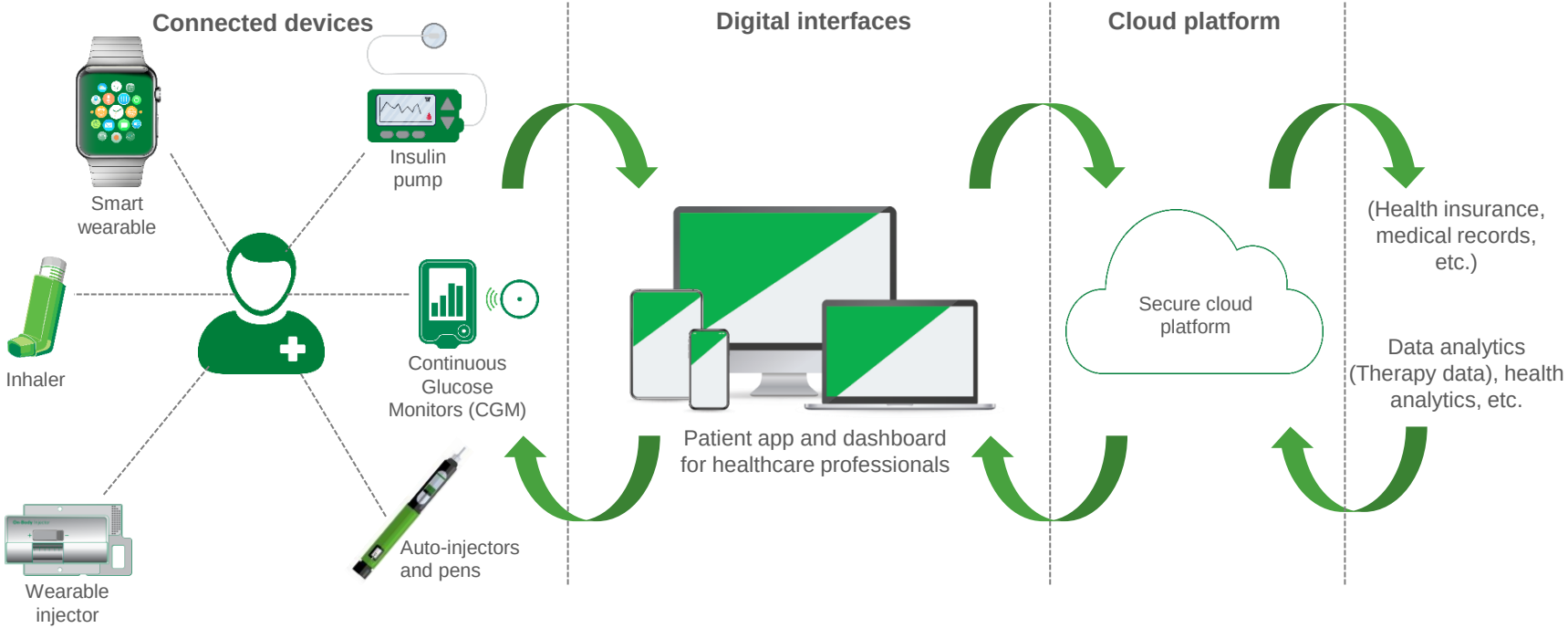
# Drug Delivery Device Ecosystem

Healthcare Solutions

Littelfuse®

Expertise Applied | Answers Delivered

# Connected drug delivery system are radically changing how services are being delivered to patients




Connected healthcare helps achieve lower healthcare costs, improves efficiency, and empowers patients.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# Drug delivery device ecosystem is growing at ~25% CAGR

## Market trends and drivers

The market size growth for connected medical devices is projected to reach $251.57 billion by 2030, with CAGR estimated at 25.3% from 2021–'28.

Personal, portable, connected medical devices with CE* mark, FDA** approval, and NMPA*** certifications allow healthcare professionals to receive and act on data.

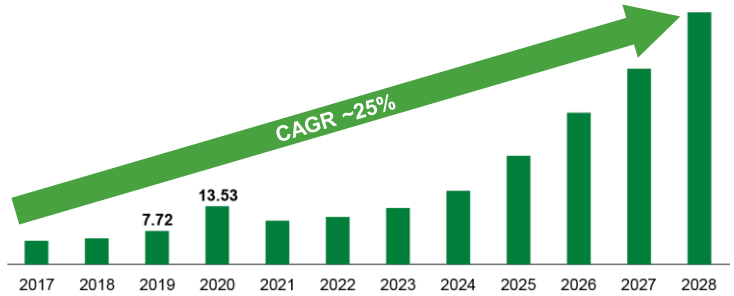
Connected auto-injectors and pens are new emerging tech in a mature conservative fast-growing drug market (Titrated Pens: 80% @ 10% CAGR; One-dose Auto Injectors: 20% @ 35% CAGR).

Decentralized healthcare relies on personal, wearable, and connected devices for patients to self-administer tests and medicines, necessitating precise data and high-performance Littelfuse parts like TMR, temperature sensing, switching, and ESD protection are used to generate precise data in robust environments.

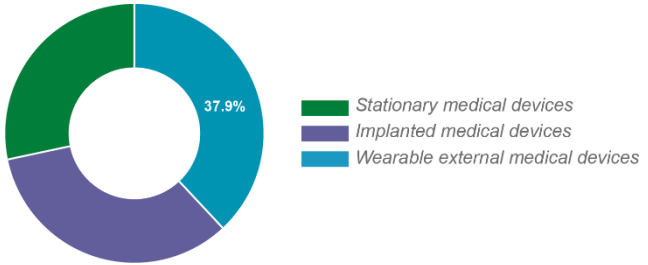
Healthcare is ready for disruption, and 5G, AI, and ML are essential for connected care. Accurate data are crucial, and Littelfuse's high-performance parts meet these demands.

