Preparation of TAMA RSE Mach-Zehnder

1. Optical Layout

長野D論の資料

2. Optics and Mounters

3. Piezoelectric actuator

3.1 PZT spec.

PI 社のカタログ資料

3.2 PZT holder

天文台：丹羽君の修論実験資料

3.3 PZT driver

MESSTEK の3軸ドライバー

4. Servo Control

4.1 Servo filter

天文台：丹羽君の修論実験資料

4.2 Monitoring signals **辰巳案**

1. Optical Layout

長野D論の資料　　現状は大きく変わっていないはずだが要確認。

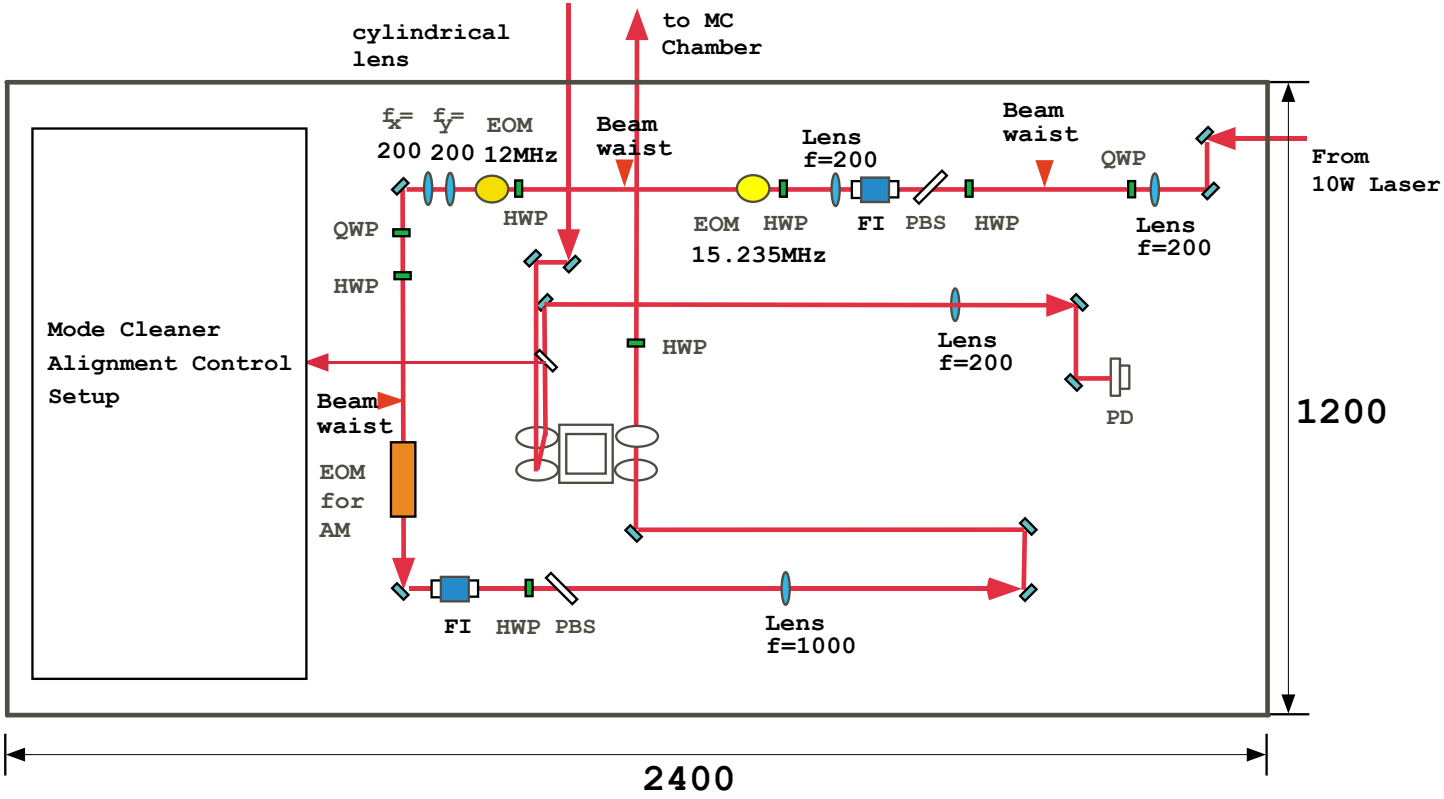
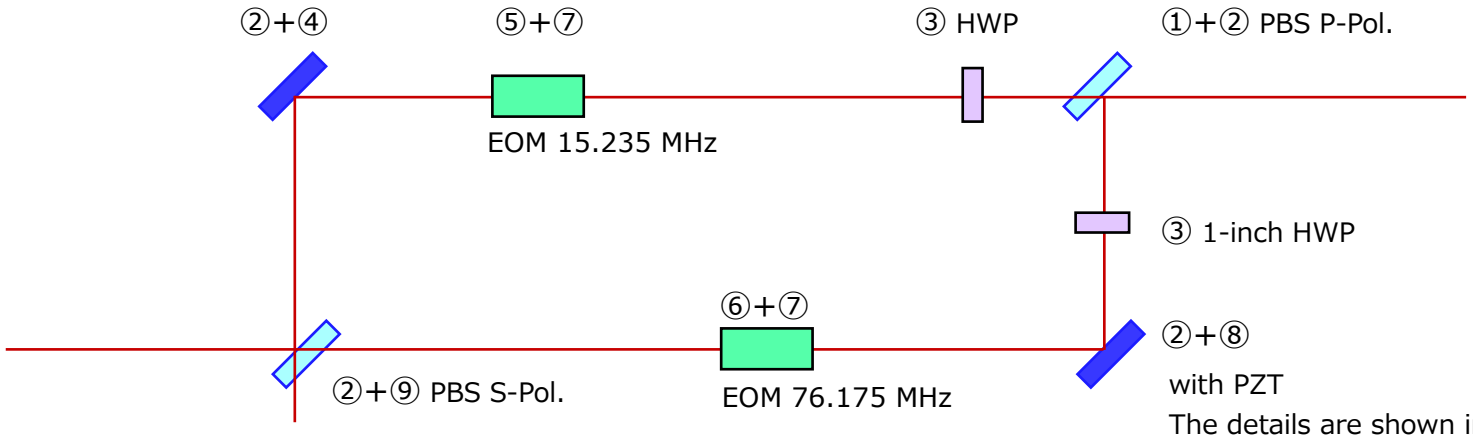


