

# User Manual

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# 1 General

## 1.1 Purpose

The purpose of this document is to define functional and technical requirements for the FJ2500 product.

## 1.2 Scope

The scope of this document is limited to describing requirements for the FJ2500 product described herein; it describes the functional and technical requirements as required to initiate development of the product

This document is intended to outline the functional and technical requirements from a general market and/or customer perspective. It is not intended to be a detailed technical design specification. Additional design specifications and other technical documentation will be generated as needed over the course of the development process.

## 1.3 General Information

The FJ2500 product is designed on proven technology from the M6 & M8 products. This product shall utilize core electrical design and firmware as the M8, with the addition of mechanical reconstruction to bring overall product footprint down.

Multiple build variants of the FJ2500 will be supported, these will be:

- FJ2500 with BLE
- FJ2500 with BLE + CAN
- FJ2500 with BLE + RS232/RS485 + CAN

Actual launch of specific SKUs will be based on the following initial priorities:

- SKU #2 - *FJ2500* with BLE + RS232/RS485

Other variants within the design shall be released upon customer/market demand.

## 2 Technical Requirements

### 2.1 Physical Requirements

#### 2.1.1 Design

The FJ2500 product is a complete and enclosed assembly. The basic form-factor of the product shall use the exact same mounting footprint as the current M6. This will enable this design to be mounted on current mounting brackets and OEM machine mount holes. The device must be designed to withstand the stresses of continuous operation in industrial equipment or outdoor heavy equipment environment like current designs. This must include being fully compliant with IP 66 & IP67 environmental specifications.

#### 2.1.2 Mechanical

The FJ2500 product enclosures shall incorporate a captive weatherproof molded grommet, from which a 10" 20 AWG harnesses terminated with the appropriate Deutsch connector on the end for ZTR into a completely sealed heavy-duty plastic casing.

Mounting tabs, or similar mounting structures shall be incorporated into the enclosure design allowing for the unit to be bolted down to a mounting surface.

A recessed area shall be provided on the top and bottom surface of the unit for attachment of the labels specified in Section 2.4.3 on the exterior of the unit. The recesses shall be minimal in depth, but sufficient to recess the surface of the label within the exterior surface plane of the enclosure.

#### 2.1.3 Size

The (target) dimensions of the FJ2500 products shall be 112 x 80 x 25mm.

These dimensions are exclusive of cables/connectors.

#### 2.1.4 Version

Hardware version: FJ2500\_P1\_V01

Software Version: M7\_MCU\_3.6\_F407

### 2.2 Hardware Features Summary

Physical properties:

- Power supply voltage range 6-90V
- Custom enclosure that maintains same mounting footprint as current M6
- (4) Status LEDs
  - GPS – Green
  - Cellular – Orange

- Bluetooth – Blue
- Diagnostics – Red (software controlled)
- 20 AWG wiring harness terminated with a Deutsch connector (8 pin or 12 pin based on SKU)
  - This harness shall be 10” in length

#### Core components:

- CPU:
  - 32-bit microprocessor (main MCU)
  - 8-bit processor (power management MCU)
  - Dedicated CAN MCU
- Flash: 4MB - 32MB flash
- NVM: 128KB
- Cellular:
  - Integrated LTE cellular receiver module
  - HSPA(3G) fallback capable
  - 2G fallback available as required for specific countries
  - Internal cellular antenna
  - Option for external antenna
- GPS:
  - Integrated GPS receiver module
  - 56 channel GPS with SBAS
  - Internal GPS antenna
  - Option for external antenna
- BLE:
  - Integrated BLE 4.2/5.0 receiver module (software upgradeable to BLE 5.0)
  - Internal Bluetooth antenna
- Integrated 3-axis Accelerometer
- Internal 5200MAH lithium ion backup battery and charger circuit