High-performance and accurate Littelfuse products are for all medical device designs. The global market for decentralized connected health and wellness solutions is expanding rapidly, with no sub-segment is being left behind. Diagnosis and treatment (includes connected pharmaceutical delivery), wellness and prevention, monitoring, and others are all experiencing accelerated growth.

## North America IoMT* market size, 2017 to 2028 ($B)




## Global IoMT market share by product, 2020




**Sources:** Fortune Business Insights

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*Country Oversight and Compliance to standards:*
** CE Mark: Europe*
*** FDA Food and Drug Administration: USA*
**** NMPA National Medical Products Administration: China*

***Acronyms:***
*CAGR – Compound Annual Growth Rate*
*TMR – Tunnel Magnetoresistance Effect*
*ESD – Electro-Static Discharge*
*AI – Artificial Intelligence*
*ML – Machine Learning*
*IoMT – Internet of Medical Things*

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# Auto-injectors or drug delivery pens

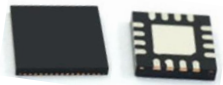
**1 Dose dialing**
Detect Switch

**2 Activity detection**
Tactile Switch, Detect Switch, Reed Switch, TMR Switch


**3 Plunger position measurement**
TMR Sensor

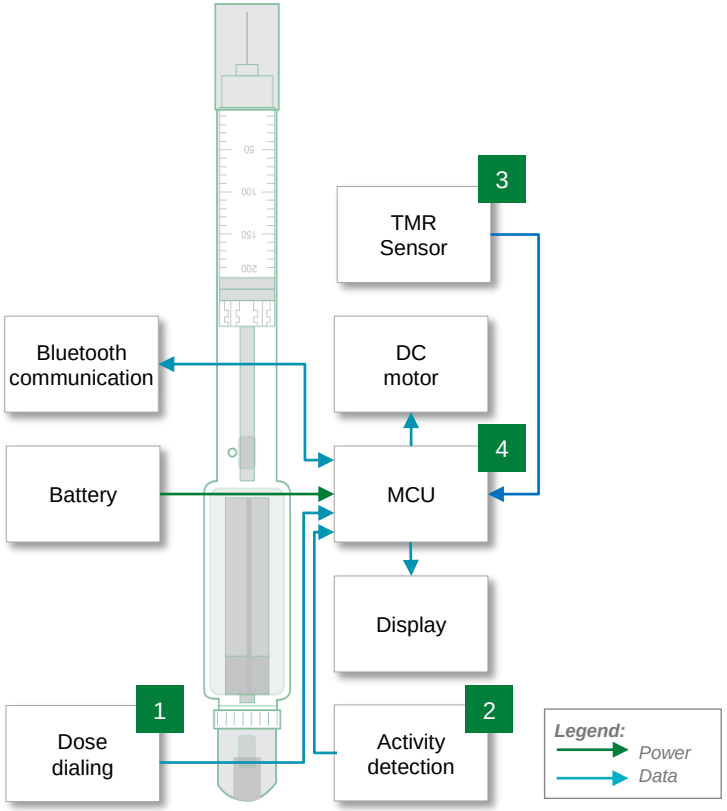
Under development

**4 Control unit**
Microcontroller



Click the product series in the table below for more info.

# Auto-injectors or drug delivery pens




| | Technology | Product series |
|---|---|---|
| 1 | Detect Switch | HDT, FDSD, FDSE |
| 2 | Tactile Switch | NanoT, KXT, KMT0, PTS, KMT0 D |
| | Detect Switch | HDT, FDSE, HDS |
| | Reed Switch | 59177 |
| | TMR Switch | TMR |
| 3 | TMR Position Sensor | Under development; contact sales |
| 4 | Microcontroller | Z8F1625*, Z8F3224 (No LCD) S3F8S19, Z8F6482 (With LCD) |

*Z8F1625 is under development*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Click the product series in the table below for more info.

# Features and benefits of Littelfuse products

| | Technology | Function in application | Product series | Benefits | Features |
|---|---|---|---|---|---|
| 1 | Detect Switch | Detects position of the dose dial | HDT, FDSD, FDSE | Extremely small package size | Integrated mechanism and lever; lead free |
| 2 | Tactile Switch | For various activity detection (for example reliable navigation; dose dialing, dose counting, cap on/off detection, activation, detection of vial in correct position, contact with patient body/skin contact) | NanoT, KXT, KMT0, PTS, KMT0 D | Board space saving and design flexibility; long life; compatible with harsh environment | Ultra-compact size; up to 1000 K life cycles; up to IP68 for sealed versions; compatibility with PCB coatings |
| | Detect Switch | | HDT, FDSE, HDS | Micro-miniature; long life; up to IP 68 sealing properties; micro-detect switches; over-travel, low actuation magnetic stress; 35 g max; low profile | Excellent performance; response to touch and feel; design allows for top or side actuation; low-profile package; normally closed circuit (FDSE) |
| | Reed Switch | | 59177 | Ease of integration within space-constrained environments; no degradation in performance; no leakage current in ‘open’ state−ideal for battery-powered IoT applications | Ultra-miniature size switch 9.0 mm x 2.5 mm x 2.4 mm (0.354"x 0.098" x 0.094"); capable of switching 170 Vdc or 0.25 A at up to 10 W; available in select sensitivities (operating distances) |
| | TMR Switch | | TMR | Ultra-low power consumption; excellent thermal stability | Ultra-low power consumption: 200 nA at 50 Hz response or 1.5 uA at 1 kHz response |
| 3 | TMR position sensor | Under development; contact sales | | | |
| 4 | Microcontroller | Bluetooth control for communication LCD display, and DC motor control | Z8F1625, Z8F3224 (No LCD) S3F8S19, Z8F6482 (With LCD) | Lower standby current; charging battery charges with high-resolution ADC; high-resolution PWM for motor control | 8-bit MCU; 12- or 14-bit ADC and LCD controller |