Figure 6.7: Optical configuration on the injection bench to the mode cleaner: FI; Faraday isolator, PBS; polarization beam splitter, EOM; electro-optic modulator, HWP; half-wave plate, and QWP; quarter-wave plate.

2. Optics and Mounter

1	Beam splitter	Lattice	P-pol, 2-inch dia.,	1	Ordered
2	2-inch mirror mount	Newport	U200-A	3	O.K.
3	Half-Wave Plate	CVI	QWPO-1064-08-4-R10-AIR	2	O.K.
4	2-inch mirror	CVI	Y1-2037-45-S	2	O.K.
5	EOM 15.24 MHz	Newfocus	4001M	1	O.K.
6	EOM 76.18 MHz	Newfocus	4001M	1	O.K.
7	4-axis tilt alignner	Newfocus	9071M	2	O.K.
8	PZT holder	Newport	U200-P	1	O.K.
9	Beam splitter	Lattice	S-pol, 2-inch dia.,	1	Ordered



with PZT
The details are shown in the following pages.

S-310 – S-316 Piezo Z/Tip/Tilt Scanner

High-Speed System with Clear Aperture

S-310.10, S-316.10
piezo systems for scanning,
optics alignment and mirror shifter alignment

- **10 mm Clear Aperture**
- **Piezo Tripod Design**
- **Optical Beam Deflection to 2,4 mrad**
- **Piston Movement up to 12 µm (phase shifter)**
- **Sub-Millisecond Response, Sub-Microradian Resolution**
- **Closed-Loop Versions for Higher Precision**
- **For Optics, Mirrors or Other Components**
- **Frictionless, High-Precision Flexure Guiding System**
- **Parallel Kinematics for Enhanced Dynamics and Better Multi-Axis Accuracy**

S-310 to S-316 multi-axis tip/tilt platforms and Z-positioners are fast, compact units based on a piezo tripod design. They offer piston movement up to 12 µm and tilt movement up to 1.2 mrad (2.4 mrad optical beam deflection) with sub-millisecond response and settling. The tripod design features optimum angular stability over a wide temperature range.

The systems are designed for mirrors and optics up to 25 mm in diameter and can be mounted in any orientation; the clear aperture is ideal for transmitted-light applications (e.g. for optical filters).

