



TDK's SmartMotion™ UHP ICM-45xxx 6-Axis Family

World's first BalancedGyro™ technology with lowest power

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Attracting Tomorrow



Motion sensors ubiquitous in consumer applications

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AR & VR



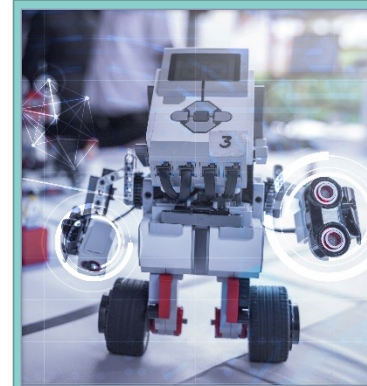
Robotic Vacuum Cleaners



Gaming



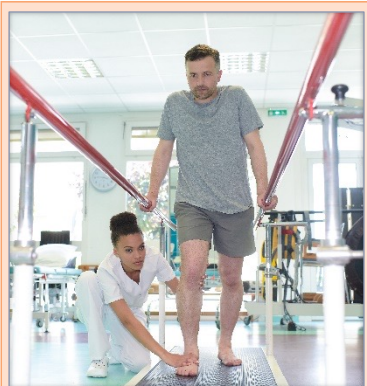
Wearables



Toys & Robotics



Power Tools



Medical IoT



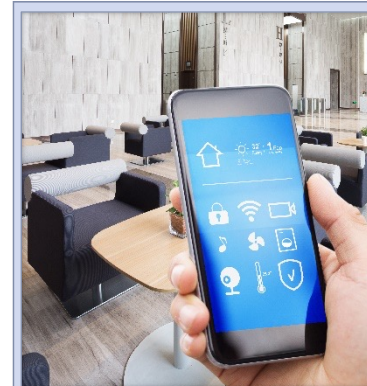
Hearables



Air Mouse & Smart Remotes



Drones



Smart Home & Smart Appliances



Sports IoT

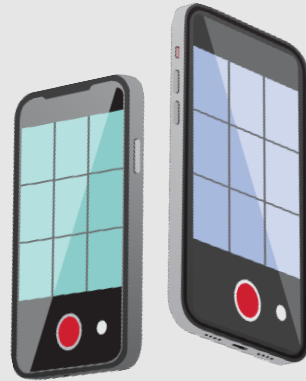
AR, VR, Metaverse



Accurate Head Pose Estimation

- Best temperature stability
- Superior vibration rejection
- High dynamic range
- Advanced sensor fusion

Smartphones



UI and Optical Image Stabilization (OIS)

- Triple-interface OIS performance
- Low sensitivity error
- Low noise, bias instability
- Superior robustness

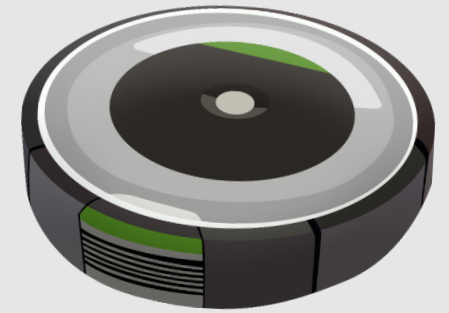
Wearables, Hearables



Low power gesture and activity detect

- Ultra-low power consumption
- On-chip gesture detection
- Activity classification: Exercise, fitness, health tracking
- Spatial Audio (Accurate head pose)

Robotic Vacuum Cleaners



Dynamic Heading Estimation

- Low bias instability, random walk (noise)
- Low sensitivity error
- Superior vibration rejection

A paradigm shift for motion sensors

WHAT IF A MOTION SENSOR...

- could bring down overall IMU power consumption by 40%
- could retain its performance over temperature
- could reject usage-induced out-of-band vibrations
- did not require calibration in the factory
- could combine performance with high dynamic range
- contained intelligence to process sensor fusion locally



Shipping in high volume!

SmartMotion™

- **ICM-42xxx family**

- Best performance to cost value
- Small Z-height

Available Now!