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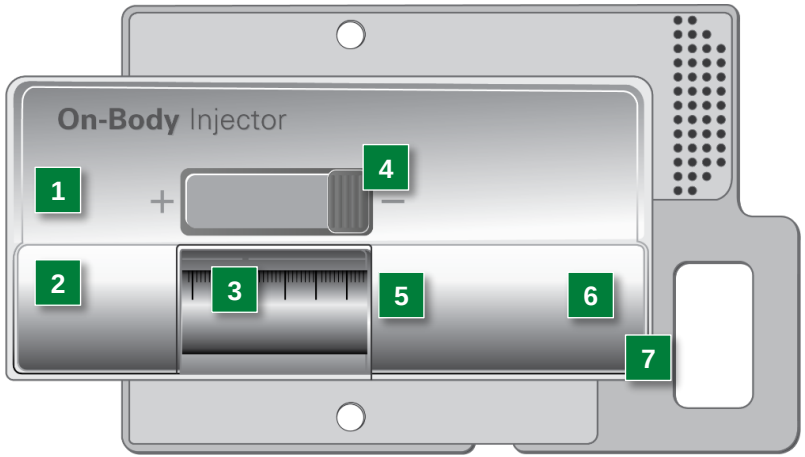
# Wearable injectors

**1 Power management**
eFuse, PPTC

**2 USB**
TVS Diode Array

**3 Dose dialing**
Detect Switch

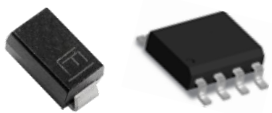



**4 Activity detection**
Tactile Switch, Detect Switch,
Reed Switch, TMR Switch

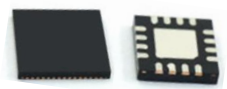
**5 Plunger position measurement**
TMR Sensor

Under development

**7 Motor control**
TVS Diode, Gate Driver



**6 Control unit**
Microcontroller



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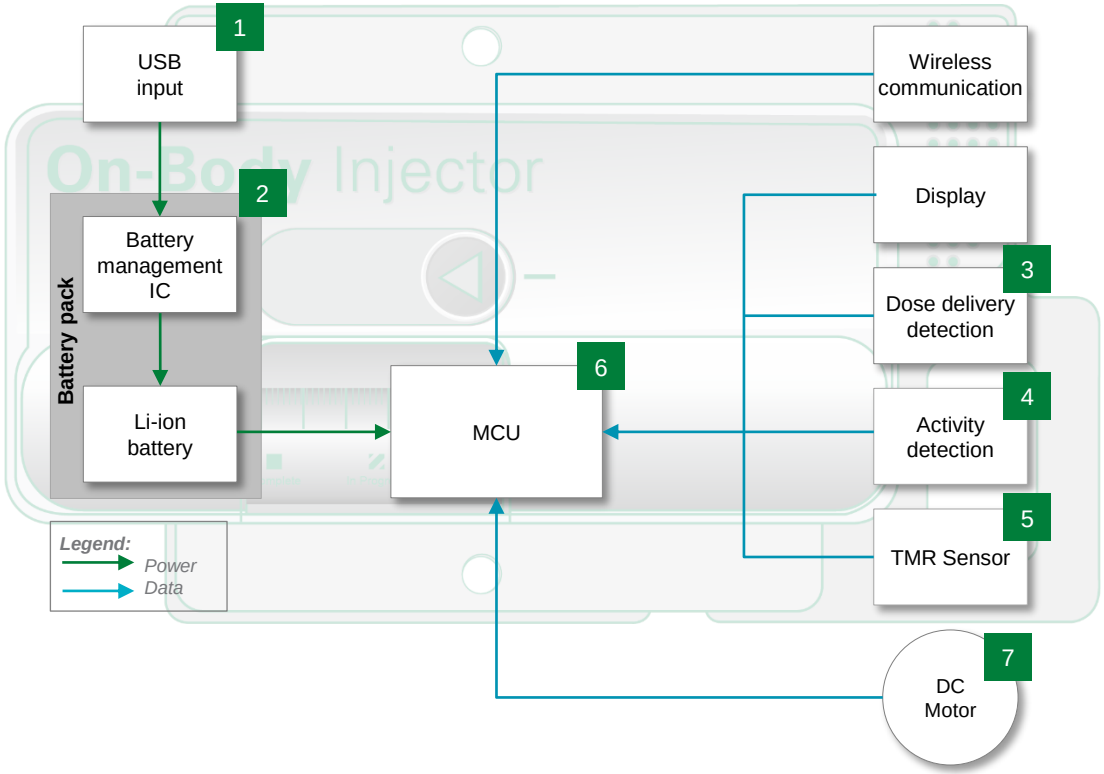
Click the product series in the table below for more info.