Application Examples

- Image processing / stablilization
- Interferometry
- Laser scanning / beam steering
- Laser tuning
- Optical filters / switches
- Beam stabilization

Open-Loop and Closed-Loop Operation

In open-loop mode, the tip/tilt angle is roughly proportional to the applied voltage. The S-310 to S-315 open-loop models are ideal for high-speed, high resolution applications where the absolute angular position is of secondary importance (e.g. for tracking) or where feedback is provided by an external sensor (e.g. CCD, PSD). The S-316.10 model is equipped with high-resolution strain gauge sensors and provides absolute position control, high linearity and high repeatability.

Available Versions

S-310.10, S-314.10

Open-loop Z-platforms; all three piezo linear actuators are electrically connected in parallel, providing vertical positioning (piston movement) of the top ring. Only one drive channel is required.

S-311.10, S-315.10

Open-loop Z/tip/tilt positioners; all three piezo linear actuators can be driven individually (or in parallel) by a three-channel amplifier. Vertical (piston movement) positioning and tip/tilt positioning are possible.

S-316.10

Closed-loop Z/tip/tilt positioner. All three piezo linear actuators are equipped with strain gauge position feedback sensors and can be driven individually (or in parallel) by a three-channel amplifier with a position servo-controller. Vertical positioning (piston movement) and tip/tilt positioning are possible. The integrated position feedback sensors provide sub-microradian resolution and high repeatability.

Ordering Information

S-310.10
Piezo Actuator, Clear Aperture, 6 µm, LEMO Connector

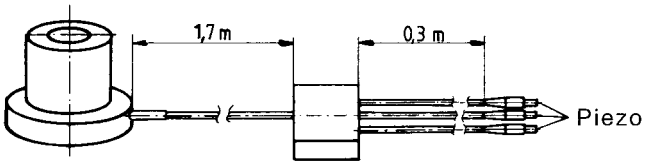
S-311.10
Piezo Z/Tip/Tilt Platform, Clear Aperture, 600 µrad, 6 µm, LEMO Connector

S-314.10
Piezo Actuator, Clear Aperture, 12 µm, LEMO Connector

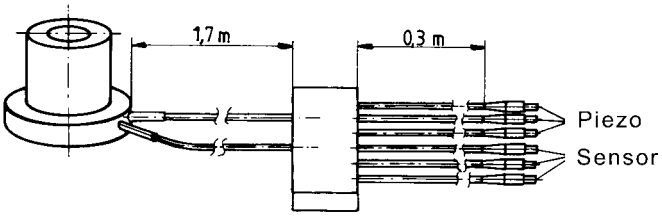
S-315.10
Piezo Z/Tip/Tilt Platform, Clear Aperture, 1.2 mrad, 12 µm, LEMO Connector

S-316.10
Piezo Z/Tip/Tilt Platform, Clear Aperture, 1.2 mrad, 12 µm, SGS, LEMO Connector

S-316.10D
Piezo Z/Tip/Tilt Platform, Clear Aperture, 1.2 mrad, 12 µm, SGS, Sub-D Connector



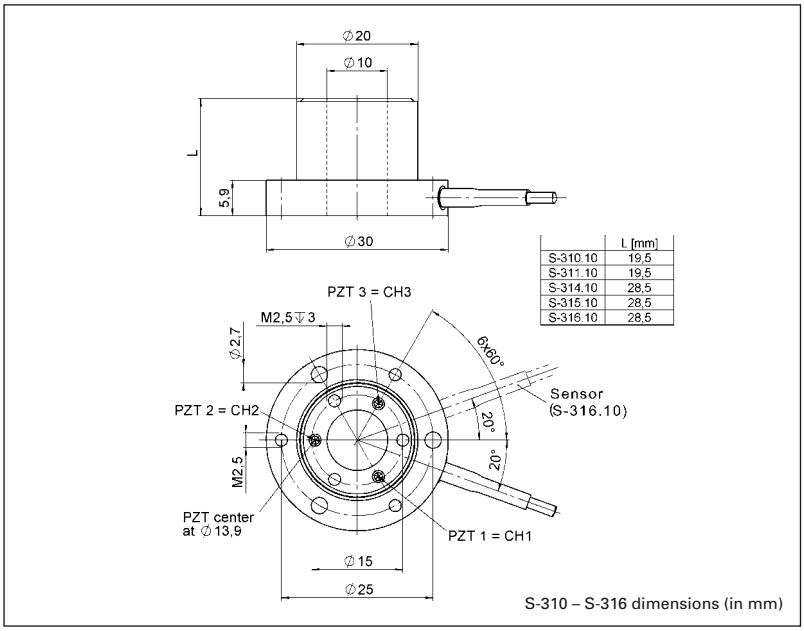
S-315 cable configuration



S-316 cable configuration

High Reliability and Long Lifetime

The compact S-310 - S-316 systems are equipped with preloaded PICMA® high-performance piezo actuators which are integrated into a sophisticated, FEA-modeled, flexure guiding system. The PICMA® actuators feature cofired ceramic encapsulation and provide better performance and reliability than conventional piezo actuators. Actuators, guidance and sensors are maintenance-free, not subject to wear and offer extraordinary reliability.



