ACKCIO

TECHNICAL SPECIFICATIONS

BEAM- TM-L LoRa Tiltmeter Datasheet

GENERAL DESCRIPTION

The Ackcio TM-L is a high-precision, low-power wireless tiltmeter designed for long-term structural and geotechnical monitoring in harsh outdoor environments.

It measures static tilt angles relative to the horizontal plane on three axes, along with acceleration and temperature, enabling detailed movement analysis.

Its rugged IP67-rated housing, combined with multi-year battery life, makes it ideal for unattended deployments in remote and demanding locations.

The TM-L operates on LoRaWAN for long-range, low-power wireless communication and integrates seamlessly with the Ackcio Gateway and Snape platform.

KEY FEATURES

- Three-axis tilt measurement (X, Y, Z)
- High precision: up to ±0.005°
- Integrated acceleration and temperature sensing
- LoRaWAN wireless connection, long range up to 5 km (rural line-of-sight with high-gain antenna)
- Multiple acquisition modes: scheduled and trigger-based
- Wide operating temperature range: −20°C to +70°C
- IP67-rated enclosure for outdoor use
- Zero-set function for relative angle measurement
- User-configurable alarm thresholds for tilt and acceleration
- Replaceable lithium battery

APPLICATIONS

STRUCTURAL HEALTH

- Superelevation (cant), twist, and vertical alignment in rail track monitoring
- Static deflections of piles, piers, and bridge decks
- Long-term settlement and deformation in infrastructure

GEOTECHNICAL MONITORING

- Slope movement detection in landslide or embankment monitoring
- Displacement monitoring in foundations and excavations
- Movement detection in retaining walls, tunnels, and earthworks

ADVANTAGES

- High accuracy from precision MEMS sensing
- Very low maintenance due to long battery life and robust design
- Compact and lightweight for easy installation in space-restricted areas
- Wide range of mounting options for flexibility in field deployment
- Provides complementary high-precision data to other geotechnical monitoring methods

OUTPUT DATA

- Tilt angles (ϕ and θ) for X, Y, Z axes
- Acceleration (X, Y, Z axes)
- Temperature
- Battery level
- Alarm status (tilt or acceleration trigger events)

WORKING PRINCIPLE

PROGRAMMED ACQUISITION

The sensor periodically measures tilt, acceleration, and temperature at user-defined intervals, with acquisition timing synchronized to UTC for consistent alignment across devices.

TRIGGER-BASED ACQUISITION

Additional data can be captured when certain thresholds are exceeded:

- **Tilt Trigger** – Wakes and records when tilt exceeds a set threshold.
- **Acceleration Trigger** – Wakes and records when acceleration exceeds a set threshold.
- **Combined Alarms** – Tilt and acceleration triggers can be used individually or together.

Triggered events are transmitted immediately for rapid analysis.

DYNAMIC MONITORING & ALARM BEHAVIOR

Triggered events are transmitted immediately for rapid analysis.

OPERATING STATES

- Sleep Mode
- Active Mode (scheduled)
- Alarm Mode (triggered)

CONFIGURABLE PARAMETERS

Parameter	Description	Default
Tilt Threshold	X or Y axis tilt to trigger alarm	5.0°
Acceleration Threshold	Any axis exceeding this triggers alarm	0.05 g
Alarm Confirmation Count	Repeated violations before trigger	0
Alarm Reporting Interval	Report interval during alarm mode	10 min
Normal Reporting Interval	Standard reporting interval	60 min

ALARM RESET LOGIC

- Device reverts to normal mode after tilt/acceleration returns within thresholds
- Optional confirmation delay before re-arming

DATA OUTPUT FORMAT

Data Type	Axis	Unit	Range	Resolution	Alarm Flag
Tilt Angle	X	°	±90	0.001	Yes
Tilt Angle	Y	°	±90	0.001	Yes
Tilt Angle	Z	°	±90	0.001	No
Acceleration	X	g	±2g	0.001	Yes
Acceleration	Y	g	±2g	0.001	Yes
Acceleration	Z	g	±2g	0.001	Yes
Battery Voltage	–	V	0.4–2	0.01	No
Internal Temp	–	°C	−40–70	0.1	No
Alarm Status	–	–	–	–	Yes

TECHNICAL SPECIFICATIONS

MEASUREMENT PERFORMANCE

Parameter	Value
Tilt sensing technology	MEMS accelerometer (3-axis)
Measurement range	±90°
Resolution	0.001°
Accuracy	< ±15°: ±0.005° > ±15°: ±0.01°
Acceleration range	±2g
Response bandwidth	20 Hz
Non-linearity	< 0.1 %FS
Cross-axis sensitivity	1 %
Resonant frequency	2.4 kHz
Zero-bias stability	< 0.002 g
Temperature coefficient	0.0004 °/°C

OPERATING MODES

- Scheduled acquisition only
- Scheduled acquisition + tilt trigger
- Scheduled acquisition + acceleration trigger
- Scheduled acquisition + combined triggers

TEMPERATURE MEASUREMENT

Parameter	Value
Range	−20°C to +70°C
Resolution	0.05°C
Accuracy	±0.2°C

ACCELERATION MEASUREMENT

Parameter	Value
Range	±2g
Resolution	0.001g
Bandwidth	0.1 – 31.25 Hz

GENERAL DATA

Parameter	Value
Wireless technology	LoRaWAN
Supported regions	EU868, US915, AU915, AS923, IN865, KR920, RU864
Wireless range	Up to 2 km (urban), 5 km (rural line-of-sight with high-gain antenna)
IP rating	IP67
Power supply	1× D-cell 3.6V Li-$SOCl_2$ (19Ah) with 2-pin connector
Operating temperature	−20°C to +70°C
Dimensions	101 × 72 × 60 mm
Weight	≤ 280 g (without battery)
Enclosure material	Industrial-grade aluminium alloy

BATTERY LIFE ESTIMATION

Mode	Interval	19Ah Lifetime
Normal (Alarm Off)	1 hr	>5 yrs
Normal (Alarm Off)	15 min	3 yrs
Dynamic (Alarm On)	1 hr	2 yrs
Dynamic (Alarm On)	15 min	2 yrs

Actual life depends on temperature, signal quality, and alarm frequency.

INSTALLATION OPTIONS

- Wall, floor, or structural mounting
- Four-point M4 screw mounting (hardware included)
- Multiple orientation options for correct axis alignment
- Optional mounting kits