# Wearable injectors functional block diagram




| | Technology | Product series |
|---|---|---|
| 1 | eFuse (USB-C) | LS0504EDD12 |
| | PPTC (for USB-A or -B) | Low Rho |
| 2 | TVS Diode Array | SC1205-01UTG, SP1006-01UTG |
| 3 | Detect Switch | HDT, FDSD, FDSE |
| 4 | Tactile Switch | NanoT, KXT, KMT0, PTS, KMT0 D |
| | Detect Switch | HDT, FDSE, HDS |
| | Reed Switch | 59177 |
| | TMR Switch | TMR |
| 5 | TMR position sensor | Under development; contact sales |
| 6 | Microcontroller | Z8F1625*, Z8F3224 (No LCD) S3F8S19, Z8F6482 (With LCD) |
| 7 | TVS Diode | SMAJ |
| | Gate Driver | LF2101N, LF2103N |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Click the product series in the table below for more info.

# Features and benefits of Littelfuse products

| | Technology | Function in application | Product series | Benefits | Features |
|---|---|---|---|---|---|
| 1 | eFuse (USB-C) | Integrated overcurrent and overvoltage protection | LS0504EDD12 | Wide input range from 1.8 V to 5.5 V; internal soft start | Hiccup mode for short circuits and overcurrents |
| | PPTC (for USB-A or -B) | Protects 5 V DC power supply from overcurrent and over-temperature events | Low Rho | Offers fast response to overcurrent events; suitable for compact portable devices | Ultra-low internal resistance; higher current holding in smallest SMD package |
| 2 | TVS Diode Array | Protects against ESD on data lines | SC1205-01UTG, SP1006-01UTG | Enables compact design; reduces assembly time | Complies with IEC standards; low leakage current of 100 nA; compact form factor |
| 3 | Detect Switch | Detects position of the dose dial | HDT, FDSD, FDSE | Extremely small package size | Integrated mechanism and lever; lead free |
| 4 | Tactile Switch | For various activity detection (for example reliable navigation; dose dialing, dose counting, cap on/off detection, activation, detection of vial in correct position, contact with patient body/skin contact) | NanoT, KXT, KMT0, PTS, KMT0 D | Board space saving and design flexibility; long life; compatible with harsh environments | Ultra-compact size; up to 1000 K life cycles; up to IP68 for sealed versions; compatibility with PCB coatings |
| | Detect Switch | | HDT, FDSE, HDS | Micro-miniature; long life; up to IP 68 sealing properties; micro-detect switches; over-travel, low actuation magnetic stress: 35 g max; low profile | Excellent performance; response to touch and feel; design allows for top or side actuation; low-profile package; normally closed circuit (FDSE) |
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| | TMR Switch | | TMR | Ultra-low power consumption; excellent thermal stability | Ultra-low power consumption: 200 nA at 50 Hz response or 1.5 uA at 1 kHz response |
| 5 | TMR position sensor | Under development; contact sales | | | |
| 6 | Microcontroller | Bluetooth control for communication, LCD display, and DC motor control | Z8F1625, Z8F3224 (No LCD) S3F8S19, Z8F6482 (With LCD) | Lower standby current; battery charges with high-resolution ADC and high-resolution PWM for motor control | 8-bit MCU; 12- or 14-bit ADC and LCD controller |
| 7 | TVS Diode | Surge protection | SMAJ | Offers board space saving; excellent clamping capability | Low-profile package; IEC-61000-4-2 ESD 30 kV (Air), 30 kV (Contact); fast response time |
| | Gate Driver | Controls the motor | LF2101N, LF2103N | Shoot-through protection; more precise control and lower torque ripple; board space saving | Logic inputs are 3.3 V logic level compatible; available in SOIC-8 |


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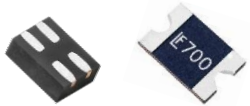
# Insulin pump

**1 Power management**
eFuse, PPTC



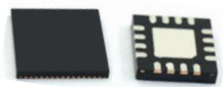

**2 USB**
TVS Diode Array

**3 Keypad**
Tactile Switch, Detect Switch

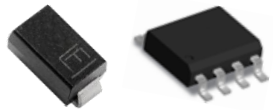

**4 Plunger position measurement**
TMR Sensor

Under development

**5 Control unit**
Microcontroller



**6 Motor control**
TVS Diode, Gate Driver



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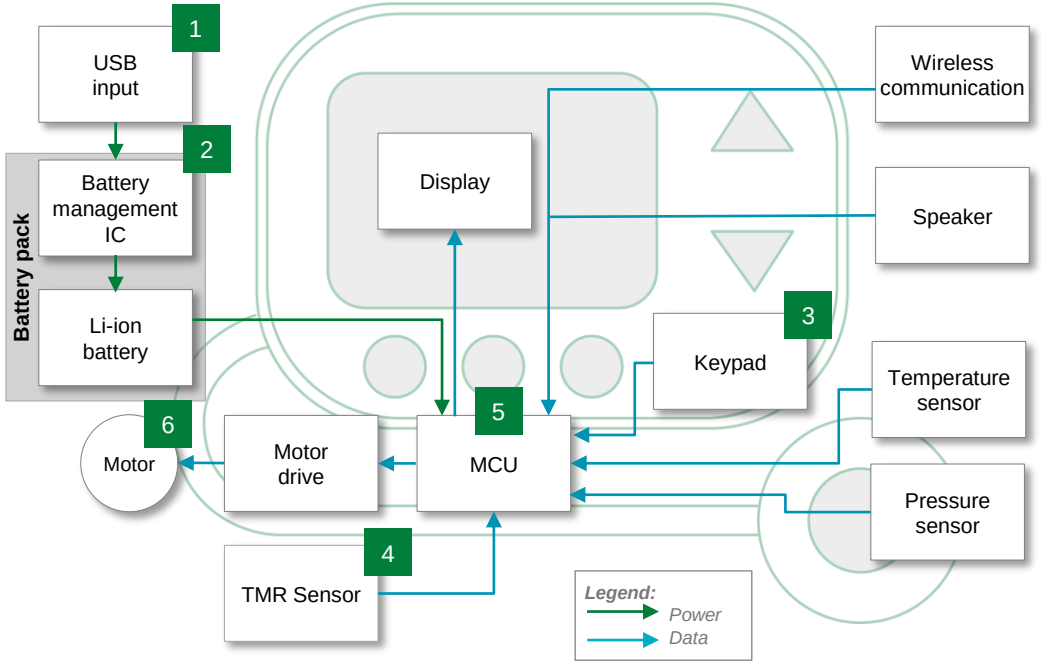
# Insulin pump functional block diagram