	L [mm]
S-310.10	19,5
S-311.10	19,5
S-314.10	28,5
S-315.10	28,5
S-316.10	28,5

S-310 – S-316 dimensions (in mm)

Technical Data

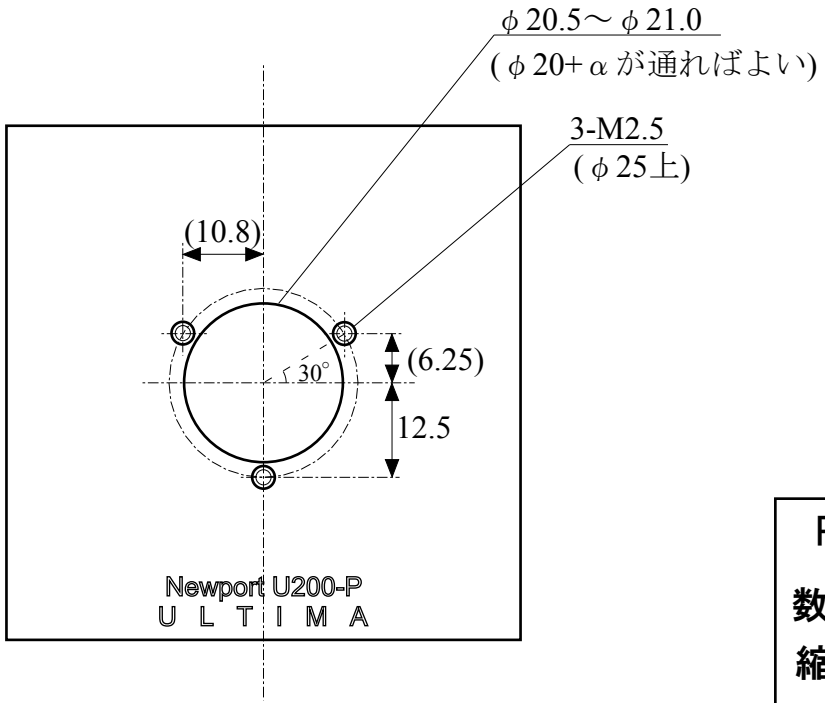
Model	S-310.10	S-314.10	S-311.10	S-315.10	S-316.10	Units	Tolerance
Active axes	Z	Z	Z, θ_X, θ_Y	Z, θ_X, θ_Y	Z, θ_X, θ_Y		
Motion and positioning							
Integrated sensor	–	–	–	–	SGS		
Open-loop travel, 0 to +100 V	6 / –	12 / –	6 / –	12 / –	12 / 12	µm	min. (+20 %/-0 %)
*Open-loop tilt angle @ 0 to 100 V	–	–	600	1200	1200	µrad	min. (+20 %/-0 %)
Closed-loop travel	–	–	–	–	12	µm	
*Closed-loop tilt angle	–	–	–	–	1200	mrad	
Open-loop resolution	0.1	0.2	0.1	0.2	0.2	nm	typ.
Open-loop tip/tilt angle resolution			0.02	0.05	0.05	µrad	typ.
Closed-loop resolution	–	–	–	–	0.4	nm	typ.
Closed-loop tip/tilt resolution	–	–	–	–	0.1	µrad	typ.
Linearity	–	–	–	–	0.2	%	typ.
Mechanical properties							
Stiffness	20	10	20	10	10	N/µm	±20 %
Unloaded resonant frequency (Z)	9.5	5.5	9.5	5.5	5.5	kHz	±20 %
Resonant frequency (with 15 x 4 mm glass mirror)	6.5	4.4	6.5	4.1	4.1	kHz	±20 %
Resonant frequency (with 20 x 4 mm glass mirror)	6.1	4.2	6.1	3.4	3.4	kHz	±20 %
Distance of pivot point to platform surface	–	–	5	5	5	mm	±1 mm
Platform moment of inertia	–	–	150	150	150	g • mm²	±20 %
Drive properties							
Ceramic type	PICMA® P-882	PICMA® P-882	PICMA® P-882	PICMA® P-882	PICMA® P-882		
Electrical capacitance	0.39	0.93	0.39	0.93	0.93	µF	±20 %
Dynamic operating current coefficient	8	10	8	10	10	µA / (Hz • mrad)	±20 %
Miscellaneous							
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	°C	
Material	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel		
Mass	0.045	0.055	0.045	0.055	0.055	kg	±5%
Cable length	2	2	2	2	2	m	±10 mm
Sensor connection	–	–	–	–	LEMO		
Voltage connection	LEMO	LEMO	LEMO	LEMO	LEMO		

Resolution of PI piezo tip/tilt platforms is not limited by friction or stiction. Noise equivalent motion with E-503 amplifier (p. 2-146).