SmartMotion UHP BalancedGyro

Ultra-High Performance

- **ICM-45xxx family**

- Powered by world's first 'BalancedGyro' technology
- On-chip self-calibration – ensuring lifetime sensor accuracy
- Industry's lowest IMU current – 420uA

Highlights



World's first BalancedGyro technology

- Highest performance balanced-gyroscope enabling:
 - Supreme vibration rejection (Lowest VRE and VIN)
 - Best-in-class temperature stability, TNL and hysteresis
 - Reduced part-to-part coupling with multiple sensors in proximity



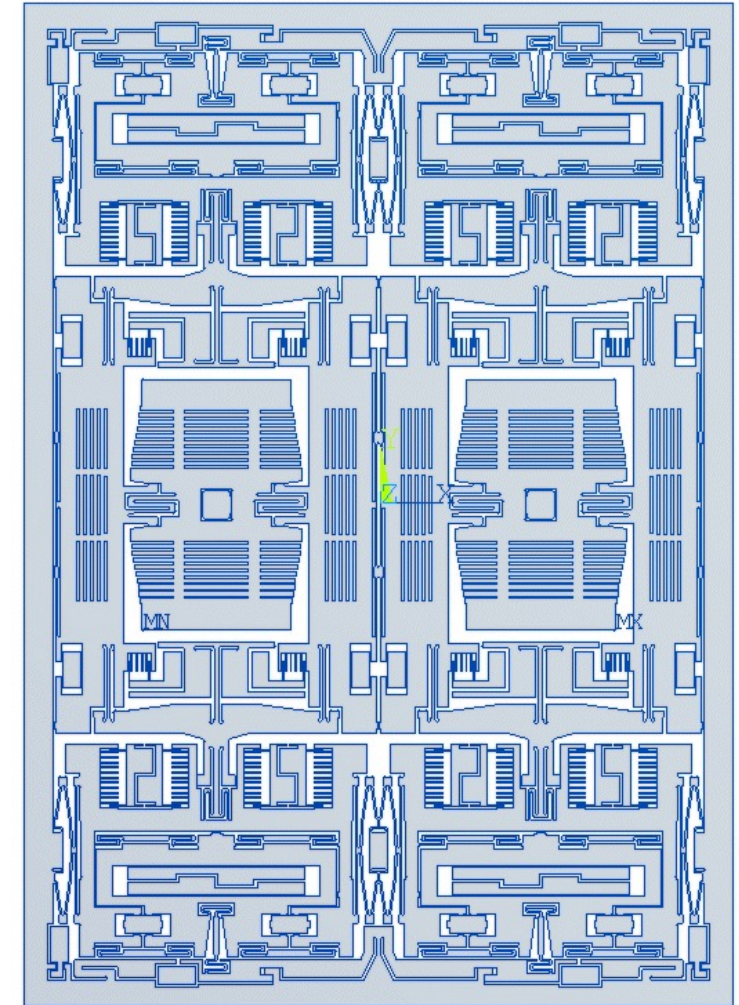
Highest accuracy self-calibration

- On-chip automated sensitivity calibration enabling:
 - 5x sensitivity accuracy advantage over competition
 - Lifetime sensor accuracy of 0.2%
 - No factory calibration overhead


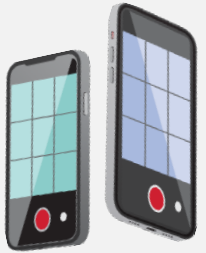



Industry's lowest current consumption

- On-chip automated sensitivity and offset calibration enabling:
 - Ultra-low Wake-on-Motion mode, Sleep current – 2.9 uA
 - Ultra-low 6-axis Active Motion current – 420 uA



BalancedGyro Family: Device Numbers

Part Number	Target Applications	Interfaces	FSR	Data Resolution	RTC Support	Applications
ICM-45686	AR/VR HMD and Controllers	Host Interface + AUX OIS Controller / I ² C Master to connect external sensors	±4000dps, ±32g	16-bits (baseline); FIFO packet option: Gyro 19-bits, Accel 18-bits	Yes	
ICM-45631	OIS SmartPhones, OIS Modules	Host Interface + 2x AUX OIS Controller Interfaces	±2000dps, ±16g	16-bits (baseline); FIFO packet option: Gyro 19-bits, Accel 18-bits	Yes	
ICM-45605	Wearables, Hearables, Game Controllers, Cameras, IoT, Drones	Host Interface + I ² C Master to connect external sensors	±2000dps, ±16g	16-bits	No	