| | Technology | Product series |
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| 2 | TVS Diode Array | SC1205-01UTG, SP1006-01UTG |
| 3 | Switch | NanoT, KXT, KMT0, KMR, HDT, KMT0 D |
| 4 | TMR position sensor | Under development; contact sales |
| 5 | Microcontroller | Z8F3224, S3F8S19, Z8F6482, S3F8S7B |
| 6 | TVS Diode | SMAJ |
| | Gate Driver | LF2101N, LF2103N |

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| 2 | TVS Diode Array | Protects against ESD on data lines | SC1205-01UTG, SP1006-01UTG | Enables compact design; reduces assembly time | Complies with IEC standards; low leakage current of 100 nA; compact form factor |
| 3 | Switch | Reliable navigation; dose dialing and activation | NanoT, KXT, KMT0, PTS, HDT, KMT0 D, FDSE, HDS, | Micro-miniature; long life; up to IP 68 sealing properties; micro-detect switches; over-travel, low actuation magnetic stress: 35 g max; low profile | Excellent performance; response to touch and feel; design allows for top or side actuation; low-profile package; normally closed circuit (FDSE) |
| 4 | TMR position sensor | Under development; contact sales | | | |
| 5 | Microcontroller | Overall system control | Z8F3224, S3F8S19, Z8F6482, S3F8S7B | Lower standby power, high resolution PWM for Motor control, direct LCD display control | 8bit MCU, 12/14bit ADC , LCD controller |
| 6 | TVS Diode | Surge protection | SMAJ | Offers board space saving; excellent clamping capability | Low profile package; IEC-61000-4-2 ESD 30 kV (Air) and 30 kV (Contact); fast response time |
| | Gate Driver | Controls the motor | LF2101N, LF2103N | Shoot-through protection; more precise control and lower torque ripple; board space saving | Logic inputs are 3.3 V logic level compatible; available in SOIC-8 |


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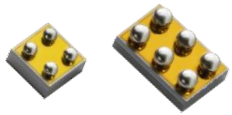
# Fitness and medical tracker

**1 Wireless charging**
PPTC, Battery mini-breakers, eFuse

**2 Touch screen display**
TVS Diode Array


**3 UI buttons**
Tactile Switch

**4 Load switching**
Load Switch IC

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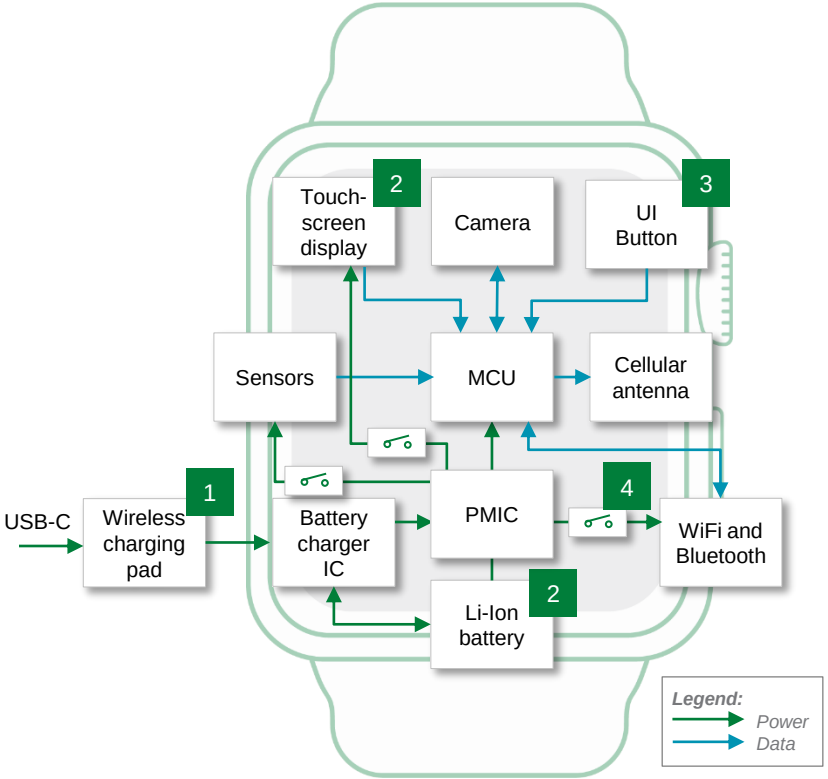
*Click the product series in the table below for more info*

# Fitness and medical tracker functional block diagram




| | Technology | Product series |
|---|---|---|
| 1 | Protection IC (eFuse) (USB-C) | LS0505EVD22, LS0504EDD12 |
| | PPTC ***OR*** Battery Mini-breakers | 0603L MHP-TAS* |
| 2 | TVS Diode Array | SPxx, SP1006-01UTG |
| 3 | Switch | NanoT |
| 4 | Load Switch IC | LQ0502, LQ0504 |

