InertialLabs
Attitude is Everything
KERNEL-210
KERNEL-220
AF 04 019
MADE IN USA
High Performance
MEMS Inertial
Measurement Units

The **Inertial Labs MEMS KERNEL-210 and KERNEL-220 Inertial Measurements** are the third generation of the Inertial Labs Miniature MEMS sensor-based family. The KERNEL-210 and KERNEL-220 are revolutionary, compact, self-contained, strapdown, Tactical-grade Inertial Measurement Units that measure linear accelerations and angular rates with precision due to their aligned and calibrated three-axis MEMS accelerometers and three-axis MEMS gyroscopes. Angular rates and accelerations are determined with low noise and very good repeatability for both motionless and dynamic applications.

The **Inertial Labs KERNEL-210 and KERNEL-220** models are the breakthrough, fully integrated inertial sensors that combines the latest MEMS sensor technologies. **KERNEL-220** model utilizes two types of accelerometers: with ±40g and ±90g measurement ranges.

Fully calibrated, temperature compensated, mathematically aligned to an orthogonal coordinate system, the IMU contains less than 1 deg/hr Bias in-run stability gyroscopes and 0.005 mg Bias in-run stability accelerometers with very low noise and high reliability.

Continuous Built-in Test (BIT), configurable communications protocols and flexible input power requirements make the **Inertial Labs KERNEL** easy to use in a wide range of higher order integrated system applications.

The **Inertial Labs KERNEL** models were designed for applications, like:

- Autonomous vehicles
- Antenna and Line of Sight Stabilization Systems
- Passengers trains acceleration / deceleration and jerking systems
- Motion Reference Units (MRU) and Motion Control Sensors (MCS)
- Gimbals, EOC/IR, platforms orientation and stabilization
- GPS-Aided Inertial Navigation Systems (INS)
- Attitude and Heading Reference Systems (AHRS)
- Guidance and Navigation
- UAV & AUV/ROV navigation and control

Parameter	KERNEL-210 Tactical	KERNEL-220 Tactical	
GYROSCOPES			
Measurement range	±2000 deg/sec	±2000 deg/sec	
Gyroscopes Bias in-run stability	1 deg/hr	1 deg/hr	
Gyroscopes Bias residual error (over temp. range)	<30 deg/hr	<30 deg/hr	
Gyroscopes Noise - Angular Random Walk	0.2 deg/√hr	0.2 deg/√hr	
ACCELEROMETERS			
Measurement range	±8g (15g/40g)	±40g and	±90 g
Accelerometers Bias in-run stability	0.005 mg	0.02 mg	1 mg
Accelerometers Bias instability over temp. range	0.5 mg	1.5 mg	200 mg
Accelerometers Noise (Velocity Random Walk)	0.015 m/sec/√hr	0.045m/sec/√hr	15 m/sec/√hr
PITCH & ROLL	0.05 deg	0.05 deg	

