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# MEMORANDUM

DATE: December 24, 2018

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| TO: | SQZ team |
| FROM: | Daniel Sigg, Marc Pirello |
| SUBJECT: | Modifications to the TTFSS V4 for locking the squeezer OPO |
| Refer to: | LIGO-E1800283-v1 |

This document lists the modifications to the 4th generation TTFSS, based on PCB D1700346-v1 and on schematics [D1700077](https://dcc.ligo.org/D1700077), [D1700076](https://dcc.ligo.org/D1700076) and [D1700078](https://dcc.ligo.org/D1700078).

The modifications in [E1700364-v2](https://dcc.ligo.org/LIGO-E1700364) need to be implemented first.

Since we lock a laser to an optical cavity, we need to use an IQ Demodulator, [D0902745-v5](https://dcc.ligo.org/LIGO-D0902745), which implements the ultra-fast option, described in [E1100044-v4](https://dcc.ligo.org/E1100044).

 **Board modifications**

Change 1 (Sign):

All TTFSS that use an IQ demodulation board need to implement jumper W1.

W1 → installed (solder jumper)

Change 2 (OPO pole):

The TTFSS transfer function is tailored to a reference cavity that has a pole around 77 kHz. For cavities with a higher pole an additional pole/zero pair has to be added. For the squeezer OPO the pole is around 2 MHz (Servo board, D1700077, top)

C18 → 100 pF (1%, NP0) + 1 kΩ
R14 → 20k

This yields a 76kHz/1.6MHz pole/zero pair after the additive offset path is summed in. This also adds an additional gain of 26 dB at DC.

Change 3 (Slew rate):

This will increase the slew rate limit in the PZT path by approximately 4
(HV board, D1700076, top & bottom).

U16 → AD829
U18 → AD829
C71 → 68 pF
C82 → 68 pF

Change 4 (Gain reallocation in PZT path):

Modify the 100 Hz pole at the PZT output to 100Hz/23kHz pole/zero pair
(HV board, D1700076, bottom).

R138 → 15 Ω

Add a 23kHz pole to the fast only path (Servo board, D1700077, top).

C52 → 4.7 nF (1%, NP0)

Take out the 23kHz zero in the other fast path (Servo board, D1700077, top).

R56 → 0 Ω

This should reduce the upfront gain above 100kHz by 5 and more.

BOM (for 10 units, changes 1 through 4):

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| **Qty** | **Item** | **Distributor** | **Description** |
| 10 | P20KDACT-ND | Digi-Key | R3; 20 kΩ |
| 10 | 80-C1206C101FBG | Mouser | C2; 100 pF |
| 10 | P1.0KDACT-ND | Digi-Key | C2; 1 kΩ |
| 20 | AD829ARZ-ND | Digi-Key | U16, 18; AD829 |
| 20 | 311-1109-1-ND | Digi-Key | C71,82; 68pF |
| 10 | CMF15.0HFCT-ND | Digi-Key | R138; 15 Ω |
| 10 | 80-C0805C472F5GACTU | Mouser | C52; 4.7 nF |
| 10 | P0.0ACT-ND | Digi-Key | R56; 0 Ω |