*Mechanical tilt, optical beam deflection is twice as large. For maximum tilt range, all three piezo actuators must be biased at 50 V. Due to the parallel-kinematics design linear travel and tilt angle are interdependent. The values quoted here refer to pure linear / pure angular motion (equations p. 2-84).

Recommended controller / amplifier
Single-channel (1 per axis): E-610 servo-controller / amplifier (p. 2-110), E-625 servo-controller, bench-top (p. 2-114)

Multi-channel: modular piezo controller system E-500 (p. 2-142) with amplifier module E-503 (three channels) (p. 2-146) or E-505 (1 per axis, high-power) (p. 2-147) and E-509 controller (p. 2-152) (optional), E-517 interface module (p. 2-156) (optional)



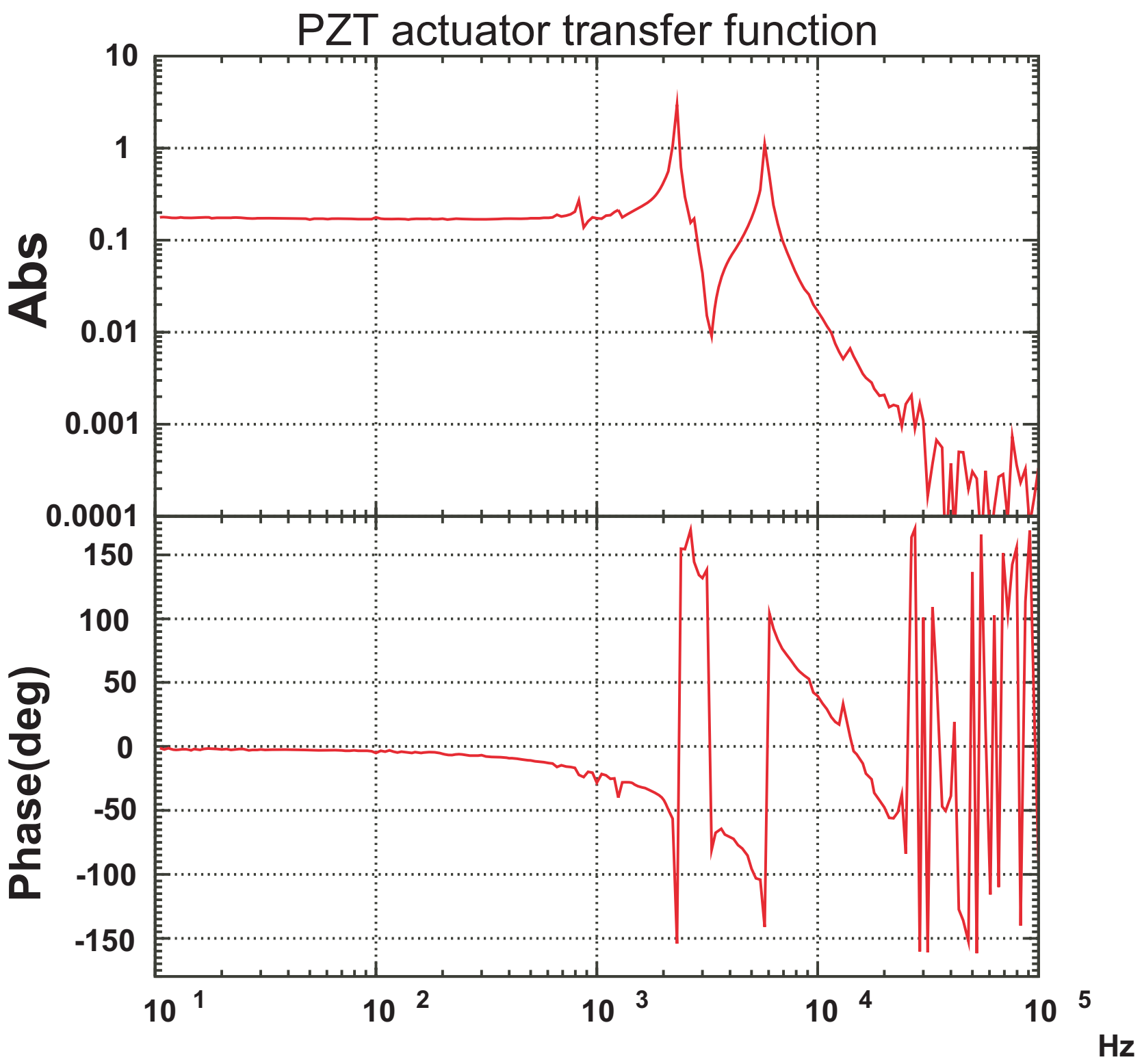
PZT holder

数量：4

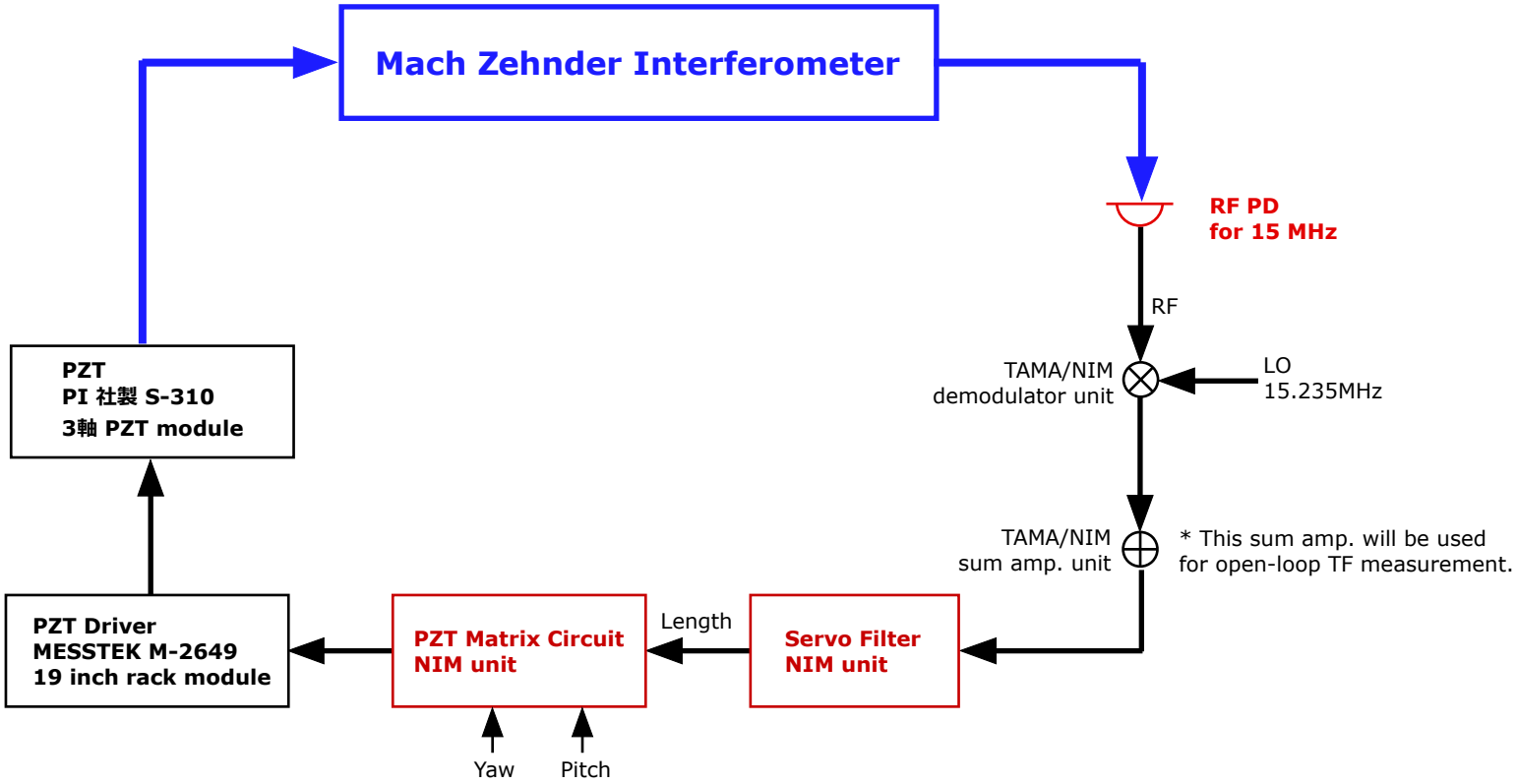
縮尺：1　　単位：mm

作図日付：2005/4/25
作図担当：丹羽佳人
所属：国立天文台JASMINE検討室

Newport U200-P
ULTIMA


PZT actuator transfer function
Abs
10
1
0.1
0.01
0.001
0.0001
Phase(deg)
150
100
50
0
-50
-100
-150
10 1
10 2
10 3
10 4
10 5
Hz

