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# MEMORANDUM

DATE: January 31, 2018

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| TO: | SQZ team |
| FROM: | Daniel Sigg, Marc Pirello |
| SUBJECT: | Modifications to the TTFSS V4 |
| Refer to: | LIGO-E1700364-v2 |

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).

**Board modifications**

Change 1:

U2 is missing the +15V rail. Add a jumper wire between the C5 pad towards U1 and the C46 pad towards U1 (Servo board, D1700077, bottom).



Change 2:

Input to U26 is floating when OPT4 is selected without an option board. Add a 10 kΩ resistor (R174) between pins 8 and 18 of header JP1 (Servo board, D1700077, bottom).

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**Part modifications:**

Change 3:

A couple of AD829 operational amplifiers are missing a small capacitor in the feedback path to make them stable (Servo board, D1700077, top).

C66 → 4.7 pF

C52 → 27 pF

C53 → 27 pF

C101 → 10 pF

C153 → 4.7 pF

Change 4:

The output of the EOM high voltage stage needs a higher output impedance to limit the maximum current drive (HV board, D1700076, top).

R99 → 470 Ω (350V)

C63 → 100 pF (500V)

Change 5:

The common boost filter knee changed to 480 Hz (Servo board, D1700077, top).

R55 → 1 kΩ

R63 → 1 kΩ

Change 6:

The gain in the fast path that is used together with the EOM needs to be increased by 4 (Servo board, D1700077, top).

R65 → 499 Ω

R66 → 499 Ω

Change 7:

The gain in the EOM path is too low and needs to be increased by a factor 10. By increasing R112 we also need to adjust the compensation of OpAmp U33 to stay at a high bandwidth (Servo board, D1700077, top/bottom).

R112 → 10 kΩ

C152 → NL

C165 → NL

Change 8:

A lead compensation is needed in the EOM path to restore a decent phase margin (Servo board, D1700077, top).

R107 → 2 kΩ

C144 → 100 pF (1% or 2%)

Change 9:

Remove pointless EOM path diodes (Servo board, D1700077, top).

D1 → NL

D2 → NL

Change 10:

Add a fourth notch filter in the fast patch to address resonances below 100kHz (Servo board, D1700077, top).

U29 → AD829

R91 → 100 Ω

R95 → NL

R99 → 249 Ω

R103 → 0 Ω

C141 → 10 nF (NP0, 1% or 2%)

BOM (for 6 units, changes 1 through 4):

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| **Qty** | **Item** | **Distributor** | **Description** |
| 10 | P10KDACT-ND | Digi-Key | Change 2; 10 kΩ |
| 20 | 478-1300-1-ND | Digi-Key | C66,153; 4.7 pF |
| 10 | 311-1099-1-ND | Digi-Key | C101; 10pF |
| 20 | 311-1104-1-ND | Digi-Key | C52,53; 27pF |
| 10 | 1135-1606-ND | Digi-Key | R99; 470 Ω |
| 10 | 80-C1206C101FBG | Mouser | C63; 100 pF |
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BOM (for 6 units, changes 5 through 11):

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| **Qty** | **Item** | **Distributor** | **Description** |
| 10 | P10KDACT-ND | Digi-Key | R112; 10 kΩ |
| 20 | P1.0KDACT-ND | Digi-Key | R55, R63; 1 kΩ |
| 10 | P2.0KDACT-ND | Digi-Key | R107; 2 kΩ |
| 20 | P499DACT-ND | Digi-Key | R65, R66; 499 Ω |
| 10 | 311-3379-1-ND | Digi-Key | C144; 100pF |
| 10 | P100DACT-ND | Digi-Key | R91; 100 Ω |
| 10 | P249DACT-ND | Digi-Key | R99; 249 Ω |
| 10 | A110380CT-ND | Digi-Key | R103; 0 Ω |
| 10 | 490-8295-1-ND | Digi-Key | C141; 10 nF, 1% |
| 7 | AD829ARZ-ND | Digi-Key | U29; OpAmp |
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