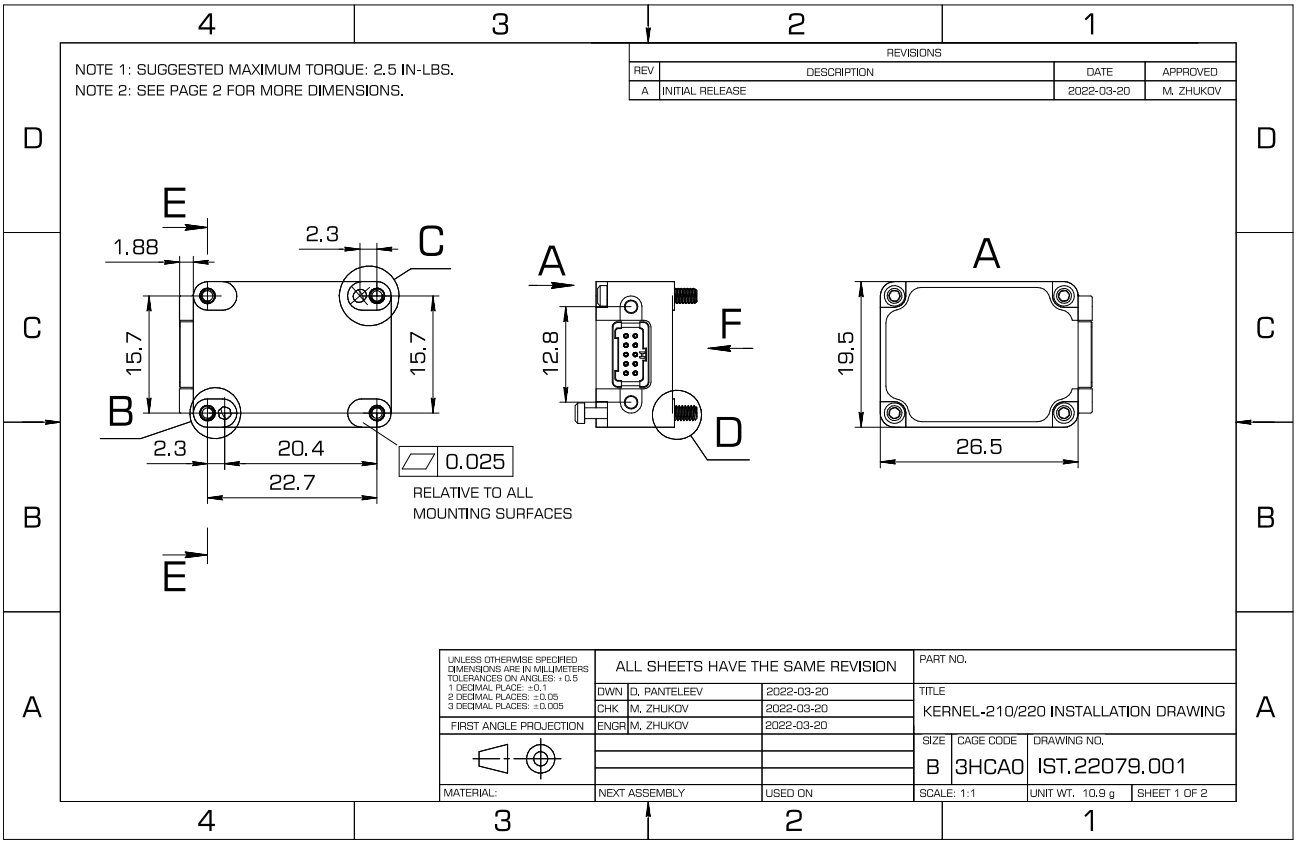
KERNEL-210 and KERNEL-220 Tactical

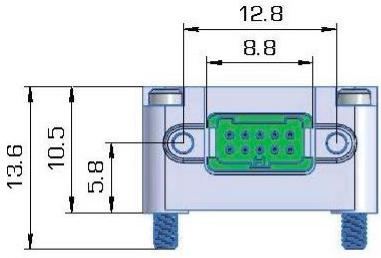
	Parameter	Units	KERNEL-210 Tactical	KERNEL-220 Tactical
GENERAL	Output signals		Pitch, Roll, Accelerations, Angular Rates, Temp., Synch	Pitch, Roll, Accelerations, Angular Rates, Temp., Synch
	Color of Enclosure		Gold	Gold
	Update rate (IMU data)	Hz	2000	2000
	Update rate (Pitch & Roll data)	Hz	2000	2000
	Start-up time	sec	<0.02	<0.02
	Full Accuracy Data (Warm-up Time)	sec	<0.05	<0.05
	Latency	milli sec	<2.4	<2.5
	Pitch & Roll	**Units**	**KERNEL-210 Tactical**	**KERNEL-220 Tactical**
PERFORMANCE	Data rate	Hz	2000	2000
	Range: Pitch	deg	±90	±90
	Range: Roll	deg	±180	±180
	Angular Resolution	deg	0.01	0.01
	Static Accuracy, RMS	deg, 1σ	0.05	0.05
	Dynamic Accuracy, RMS	deg, 1σ	0.08	0.08
	Gyroscopes	**Units**	**KERNEL-210 Tactical**	**KERNEL-220 Tactical**
	Measurement range	deg/sec	±2000	±2000
	Bandwidth (-3dB)	Hz, 1σ	260	260
	Data update rate	Hz	2000	2000
	Bias in-run stability (Allan Variance, RMS)	deg/hr, 1σ	1	1
	Bias repeatability (turn-on to turn-on, RMS)	deg/hr, 1σ	15	15
	Bias residual error (over temp. range, RMS)	deg/hr, 1σ	30	30
	SF accuracy (over temperature range)	ppm, 1σ	750	750
	Noise. Angular Random Walk (ARW)	deg/√hr, 1σ	0.2	0.2
	Non-linearity	ppm, 1σ	100	100
	Axis misalignment	mrad, 1σ	0.5	0.5
	Accelerometers	**Units**	**KERNEL-210 Tactical**	**KERNEL-220 Tactical**
	Measurement range	g	±8 / ±15 / ±40	±40 and ±90
	Bandwidth (-3dB)	Hz, 1σ	260	260 / 260