** Contact Littelfuse sales for more details.*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*Click the product series in the table below for more info*

# Features and benefits of Littelfuse products

| | Technology | Function in application | Product series | Benefits | Features |
|---|---|---|---|---|---|
| 1 | Protection IC (eFuse) (USB-C) | Integrated overcurrent and overvoltage protection | LS0505EVD22, LS0504EDD12 | Integrated solution with features like current limit protection, thermal shutdown, and internal soft start | 5 V, 5 A eFuse with 30 V max and overvoltage protection and overcurrent protection |
| | PPTC ***OR*** Battery Mini-breakers | Overcurrent and over-temperature protection | 0603L MHP-TAS* | Compact design suitable for situations where space is at a premium and resettable protection is desired (for example, smart watches) | Low profile; fast response to short-circuit currents; low resistance |
| 2 | TVS Diode Array | Protects against ESD | SPxx, SP1006-01UTG | Maintains signal integrity of high-speed data lines; reliable ESD protection | Small footprint; extremely low dynamic resistance |
| 3 | Switch | Controls Bluetooth functions of wearable devices | NanoT | Board space saving and design flexibility; reduces cost and integration difficulties versus designing full interface button; improves lifetime and reliability of the end equipment | Ultra-compact size; up to 300000 life cycles; IP67 for sealed switch compatibility with PCB coatings |
| 4 | Load Switch IC | Integrated electronic switches used to turn on and turn off power rails | LQ0502, LQ0504 | Reduces parasitic leakage current; improves system efficiency; increases battery lifetime; board space saving; low power consumption | Lowest quiescent current (IQ) and shutdown current (ISD); integrated slew rate control and output discharge switch; small package |


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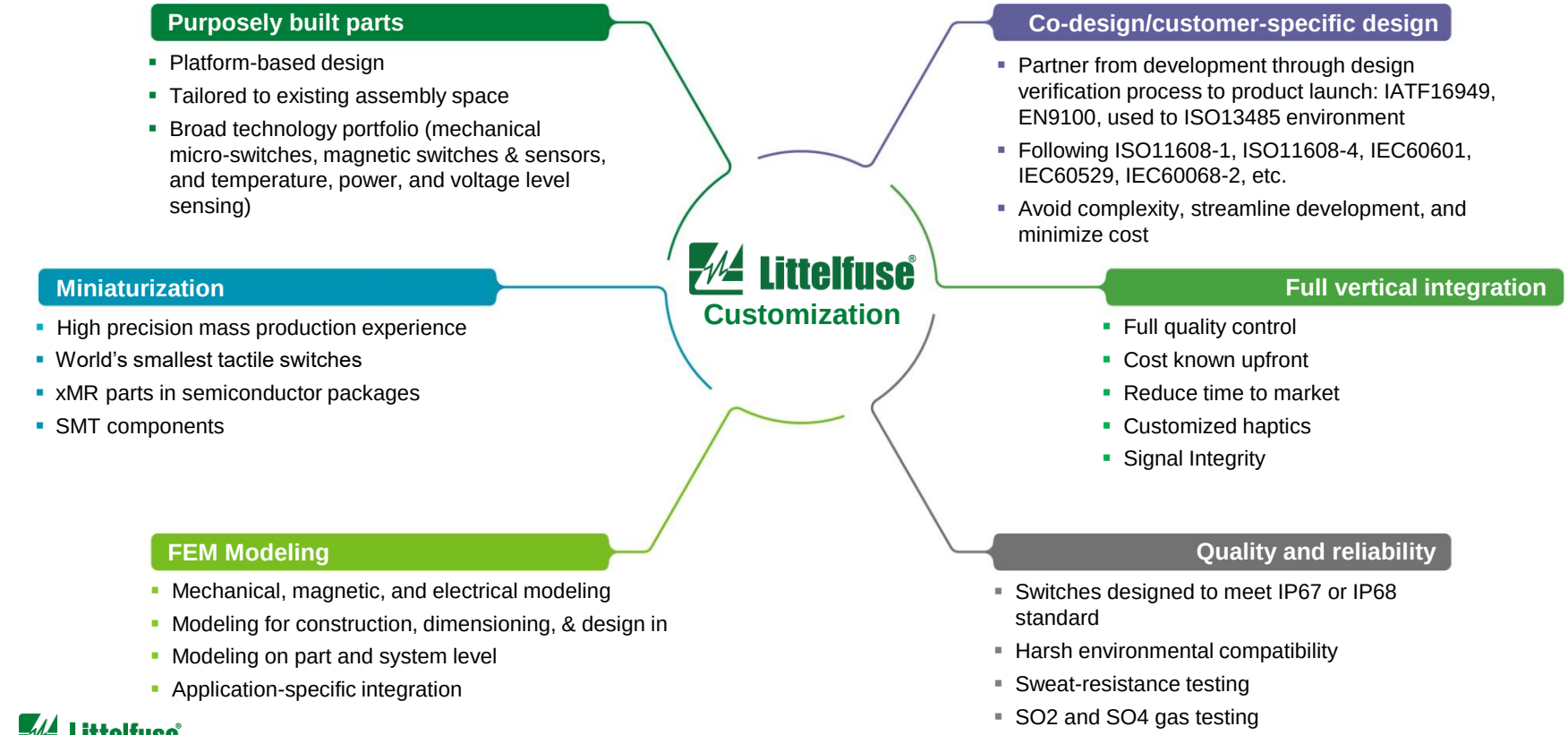
# Driving device design: personal, portable, & connected