#### Interface:

- Connecting scheme via 10 inch harness terminated with a Deutsch connector (8-pin or 12-pin based on SKU)
- Physical Digital Inputs / Outputs (may vary on SKU)
  - BND control
  - Input 1 (BND dependent) (Ignition)
  - Input 2 (BND dependent) (Utilization)
  - Input 3 (spare) - can be biased high/low
  - Output 1 (Start/Stop)
- Physical Analog (may vary on SKU)
  - (1) 0-60V or 4-20mA or 0-1 (discrete / logic)
- Internal (Virtual) Inputs / Outputs
  - BND Status (input)
    - Indicates if BND switch is open/closed (if present)

- CAN/Serial Active (input)
  - Indicates activity on the bus
- Internal Battery Low (input)
  - Transitions HIGH when internal battery is below the voltage cutoff threshold
- Power State (input)
  - Allows selection between internal battery and external power source
- Charge disable (output)
  - Control over the internal battery charger via software
- Analog Mode (output)
  - Mode selection for the analog input controlled via software
    - OFF: Voltage mode (default)
      - Input range of 0-60V
    - ON: Current mode
      - 560 ohm shunt resistor used to convert current sensor output to voltage
- Motion
  - Will go high when motion is detected
- SMS received
  - Momentarily goes high when an SMS is received
- Internal (Virtual) Analogs
  - GPS antenna
  - Internal temperature (main MCU)
  - Vref
  - Internal battery voltage
  - External power source voltage
- CAN/J1939
- Serial RS232/485 (Modbus)

## **2.3 Hardware Feature Details**

### **2.3.1 Cellular**

- The product shall use industry standard developed cellular modem from Telit(xE910)
- This module shall support HSPA (3G) fallback and will be LTE ready
  - Where required (ex. New Zealand) a 2G option shall be available
- An internal cellular patch antenna shall be utilized
  - U.FL connector on board to allow for optional external antenna
- Standard cellular certification shall be conducted to meet regulatory standards.
- In addition, this product shall meet Specific Absorption Rate (SAR) requirements that will allow safe operation of product within close proximity of a human
- Global roadmap considerations are being planned (shown in table below)
- HSPA Upload (Mbps): 5.76

- HSPA Download (Mbps): 7.2
- Frequencies: UMTS | HSPA bands (MHz) 800/850/900/1900/2100
- GL variants:
- 4 Bands GSM|GPRS|EDGE:
- 850/900/1800/1900 MHz
- 5 Bands UMTS|HSPA:
- 800/850/900/1900/2100 MHz

Region	FJ2500_P1_V01
North America	
EMEAR, APAC, LATAM, China	3G and 2G Pentaband
AUS/NZ/APAC	
JAPAN	

### 2.3.2 GPS

- Integrated U-bloxGPS receiver module (UBX7020)
- 56 Channel GPS with SBAS
- Internal GPS antenna will be utilized in the product (similar to M6 & M8)
  - U.FL connector on board to allow for optional external antenna
- High sensitivity receiver capable of getting an general location within enclosed space
- Ability to ‘hard code’ the GPS coordinates for applications that require GPS without ability for the device to acquire GPS (ie. indoor applications, underground, etc.)
- Stores the last known good coordinates to use in cases where GPS cannot get a fix

### 2.3.3 BLE

- Integrated BLE module (CC2640R2F V4.2/V5.0)
- Will initially support V4.2 but will be cable to be software updated to be V5.0 compliant
- ZTR uses this chipset family currently in the T25/T15 product.
- Will allow for Over-The-Air (OTA) updates to all chipsets integrated into the M7

### 2.3.4 CPU

- Main MCU (STM32F407VE) will be used to handle core application computations.
  - Most of the application logic shall reside on this OTA updatable CPU
- Power management MCU (STM8L151G4) to be used to reduce current consumption during times of sleeping/hibernating
  - Proven design as in existing M6 and M8
  - Various sleep modes (hibernate, normal sleep) selectable via software
- To facilitate real-time data CAN data filtering and monitoring a dedicated CAN MCU (STM32F105) will be utilized.
  - This concept was introduced in the M8 family variants of products and yields strong performance in handling overloaded CAN networks