3. Servo Control



***** Red colored letters indicate things to be ordered or to be made。**

SWEEP LINEAR/LOG
START FREQ
STOP FREQ
RESET/ START
MKR FREQ
SINGLE
MKR→CF
LOG
FREQ
AMPTD
PHASE
DC OFFSET
STORE
RECALL
CLEAR
7
8
9
4
5
6
1
2
3
0
POWER
STBY
ON
SIGNAL
REAR ONLY
CAUTION DC COUPLED

CH-1
150V:200mAor600mA
CH-2
150V:200mA
CH-3
150V:200mA
GAIN A
OFFSET
INPUT A
INPUT B
MONITOR SELECT
CH.1
CH.2
CH.3
OUTPUT LIMIT
M-2649 PIEZO DRIVER
MONITOR
OUTPUT
POWER
OUTPUT MONITOR
MESS-TEK CO.,LTD

3.15A

OUTPUT

CH.1

CH.2

AC100V

CH.3

国立天文台

B - 4 - 1999 - 3 -

位置天文・天体力学研究系

MESS-TEK

MODEL

NO.

DATE

STYLE FAN

MODEL US80D10

WARNING

DO NOT TOUCH ROTOR BLADES

BALL BEARING

100 V~ 50/60Hz 11/10 W

STYLE ELECTRONICS CO.,LTD. MADE IN JAPAN

CAUTION!!