Beating the competition by a wide margin

Parameters		Competitor 1	Competitor 2	TDK ICM-45xxx	ICM-45xxx Advantages
Sensor		6-axis device	6-axis device	6-axis IMU	
CPU		Finite 16-State Machine, 9KB FIFO, motion events	2KB FIFO, motion events	APEX Functions, 8 KB FIFO (up to 32 KB)	FIFO saves system power APEX motion features such as Tap, Freefall, WOM
Package		2.5 x 3 x 0.83 mm, 14-pin	2.5 x 3 x 0.83 mm, 14-pin	2.5 x 3 x 0.81mm, 14-pin	15% reduction in Z height
1.2 V IO support		No	Yes	Yes	Saves significant system power
Real Time Clock (RTC)		No	No	Yes	Improves accuracy and multi-sensor synchronization
Max ODR		6.4 KHz	6.4 KHz	6.4 KHz	
Gyro	Units				
FSR	dps	±2k	±2k	±4k	Extended range prevents saturation and enables 'high-speed' monitoring/control applications
Noise Density @25°C (Low-Noise Mode)	mdps/rt-Hz	3.8 TYP	7 TYP	3.8 TYP	1x-2x advantage
Offset over Temp	dps/°C	0.01 TYP	0.015 TYP	0.005 TYP	2x-3x advantage
Sensitivity Tolerance	%	1 TYP (component)	2 TYP (component)	0.2 TYP	5x-10x accuracy advantage
Accel	Units				
FSR	g	±16	±16	±32	Extended range prevents saturation and enables 'high-speed' monitoring/control applications
Noise Density @25°C	µg/rt-Hz	70 - 110 TYP (= f{FSR})	160 TYP	70 TYP	1x-2x advantage
Sensitivity Tolerance	%	±1 TYP (component)	±0.4 TYP (component)	0.1 TYP	4x-10x accuracy advantage
Offset over Temp	(mg/°C)	0.1 TYP	0.25	0.08 TYP	1x-3x temperature stability advantage
Current @ 1.2V	Units				
Accel Ultra Low-Power (50 Hz, 1x AVG)	µA	9.5 TYP	14	13 TYP	
Accel Low-Noise	µA	170 TYP (high-perf mode)	200 TYP (high-perf mode)	120 TYP	~2x advantage
6-Axis Low-Noise	µA	550 TYP (high-perf mode)	685 TYP (high-perf mode)	420 TYP	Lowest 6-axis Low Noise IMU current
Sleep Mode		3 uA	3.5uA	2.9 TYP	Lowest Sleep current

Feature	Description
Pedometer	Tracks step count, also issues step detect interrupt.
Tilt	Issues an interrupt when the tilt angle exceeds 35° for more than a programmable time.
Raise-to-Wake/Sleep	Gesture detection for wake and sleep events. Interrupt is issued when either of these two events are detected.
Significant Motion Detection (SMD)	Detects significant motion based on accelerometer data.
Free-Fall Detection	Triggers an interrupt when device freefall is detected and outputs freefall duration.
Wake on Motion	Detects motion when accelerometer data exceeds a programmable threshold.
Low-G Detection	Triggers an interrupt when absolute value of accelerometer combined axis falls below a programmable threshold and stays below the threshold for a programmable time.
High-G Detection	Triggers an interrupt when absolute value of accelerometer goes above a programmable threshold and stays above the threshold for a programmable time.
Single Tap / Double Tap Detection	Issues an interrupt when a tap is detected, along with the tap type.
Hard-Iron / Soft-Iron Correction	Applies calibration matrix and offset vector to raw magnetometer data to correct for hard-iron and soft-iron effects. Supported on devices with I ² C master interface: ICM-45605, ICM-45686
Self-test	Self-test for sensor diagnostics.
Bring-to-See	Requires customer to download SW image to IMU.



With superior sensor performance...