### 2.3.5 Flash

- SKU with CAN functionality will have more flash space for future features like remote customer ECU reprogramming
- The product will come with two different memory flash sizes
  - SKU #1 - FJ2500 with BLE shall have 4MB flash
  - SKU #2 - FJ2500 with BLE + RS232/RS485 shall have 4MB flash
  - SKU #3 - with BLE + RS232/RS485 + CAN shall have 32MB flash
  - SKU #4 - with BLE + RS232/RS485 + CAN (Customer Specific) shall have 32MB flash

### 2.3.6 NVM

- The product will have dedicated nonvolatile 128KB memory space on all SKUs
  - Used for unique device data storage and will be read only
  - Electronic Serial Number (ESN)
  - Hardware Revision
  - Manufacturing Diagnostics Test Results (TBD)

### 2.3.7 Accelerometer

- An integrated accelerometer has been used in most ZTR products to facilitate unique application requirements
  - Driver behavior (hard braking/acceleration/steering, motion wakeup, etc.)
- This shall be a 3-axis accelerometer that can be used for motion and impact detection
- Shall be capable of detecting upwards to 16 g-forces

### 2.3.8 Includes Battery Negative Disconnect Solution (BND)

- This unique concept (originally introduced on M8HBZ product) prevents on-site power back-feed issues when equipment's battery is disconnected. This may not be required in all application and may not be outward facing in all variants.
- This is an integrated hardware solution, using opto-isolators, that disables transitions on the first 2 inputs from being acted upon when the battery negative disconnect switch, on the equipment, is opened

- When the switch is open, there is a floating ground which has cause false positives on input detection
- This prevents false ignition signal, keeps run hours accurate (when measured on machines that do not have an ECU/Run Hours PGN)

### **2.3.9 LED**

A total of four Status LEDs will be integrated into the FJ2500

- GPS – Green
- Cellular – Orange
- Bluetooth – Blue
- Diagnostics – TBD (Software controlled)

### **2.3.10 Power**

- 6-90 VDC operating voltage
- Power states
  - Hibernation/Deep Sleep (< 150 uA @ 12V)
  - Normal Sleep (<14 mA @ 12V)
- Active Tracking (70 mA @ 12V)

## **2.4 Interface Requirements**

### **2.4.1 Status Indicators**

The product shall include (4) LEDs for indication of status of the Cellular, GPS, Bluetooth and Diagnostics of sub-systems. Status should be indicated using blinking patterns of the individual LEDs.

Reference section 2.2.1.9 for additional information.

The enclosure design shall incorporate features allowing for external viewing of the LEDs.

### **2.4.2 RF interfaces**

#### **2.4.2.1 Cell**

The interface to the cellular module shall utilize a connection to an internal antenna as well as a U.FL connector to allow for external antenna

#### **2.4.2.2 GPS**

The interface to the GPS receiver shall utilize a connection to an internal 25mm patch antenna as well as a U.FL connector for external antenna option.

#### **2.4.2.3 Bluetooth**

The RF interface shall utilize an internal antenna.

## 2.4.3 Communication Interfaces

### 2.4.3.1 Serial

The device platform shall incorporate a single dual purpose external serial interface. The objective of this interface is to provide access to the M7 CPU for purposes of programming, testing, and provisioning. This interface shall also provide functionality for application interfacing to a variety of external products and devices.

This serial interface shall be an RS232 & RS485 port with hardware handshaking. This interface shall also include an optional switchable voltage output providing a selectable voltage output and operating mode (RS232 or RS485).

- Voltage selections: 3.3/5/9/12/V\_IN

### 2.4.3.2 CAN/J1939

The device platform shall incorporate an interface for CAN/1939 communications. The objective of this interface is to read and request information from the ECU to provide critical equipment information to the end-user.

### 2.4.3.3 Modbus RTU

The device shall incorporate an interface for the Modbus RTU protocol over RS-232, for communication with external hardware, with the following requirements:

- Modbus RTU protocol with standard registers (Coil, Di, Input & Holding)
- Protocol must support all standard Modbus RTU function codes and exception codes
- Provide access to incoming/outgoing packets at any time via software hook
- Ability to operate in both master and slave modes
- Configurable (baud rate, master/slave mode, slave ID, etc..) with configuration to hold through hardware reset
- No extended registers required
- Interface Connectors

The FJ2500 product shall utilize a Deutsch DT series plug for all external power and I/O connections. The pinout of this connector shall be SKU dependent. A block diagram of these connections are shown on the following page.