*Understanding these standards and the impact on the device during development is critical*

| Standard | Title | General scope | Market |
|---|---|---|---|
| **ISO 11608-1** | Needle-based injection systems for medical use.<br>Part 1: Needle-based injection systems | Specifies requirements and test methods for Needle-Based Injection Systems (NISs) for single-patient use intended to deliver discrete volumes (bolus) of medicinal product, which can be delivered through needles or soft cannulas for intradermal, subcutaneous, and/or intramuscular delivery, or all three incorporating pre-filled or user-filled, replaceable, or non-replaceable containers. | Global |
| **ISO 11608-4** | Needle-based injection systems for medical use.<br>Part 4: Needle-based injection systems containing electronics | Specifies requirements and test methods for needle-based injection systems (NISs) containing electronics with or without software (NIS-Es). | Global |
| **IEC 60601** | Medical Electrical Equipment Testing and Certification | Part 1-11: General requirements for basic safety and essential performance−Collateral standard: Requirements for medical electrical equipment and medical electrical systems used in the home healthcare environment. | Global |
| **IEC 60529** | Degrees of protection provided by enclosures (IP Code) | Developed to rate and grade the resistance of enclosures of electrical and electronic devices against the intrusion of dust and liquids. It also rates how easy it is for individuals to access the potentially hazardous parts within the enclosure. | Global |
| **IEC 60068-2-XX** | Environmental testing of electrotechnical products | A collection of methods for environmental testing of electronic equipment and products to assess their ability to perform under environmental conditions including extreme cold and dry heat. | Global |

CE Mark, FDA Approval, and NMPA certifications provide for actionable data for medical professionals.

# Littelfuse purposely built parts for drug delivery device ecosystem




## Purposely built parts

- Platform-based design
- Tailored to existing assembly space
- Broad technology portfolio (mechanical micro-switches, magnetic switches & sensors, and temperature, power, and voltage level sensing)

## Co-design/customer-specific design

- Partner from development through design verification process to product launch: IATF16949, EN9100, used to ISO13485 environment
- Following ISO11608-1, ISO11608-4, IEC60601, IEC60529, IEC60068-2, etc.
- Avoid complexity, streamline development, and minimize cost

## Miniaturization

- High precision mass production experience
- World's smallest tactile switches
- xMR parts in semiconductor packages
- SMT components

## Full vertical integration

- Full quality control
- Cost known upfront
- Reduce time to market
- Customized haptics
- Signal Integrity

## FEM Modeling

- Mechanical, magnetic, and electrical modeling
- Modeling for construction, dimensioning, & design in
- Modeling on part and system level
- Application-specific integration

## Quality and reliability

- Switches designed to meet IP67 or IP68 standard
- Harsh environmental compatibility
- Sweat-resistance testing
- SO2 and SO4 gas testing



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# Sustainability: Environmental, Social, and Governance

*More information can be found in our third Littelfuse 2022 Sustainability Report on www.littelfuse.com*

## Environmental

**22%**
decrease in Scope 2 GHG emissions intensity

**138%**
increase in renewable energy

**12%**
decrease in overall energy intensity

**84%**
manufacturing sites ISO 14001 certified

**70%**
of our generated waste is recycled

**Cobalt and Mica**
included in supply chain due diligence

## Social

Respect | Customer Focus | Agility | Collaboration

Refined values to support long-term growth strategy

America's Best Midsize Employer Recognition from Forbes

**~20%**
Reduced total case incident rate

**574**
significant suppliers screened from ESG perspective

Started US pay equity analysis

## Governance

**2.5 Hours per Employee**
of Ethics and Compliance training with
**99%**
Average completion

Expanded Enterprise Risk Management, formed climate-related risk and opportunities committee, and implemented supplier assessments

Formal ESG Policy

Manufacturing site sustainability teams

Central ESG software to manage and internally audit our ESG data

**~5000 Hours**
of Cybersecurity and Data Privacy training globally


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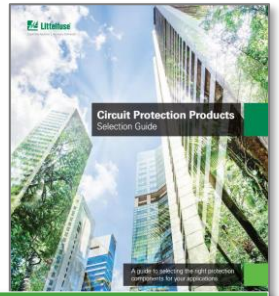
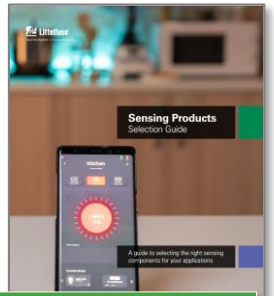
# More information can be found at Littelfuse.com

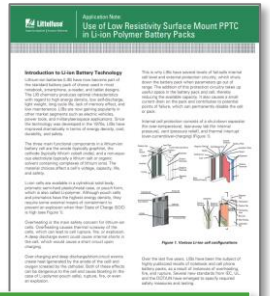
Explore the world of Littelfuse with the electronic ecatalogs (ecatalogs.littelfuse.com)