	Data update rate	Hz, 1σ	2000	2000 / 2000
	Bias in-run stability (RMS, Allan Variance)	mg, 1σ	0.005 / 0.01 / 0.02	0.02 / 1
	Bias residual error (in temp. range, RMS)	mg, 1σ	0.5 / 0.7 / 1.2	1.2 / 200
	Bias one-year repeatability	mg, 1σ	1.0 / 1.3 / 1.5	1.5 / 200
	SF accuracy (over temperature range)	ppm, 1σ	150 / 300 / 500	500 / 2000
	SF one-year repeatability	ppm, 1σ	500 / 1300 / 1500	1500 / 2000
	Noise. Velocity Random Walk (VRW)	m/sec/√hr, 1σ	0.015 / 0.035 / 0.045	0.045 / 15
	Non-linearity	ppm, 1σ	150 / 150 / 150	150 / 3000
	Axis misalignment	mrad, 1σ	0.5	0.5 / 0.5
	Environment	**Units**	**KERNEL-210 Tactical**	**KERNEL-220 Tactical**
ELECTRICAL & MECHANICAL	Mechanical shock	g, msec	400 g, 0.1 ms	400 g, 0.1 ms
	Vibration	g RMS, Hz	8, 10 – 2000	8, 10 – 2000
	Operating temperature	deg C	-40 to +85	-40 to +85
	Storage temperature	deg C	-50 to +90	-50 to +90
	Low pressure	Pa, min	1750, 30	1750, 30
	Humidity	%	up to 95	up to 95
	MTBF (G_M @+65degC, operational)	hours	100,000	100,000
	Life time (operational)	years	10	10
	Life time (storage)	years	17	17
	Electrical	**Units**	**KERNEL-210 Tactical**	**KERNEL-220 Tactical**
	Supply voltage	V DC	5.4 - 36	5.4 - 36
	Power consumption	Watts	0.5	0.55
	Output Interface	-	RS422 + discrete IOs	RS422 + discrete IOs
	Output data format	-	Binary, ASCII, KERNEL	Binary, ASCII, KERNEL
	Physical	**Units**	**KERNEL-210 Tactical**	**KERNEL-220 Tactical**
	Size	mm	28.38 x 19.5 x 10.5	28.38 x 19.5 x 10.5
	Weight	grams	15	17

