

μASTP Analog Signal Conditioning Card

General Description:

The μASTP board is a signal conditioning circuit module for high-frequency measurements of acceleration, shear, temperature, and pressure. It is a core module for microstructure measurements and is designed for high-accuracy, high-precision and low-noise. The design philosophy of the μASTP board was to optimize the signal-to-noise ratio without any compromise with respect to power, size or any other consideration. Every board is fully tested and its frequency response and noise characteristics are fully documented. The noise, for example, of the thermistor circuits is at the theoretically limit (the Johnston noise).



Figure 1. μASTP Board

Specifications:

Input Channels

P:	Pressure	Pressure Transducer, Keller PA10/11
T1,T2:	Temperature	fast tip thermistor, FP07-38-1/6
S1,S2:	Shear	shear probe, e.g. SPM-38-1/6
A1,A2,A3 :	Acceleration	Measurement Specialties Model 4000

Output Signals

Description	Signal	No. Channels	Dynamic Range	Band-width
Pressure	P	1	0 - 1.25 V @ FS	5 Hz
Pressure + derivative	P + 21dP/dt	1	±2.5 VDC	5 Hz
Temperature	T1, T2	2	-1 to +1 V @ -5 to 35 C	150 Hz
Temperature + derivative	T1+dT1/dt T2+dT2/dt	2	±2.5 VDC	150 Hz
Shear	S1, S2	2	±2.5 VDC (variable gain)	200 Hz
Acceleration	Acc1, Acc2, Acc3	3	±2.5 VDC @ ±2.5 g	1 MHz
Aux1	T1 (50 Ω)			
Aux2	-2.500 V Reference (50 Ω)			

The auxiliary outputs can be sent to independent data measurements systems for data synchronization.

Output Connectors

IDC Pin	Channel	Signal
1	0	Reference Ground for ADC (no connection on the μ ASTP board)
2	1	Ax – accelerometer
3	2	Ay – accelerometer
4	3	Az – accelerometer
5	4	T1, Thermistor 1 without pre-emphasis
6	5	T1_dT1, Thermistor 1 with pre-emphasis
7	6	T2, Thermistor 2 without pre-emphasis
8	7	T2_dT2, Thermistor 2 with pre-emphasis
9	8	Sh1, Shear probe 1
10	9	Sh2, Shear probe 2
11	10	P, pressure without pre-emphasis
12	11	P_dP, pressure with pre-emphasis
13	12	Spare, (usually the SBE7 micro-conductivity signal, if available)
14	13	Spare
15	14	Spare
16	15	Spare
17	NA	Analog Signal Ground
18	NA	Analog Signal Ground
19	NA	Analog Signal Ground
20	NA	Analog Signal Ground

Shear Probe Channels

Number of Channels	2
Front-end	Charge-transfer amplifier
Gain	-0.667×10^9 volts per coulomb (1.50nF \pm 2% capacitor)
Differentiator Gain	1 second, can be increased with a single resistor
Bandwidth	250 Hz
Output Noise	Electronic contributions are completely negligible compared to vehicular vibrations and other spurious signals $5 \times 10^{-9} \text{ s}^{-2}$ for 0.1 to 10 Hz band ($4 \times 10^{-13} \text{ W kg}^{-1}$) $5 \times 10^{-7} \text{ s}^{-2}$ for 0.1 to 100 Hz band ($4 \times 10^{-10} \text{ W kg}^{-1}$) for a profiling speed of 0.7 m s^{-1} and probe sensitivity of $0.1 \text{ V/ (m s}^{-1})^2$ or 0.15×10^{-9} coulomb per $\text{m}^2 \text{ s}^{-2}$

Thermistor Channels

Number of Channels	2	
Front-end	Four-arm, equal-resistor bridge optimized for 3kΩ thermistor (FP07DA202N by Thermometrics)	
Temperature Output	-1 to +1 V for -2° to 32°C $E_T \approx \frac{T - 15^\circ}{15^\circ}$	
Temperature Output with pre-emphasis	$E_T + \frac{\partial E_T}{\partial t}$, ±2.5 V	
Thermistor internal heating	35 x 10 ⁻⁶ W	
Output Noise	Equivalent to Johnson noise of 3kΩ resistor.	
Temperature noise	10 x 10 ⁻⁶ °C rms in the 0.5 to 10 Hz band.	
Noise in terms of the dissipation of temperature variance, X_N [°C ² s ⁻¹]	W [m s ⁻¹]	X_N [°C ² s ⁻¹]
	0.1	3 x 10 ⁻¹¹
	0.3	4 x 10 ⁻¹²
	0.5	1 x 10 ⁻¹²
	0.7	7 x 10 ⁻¹³
Contamination of X by velocity fluctuations when $\epsilon = 10^{-6}$ W kg ⁻¹	W [m s ⁻¹]	X_F [°C ² s ⁻¹]
	0.1	9 x 10 ⁻¹¹
	0.3	7 x 10 ⁻¹²
	0.5	2 x 10 ⁻¹²
	0.7	9 x 10 ⁻¹³
1.0	4 x 10 ⁻¹³	

Pressure Channel

Number of Channels	1
Excitation	Constant current or constant voltage. Nominally 1.024 mA or 2.048 V
Front End	Differential amplifier optimized for Keller P10/11 3.5kΩ silicon strain-gauge pressure transducer
Pressure Output	$E_p = 1.5 \frac{P}{P_0}$ where P_0 is the full-scale range of the pressure transducer
Pressure Output with pre-emphasis	$E_p + 20.5 \frac{\partial E_p}{\partial t}$
Output Voltage Range	0 – 1.5 V for P without pre-emphasis ±2.5 V for P with pre-emphasis
Output Voltage Noise	Less than 1 x 10 ⁻³ dBar for a transducer with a full-scale range of 1000 dBar.

Accelerometer Channels

Number of Channels	3
Front-end	Gain of 1 difference amplifiers optimized for Measurement Specialties Model 4000 accelerometers. Can also be used with current output accelerometers by inserting suitable resistor on μASTP board.
Output Voltage range	±2.5 V for ±2.5 g or ±24.6 m s ⁻²

Power Supply

Voltage	±5VDC nominal, ±12VDC absolute maximum.
Ripple	Less than 10mV peak-to-peak 0 to 1MHz to achieve full specification.
Current	50 mA, reduced current available by special request with small sacrifice in signal-to-noise ratio.
Dimensions	17.78 x 4.45 x 1.52 cm (including connector)