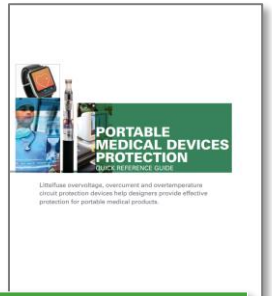

Circuit Protection Selection Guide




Sensing Products Selection Guide



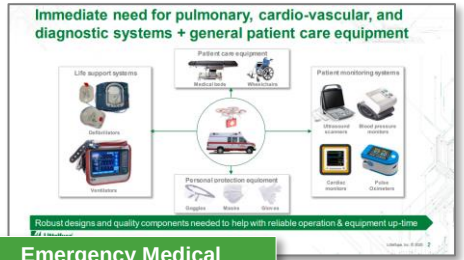

Lithium-Ion Battery Pack Protection with PPTC




Portable Medical Devices Protection Guide

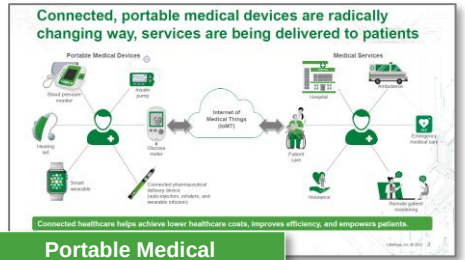

Switches for Medical Applications

Click the images for more information




Emergency Medical Equipment Spotlight


Personal Care Solutions Spotlight




Portable Medical Devices Spotlight

Scan the code to learn more!

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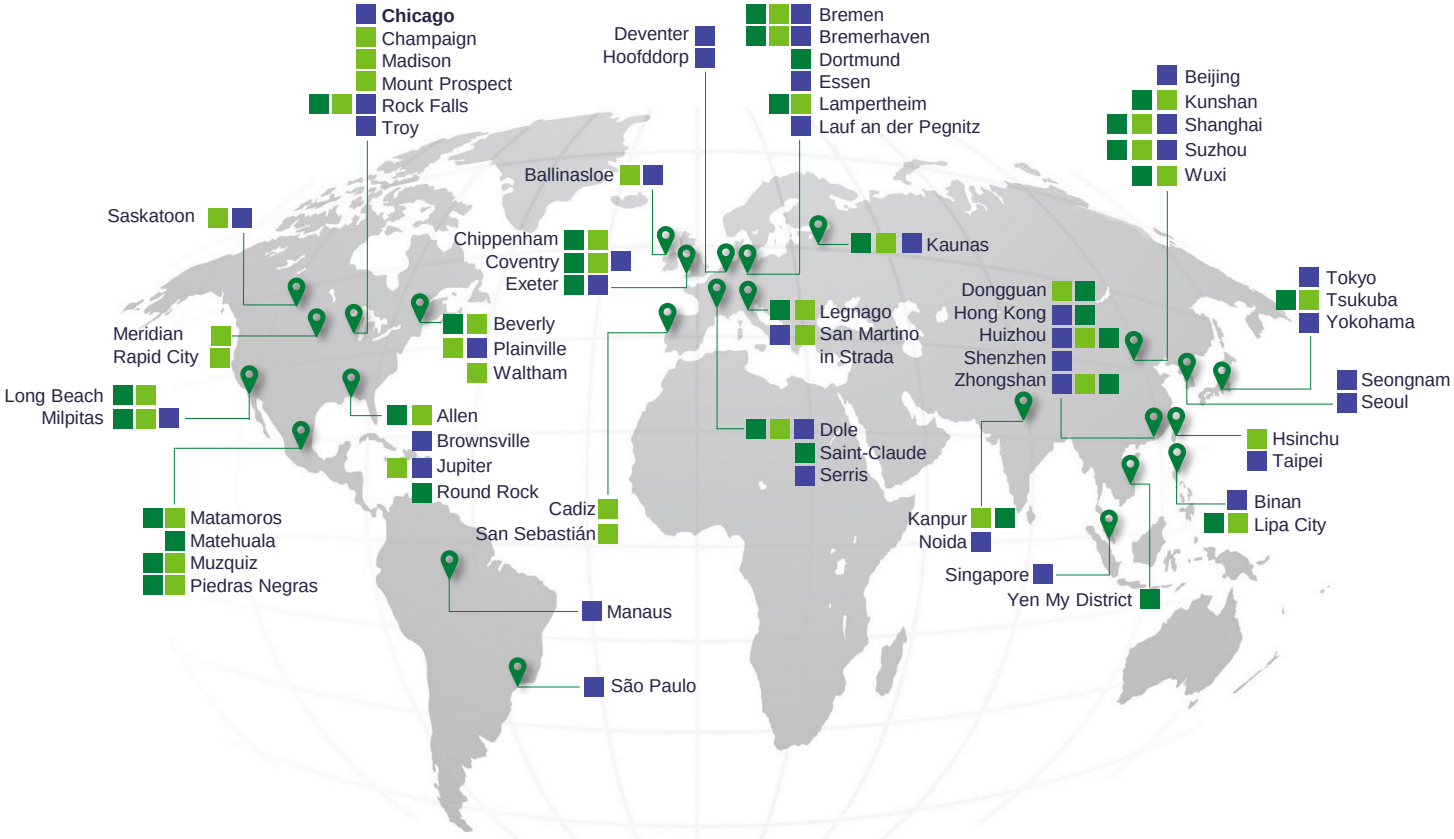
# Local resources supporting our global customers

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# Partner for tomorrow’s electronic systems

**Broad Product Portfolio**

We are an industrial technology manufacturing company empowering a sustainable, connected, and safer world.

**Testing Capabilities**

We help customers get products to market faster, and we offer certification testing to global regulatory standards.


**Application Expertise**

Our engineers partner directly with customers to help speed up product design and meet their unique needs.

**Compliance and Regulatory**

We help customers in the design process to account for requirements set by global regulatory authorities.

**Global Customer Service**

Our global customer service team is with you to anticipate your needs and ensure a seamless experience.

**Global Manufacturing**

Our high-volume manufacturing that is committed to the highest quality standards.


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