Advanced LIGO PSL
ILS/PMC servo and fieldbox function and interface document
LIGO-T0900578-v1

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1 Requirements

The goal is to design one electronic module for the injection locking (ILS) of the 200W slave laser and for the pre-mode-cleaner (PMC) length control. The main inputs of the module will be an RF photodiode signal and a local oscillator signal with already optimized demodulation phase. A fixed gain, resonant InGaAs photodiode will be used which is not described in this document. The main output of the module will be a high voltage signal to drive a PZT actuator. Some parameters of the servo module can be controlled by signals of the field box.

The associated field box connects the servo module with a (possibly inexistent) computer system. All control parameters of the servo module will pass the field box. The field box contains an optional analog auto-lock circuit which can be, but must not, controlled by the computer system. DAQ and control signals are whitened and de-whitened in the field box. The field box connects to the servo module via the back plane of a crate the modules reside in.

1.1 Application scenarios

- ILS at the LZH with Beckhoff control, Beckhoff controlled analog autolock
- PMC at the LZH with no computer control, analog autolock
- ILS at the AEI/observatories with Beckhoff control and RTLinux DAQ, Beckhoff controlled analog autolock
- PMC at the AEI/observatories with RTLinux control and RTLinux DAQ; RTLinux lock acquisition, RTLinux controlled analog autolock, or full digital RTLinux control and lock acquisition.

1.2 Servo module features

- Calibration peak inputs, remote on/off switching
- Adjustable loop gain
- At least two notch filters (potentiometer adjustable notch parameters, frequency, Q)
- At least two loop shaping filters
- Measurement of closed and open loop transfer functions
- Input offset control
- Interface to PMC thermal control
- DAQ of the error- and control signal
- High voltage drive for PZT actuators
- Switchable integrator
- All servo control signals are received from the field box, no front panel controls
- Mixer with transformer-coupled RF-inputs
- Test points and test inputs/outputs at the front panel
- Diagnostic signals
- Optional bypassing of the analog loop shaping filters for digital feedback control
- Compatible to low power operation mode of the PSL

1.3 Fieldbox module features

- Control of servo module
- Whitening and de-whitening of sensitive signals
- Interface to RTLinux/Beckhoff
- Field box is controlled by RTLinux, Beckhoff or on-board/front-panel controls
- Analog autolock, controlled by computer system or on-board/front-panel controls, isolated inputs/outputs
- Opto-couplers for digital signals

2 Interface

2.1 Servo front-panel

Name	Connector	Type	Desc.
PD	SMA	input	PDH photodiode signal
LO	SMA	input	Local oscillator with optimal phase
TEST1	Lemo	input	Switchable test input
TEST2	Lemo	input	Test input
MIXEROUT	Lemo	output	Error signal
TEST3	Lemo	input	Offset/Test input for HV amplifier, switchable
HVMON	Lemo	output	HV monitor signal
PZT	Lemo 0S	output	HV signal for PZT actuator
HVIN	BNC	input	HV amplifier power supply
HEATER	Lemo	output	High current output for heater
TEMP	Lemo	input	AD590 temperature sensor for PMC spacer

2.2 Bus between servo and fieldbox

Name	Direction	Digital/Analog	Desc.
SW1	F->S	D	Activates test input
SW3	F->S	D	Activates test input
CALIIN	F->S	A (differential)	Calibration input
LODET	S->F	A	LO power
INOFFSET	F->S	A	Offset injected at error signal
BOOST	F->S	D	Activates integrator
MIXEROUT	S->F	A	error signal
BLANKING	F->S	D	Opens feedback loop
RAMP	F->S	A	Signal added to control signal
HVMON	S->F	A	HV monitor
GAIN	F->S	A	P-Gain
HEATER	F->S	A	Heater input
TEMP	S->F	A	PMC spacer temperature
TFOUT	S->F	A	Monitor signal for transfer function measurements