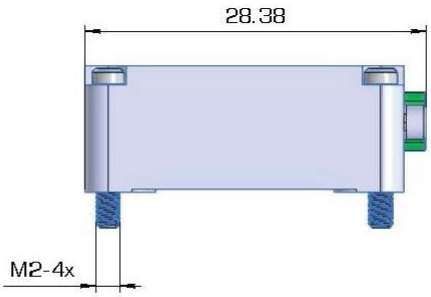
KERNEL-210 and KERNEL-220 Industrial

	Parameter	Units	KERNEL-210 Industrial	KERNEL-220 Industrial
GENERAL	Output signals		Pitch, Roll, Accelerations, Angular Rates, Temp., Synch	Pitch, Roll, Accelerations, Angular Rates, Temp., Synch
	Color of Enclosure		Gold	Gold
	Update rate (IMU data)	Hz	2000	2000
	Update rate (Pitch & Roll data)	Hz	2000	2000
	Start-up time	sec	<0.02	<0.02
	Full Accuracy Data (Warm-up Time)	sec	<0.05	<0.05
	Latency	milli sec	<2.4	<2.5
	Pitch & Roll	**Units**	**KERNEL-210 Industrial**	**KERNEL-220 Industrial**
PERFORMANCE	Data rate	Hz	2000	2000
	Range: Pitch	deg	±90	±90
	Range: Roll	deg	±180	±180
	Angular Resolution	deg	0.01	0.01
	Static Accuracy, RMS	deg, 1σ	0.05	0.05
	Dynamic Accuracy, RMS	deg, 1σ	0.08	0.08
	Gyroscopes	**Units**	**KERNEL-210 Industrial**	**KERNEL-220 Industrial**
	Measurement range	deg/sec	±2000	±2000
	Bandwidth (-3dB)	Hz, 1σ	260	260
	Data update rate	Hz	2000	2000
	Bias in-run stability (Allan Variance, RMS)	deg/hr, 1σ	3	3
	Bias repeatability (turn-on to turn-on, RMS)	deg/hr, 1σ	30	30
	Bias residual error (over temp. range, RMS)	deg/hr, 1σ	50	50
	SF accuracy (over temperature range)	ppm, 1σ	4000	4000
	Noise. Angular Random Walk (ARW)	deg/√hr, 1σ	0.3	0.3
	Non-linearity	ppm, 1σ	200	200
	Axis misalignment	mrad, 1σ	0.5	0.5
	Accelerometers	**Units**	**KERNEL-210 Industrial**	**KERNEL-220 Industrial**
	Measurement range	g	±8 / ±15 / ±40	±40 and ±90
	Bandwidth (-3dB)	Hz, 1σ	260	260 / 260
	Data update rate	Hz, 1σ	2000	2000 / 2000
	Bias in-run stability (RMS, Allan Variance)	mg, 1σ	0.01 / 0.03 / 0.05	0.05 / 1
	Bias residual error (in temp. range, RMS)	mg, 1σ	0.7 / 1.1 / 1.5	1.5 / 200
	Bias one-year repeatability	mg, 1σ	1.5 / 2.0 / 2.5	2.5 / 200
	SF accuracy (over temperature range)	ppm, 1σ	500 / 700 / 850	850 / 2000
	SF one-year repeatability	ppm, 1σ	800 / 1400 / 1700	1700 / 2000
	Noise. Velocity Random Walk (VRW)	m/sec/√hr, 1σ	0.02 / 0.045 / 0.06	0.06 / 15
	Non-linearity	ppm, 1σ	340 / 800 / 1000	1000 / 3000
	Axis misalignment	mrad, 1σ	0.5	0.5 / 0.5
	Environment	**Units**	**KERNEL-210 Industrial**	**KERNEL-220 Industrial**
ELECTRICAL & MECHANICAL	Mechanical shock	g, msec	400 g, 0.1 ms	400 g, 0.1 ms
	Vibration	g RMS, Hz	8, 10 – 2000	8, 10 – 2000
	Operating temperature	deg C	-40 to +85	-40 to +85
	Storage temperature	deg C	-50 to +90	-50 to +90
	Low pressure	Pa, min	1750, 30	1750, 30
	Humidity	%	up to 95	up to 95
	MTBF (G_M @+65degC, operational)	hours	100,000	100,000
	Life time (operational)	years	10	10
	Life time (storage)	years	17	17
	Electrical	**Units**	**KERNEL-210 Industrial**	**KERNEL-220 Industrial**
	Supply voltage	V DC	5.4 - 36	5.4 - 36
	Power consumption	Watts	0.5	0.55
	Output Interface	-	RS422 + discrete IOs	RS422 + discrete IOs
	Output data format	-	Binary, ASCII, KERNEL	Binary, ASCII, KERNEL
	Physical	**Units**	**KERNEL-210 Industrial**	**KERNEL-220 Industrial**
	Size	mm	28.38 x 19.5 x 10.5	28.38 x 19.5 x 10.5
	Weight	grams	15	17

