charge, memos, final report, etc.) are to be added to the “Related Documents” field for this ECR.
* **CCB**: a change request for approval of additional funds or schedule impact is to be submitted to the Configuration Control Board. Links to the CCB’s documentation (CR, etc.) are to be added to the “Related Documents” field for this ECR.

**Concurrence by Project Management:** Acknowledgement/acceptance/approval of the disposition is to be indicated by the electronic “signature” feature in the DCC entry for this ECR, by one the following personnel:* Systems Scientist
* Systems Engineer
* Deputy Systems Engineer
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