2.3 Fieldbox front-panel

Name	Connector	Type	Desc.
TRIGGER	Lemo	input	Photodiode input for lock acquisition
TRIGGERMON	Lemo	output	Monitor of trigger signal
LOCKON	Switch	input	Activates autolock
RAMPON	Switch	input	Enables ramp signal of autolock
GAIN	Poti	input	P-Gain

2.4 Signals between fieldbox and computer system

Signals needed by Beckhoff or RTLinux:

Name	Direction	Digital/Analog	Desc.
REF	C->F	A	Threshold level for autolock
LOCKON	C->F	D	Activates autolock
RAMPON	C->F	D	Enables ramp signal for autolock
SW1	C->F	D	Activates test input
SW2	C->F	D	Activates test input
INOFFSET	C->F	A	Offset injected at error signal
GAIN	C->F	A	P-Gain
HVMON	F->C	A	HV monitor
HEATER	C->F	A	Heater control signal

Signals needed by RTLinux:

Name	Direction	Digital/Analog	Desc.
HVMON	F->C	A	HV monitor
TRIGGER	F->C	A	Trigger signal for autolock
MIXEROUT	F->C	A	Error signal
LODET	F->C	A	LO power
RAMP	C->F	A	Signal added to control signal
BLANKING	C->F	D	Opens feedback loop
BOOST	C->F	D	Activates integrator
TFOUT	F->C	A	Monitor signal for transfer function measurements
TEMP	F->C	A	Temperature of PMC Spacer
CALIIN	C->F	A	Calibration input

3 Block Diagram

The servo block diagram (Fig. 1) is a functional copy of the Initial LIGO PMC servo (D980352-E1) with some additions: An additional monitor output (TFOUT), a switchable integrator stage and an additional notch filter was added.

The field box block diagram (Fig. 2) contains the autolock electronics, many manual on board switches to adjust the field box to the different application scenarios, and whitening and de-whitening filters. The autolock electronics consists of a ramp generator, which can be paused, and a comparator. In the unlocked state a ramp is injected to the HV amplifier to scan for a resonance. A photodiode DC signal is used as trigger signal to pause the ramp and to close the feedback loop.

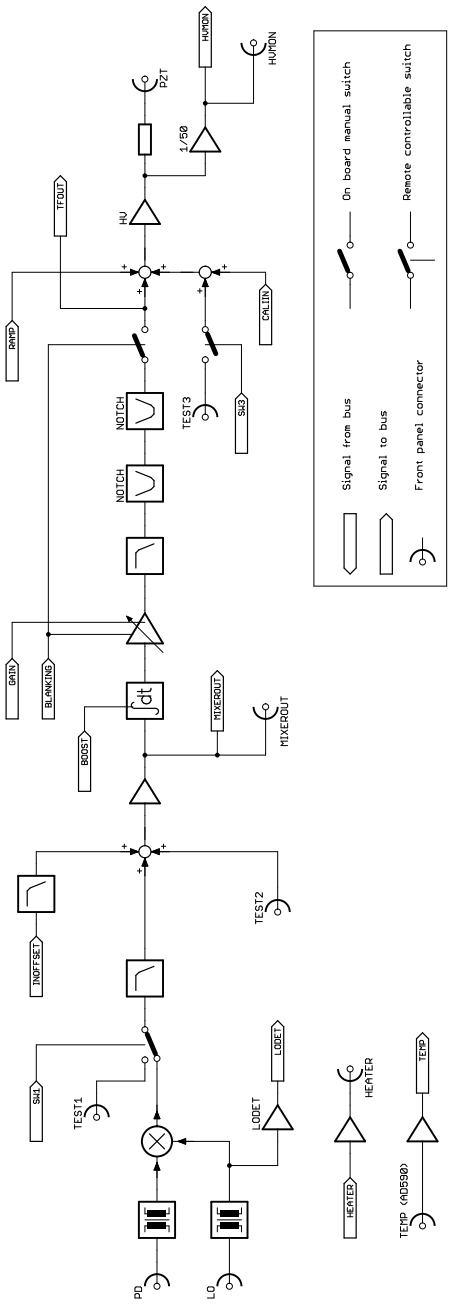

Figure 1: Block diagram of the servo module.