スイッチの切換は、必ず電源OFFで行って下さい

CH.SELECT

CH.1 ONLY CH.1~3

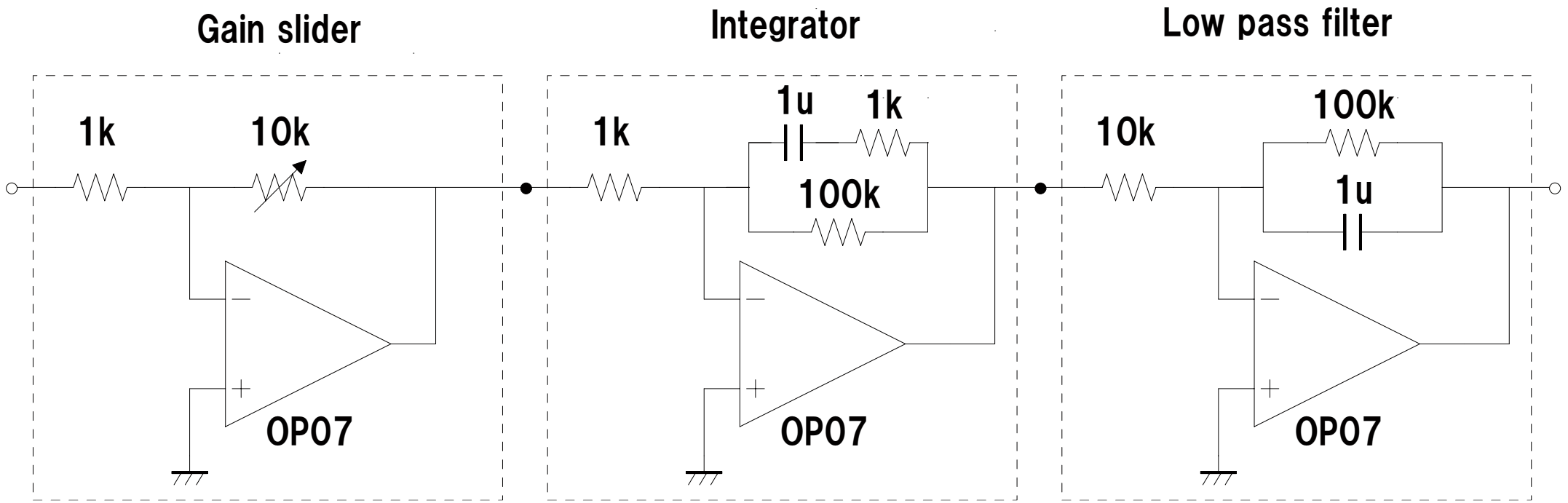
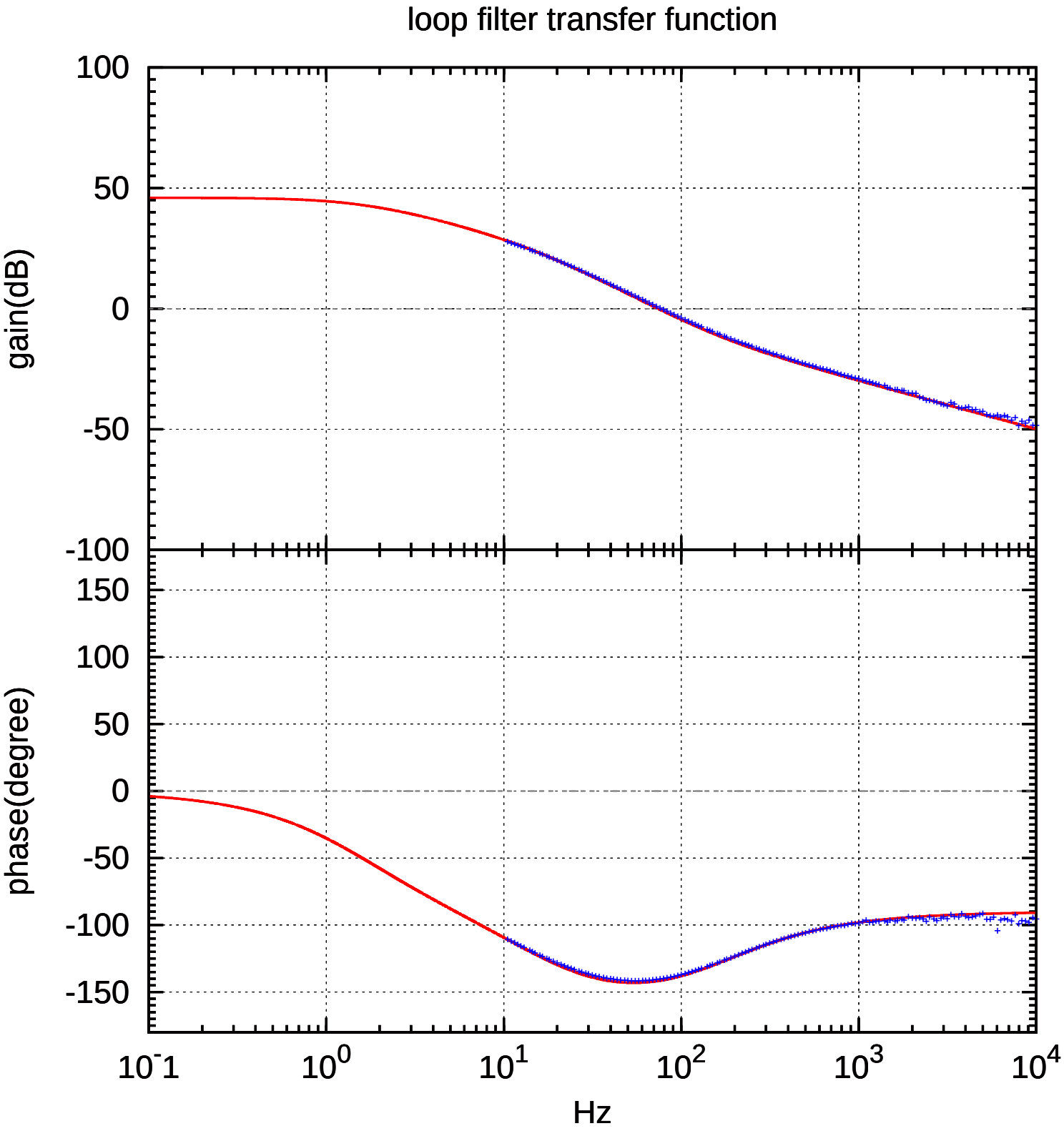


Fig.D.1.3　光軸制御で使用したループフィルターの回路図


loop filter transfer function
gain(dB)
100
50
0
-50
-100
phase(degree)
150
100
50
0
-50
-100
-150
10^-1
10^0
10^1
10^2
10^3
10^4
Hz

3.1 Monitoring signals

TAMA operator need to monitor status of the MZ.

* DC light power at Dark Port

* DC light power at Bright Port (injection light to the Mode Cleaner)

* Error signal

* Feedback signal