Inertial Labs

a **VIAVI Solutions** company

KERNEL-210

KERNEL-220

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	

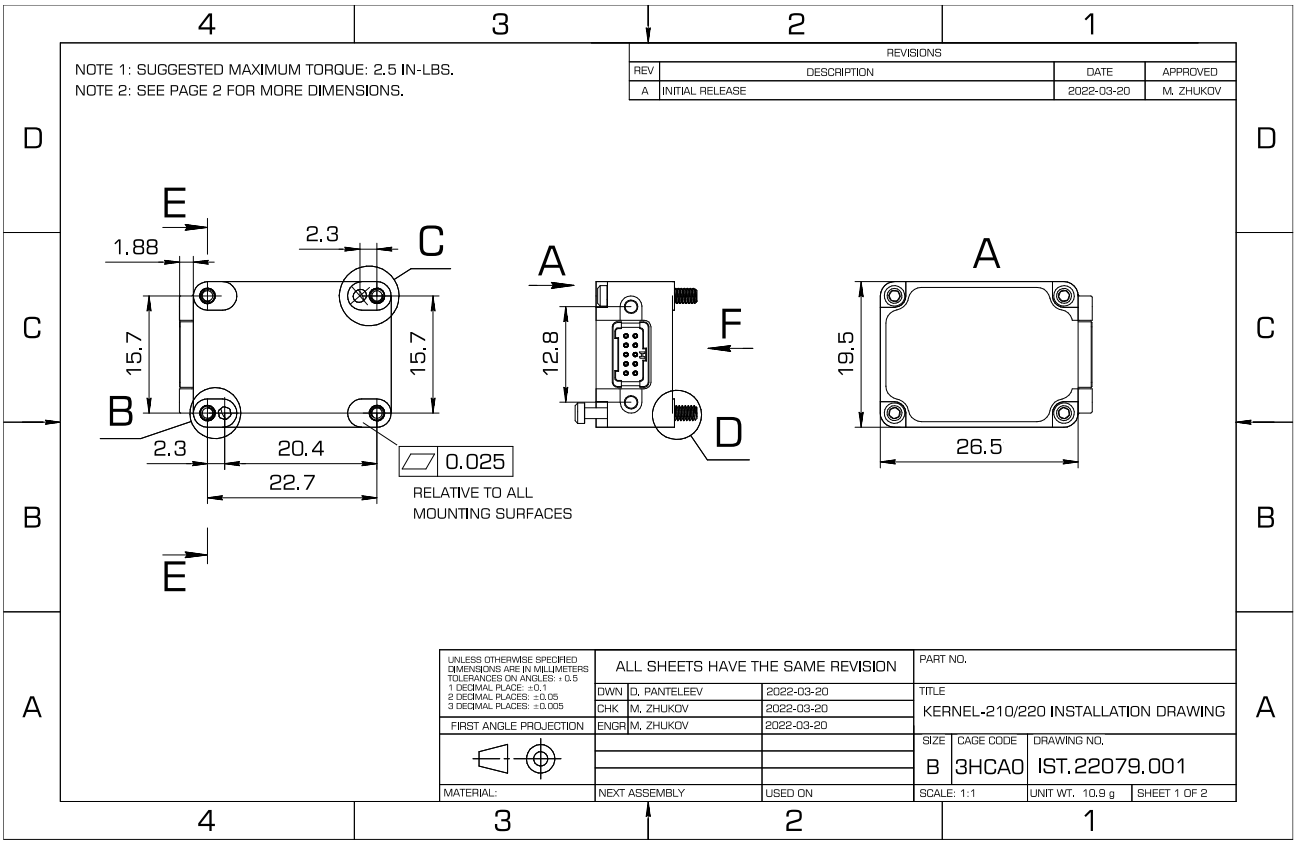
KERNEL-210 and KERNEL-220 Tactical

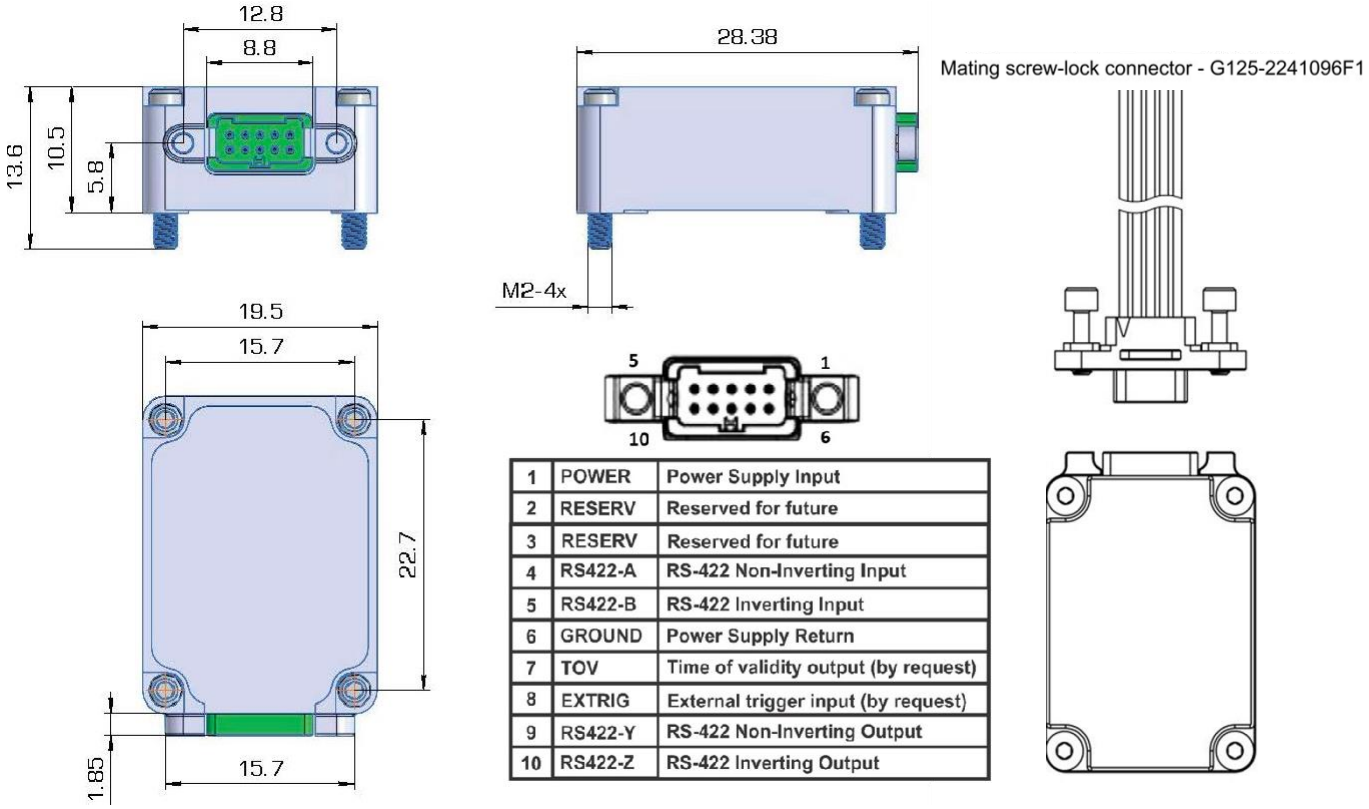
	Parameter	Units	KERNEL-210 Tactical	KERNEL-220 Tactical	
GENERAL	Output signals		Pitch, Roll, Accelerations, Angular Rates, Temp., Synch	Pitch, Roll, Accelerations, Angular Rates, Temp., Synch	
	Color of Enclosure		Gold	Gold	
	Update rate (IMU data)	Hz	2000	2000	
	Update rate (Pitch & Roll data)	Hz	2000	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**			
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**			
	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**			
	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**			
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**			
	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**			
	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**			
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**			
	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**			
	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**			
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**			
	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**			
	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





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	TGA	C12	A	V1	2
		A15		C42		V2	
		A40					

KERNEL-220 Product Code structure

Model	Gyroscope	Accel	Calibration	Connector	Color	Version	Interface
KERNEL-220	G2000	A40A90	TGA	C12	A	V1	2
				C42		V2	

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 (with 12mm captive screws)
- C42: Aluminum case (with 10.5mm captive screws)
- A: Color of enclosure: Aurum (Gold)
- V1: Tactical
- V2: Industrial
- .2: RS-422 interface