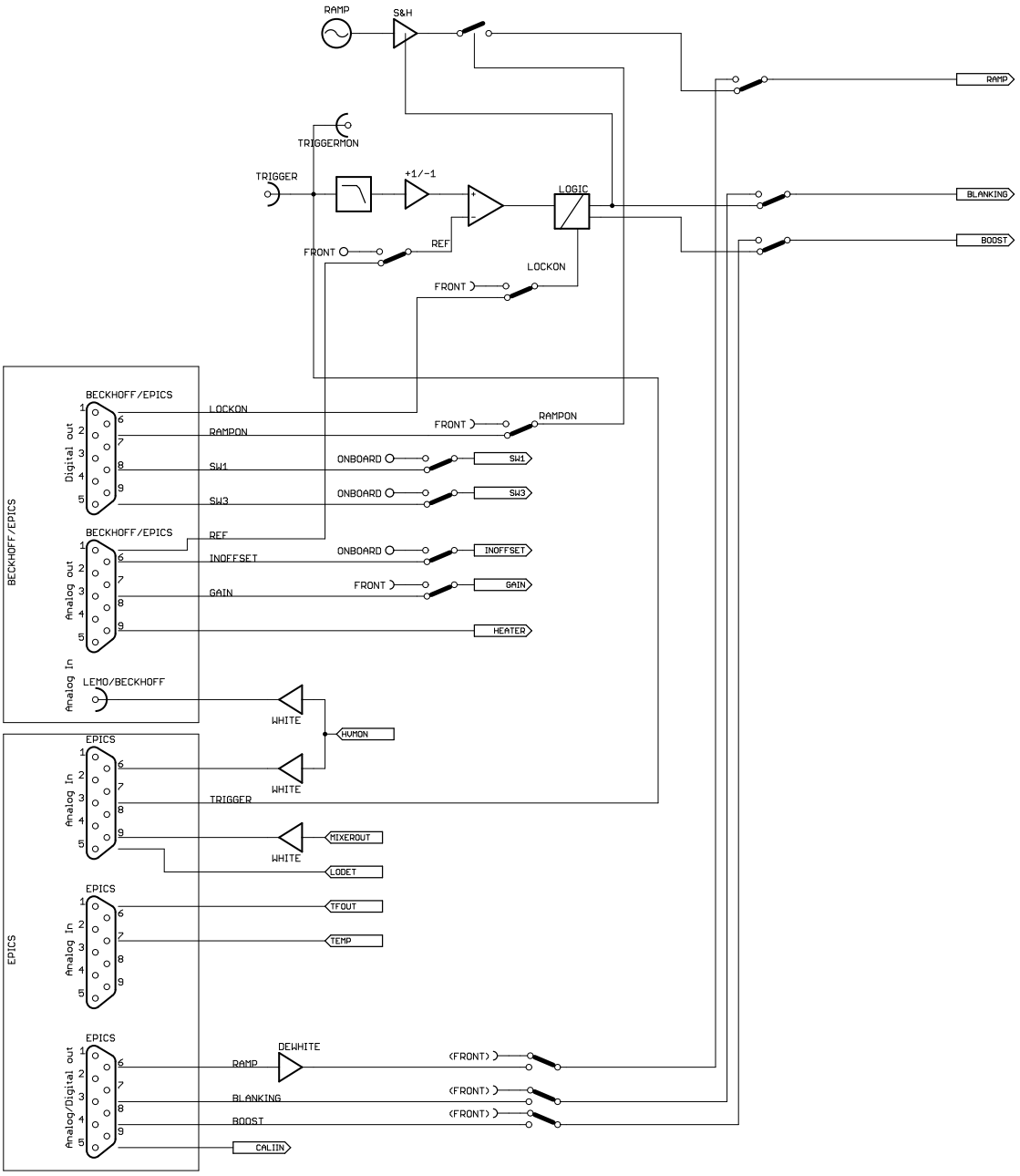

Figure 2: Block diagram of the field box.