## 2.5 Size

The label shall be approximately 40 x 50 mm in size.

## **2.6 Operational Environmental Requirements**

Temperature: -40 to +85 °C

Humidity: 0 to 90% non-condensing

Random Vibration per SAE J1455 (Aug. 2012), Section 4.9, Figures 6, 7, & 8

Mechanical Shock per SAE J1455 (Aug. 2012), Method 213B, Test Condition J

Dust, Water and Ingress Protection per IP66, IP67

## **2.7 Storage Environmental Requirements**

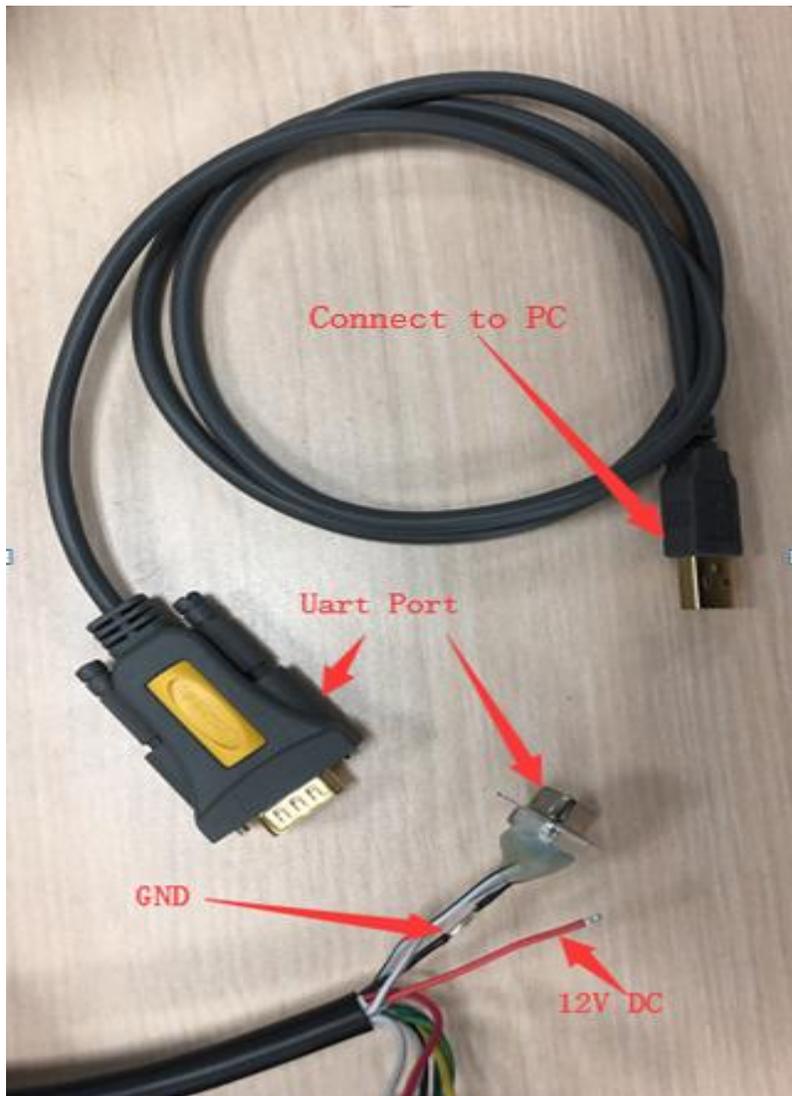
Temperature -45 to +90 degrees C

Humidity 0 to 90% non-condensing

## 2.8 Conceptual Design



## 2.9 Connection method:



### **FCC STATEMENTS**

**WARNING:** Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**NOTE:** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

### **INDUSTRY CANADA**

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement

The distance between user and device should be no less than 20cm.  
la distance entre l'utilisation et l'appareil ne doit pas être inférieure à 20 cm