(powered by BalancedGyro Technology)

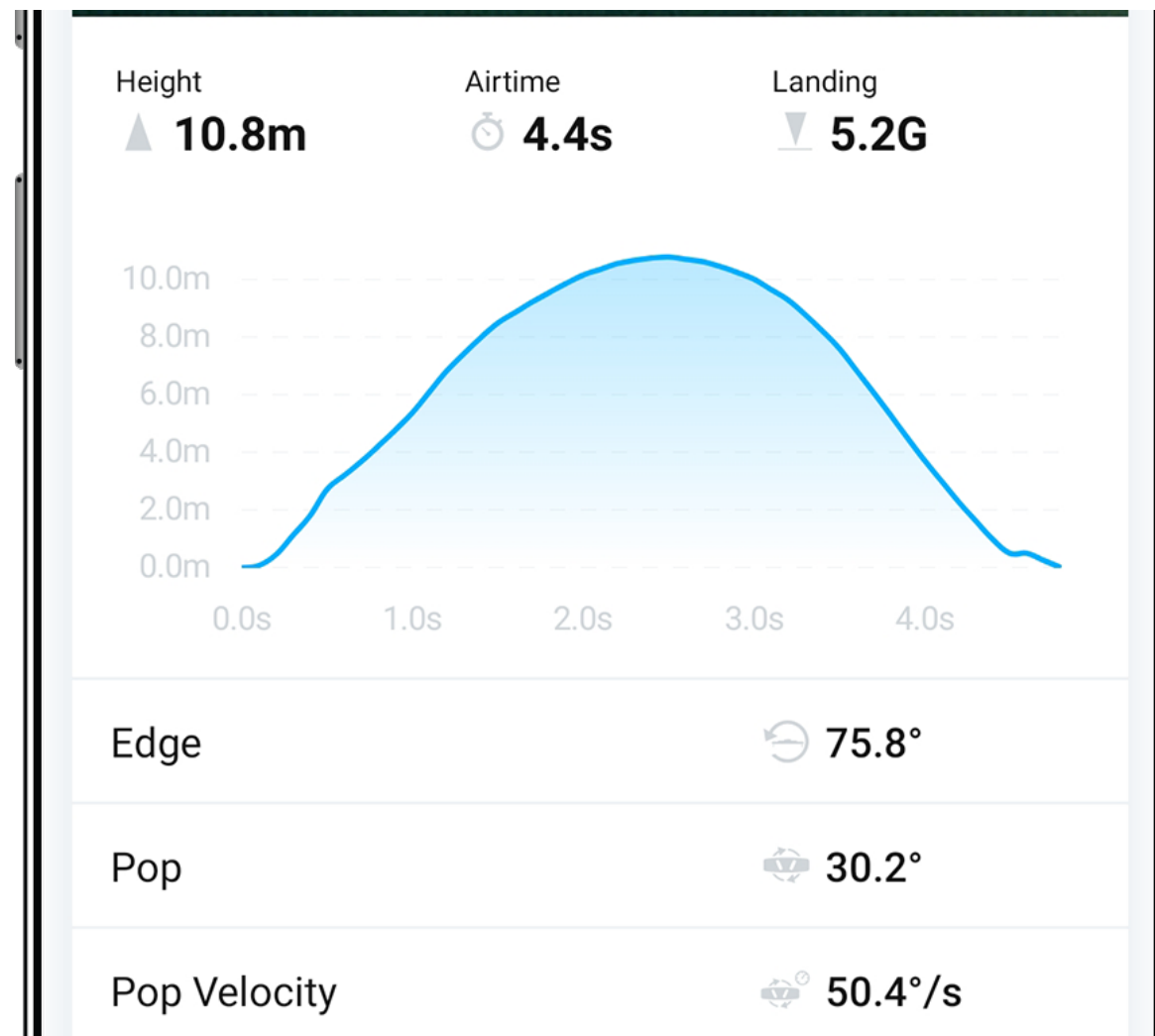
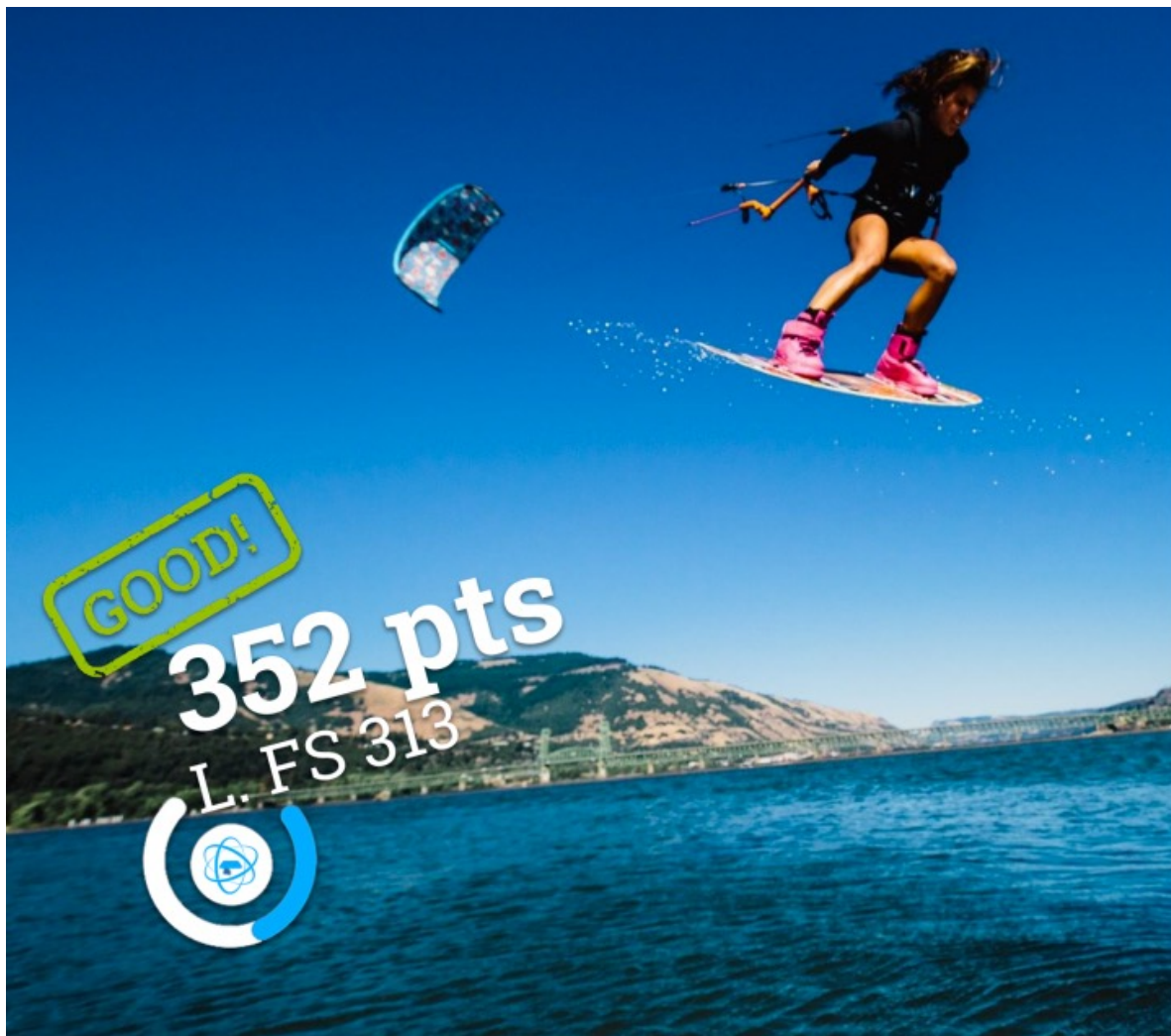
- Unparalleled sensitivity and offset accuracy
- Temperature stability, vibration rejection
- High-range accel & gyro for fast motion

and lowest power in the industry...

- Lowest 6-axis IMU current
- Lowest Accel LN mode current
- Lowest Sleep current
- 8KB FIFO for system power savings

ICM-45xxx is perfect for smartphones, wearables, hearables, AR/VR, & IoT

- ICM-45xxx delivers leading performance & features combined with power and system level benefits for a broad spectrum of devices and applications



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Questions?