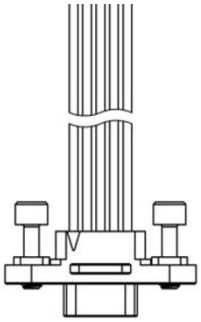
KERNEL-210 and KERNEL-220 Mechanical & Electrical Interfaces Description

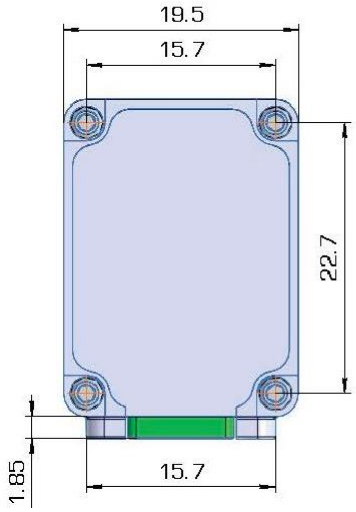




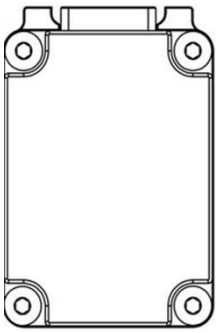


Mating screw-lock connector - G125-2241096F1





1	POWER	Power Supply Input
2	RESERV	Reserved for future
3	RESERV	Reserved for future
4	RS422-A	RS-422 Non-Inverting Input
5	RS422-B	RS-422 Inverting Input
6	GROUND	Power Supply Return
7	TOV	Time of validity output (by request)
8	EXTRIG	External trigger input (by request)
9	RS422-Y	RS-422 Non-Inverting Output
10	RS422-Z	RS-422 Inverting Output



KERNEL-210 Product Code structure

Model	Gyroscope	Accel	Calibration	Connector	Color	Version	Interface
KERNEL-210	G2000	A8 A15 A40	TGA	C12	A	V1 V2	2

KERNEL-220 Product Code structure

Model	Gyroscope	Accel	Calibration	Connector	Color	Version	Interface
KERNEL-220	G2000	A40A90	TGA	C12	A	V1 V2	2

Example:
KERNEL-210-G2000-A15-TGA-C12-A-V1.2
KERNEL-220-G2000-A40A90-TGA-C12-A-V1.2

Product code details:

- G2000: Gyroscopes measurement range = ±2000 deg/sec
- A8: Accelerometers measurement range = ±8 g
- A15: Accelerometers measurement range = ±15 g
- A40: Accelerometers measurement range = ±40 g
- A40A90: Accelerometers measurement range = ±40 g and ±90 g
- TGA: Gyroscopes and Accelerometers are calibrated over temperature range
- C12: Aluminum case (Captive screws; reference mechanical drawing)
- A: Color of enclosure: Aurum (Gold)
- V1: Tactical
- V2: Industrial
- .2: RS-422 interface