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Operational Manual

for the

Space-based Short Message System Terminal (SSMS)
Model CT2A

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Contacting the Manufacturer

BotCor America/Mobilacomm

Technical Support

Address:	775 Main Street, Suite # 230 Buffalo, New York, U.S.A. 14203
Telephone:	716 842 1033
Fax:	76 842 1025
E-Mail:	Chris_Rampen@Botcorp.com
Business Hours:	Monday-Friday, 9:00 – 17:00 Eastern Standard Time

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This document was prepared by BOTCORP America.

1. Prepared by: Chris Rampen
Special Projects
Bot Engineering Ltd.

2. Proofed by: Barbara Prescott
Editor
Bot Engineering Ltd.

3. Engineering Review by: Roger P. Bot
Vice President
Bot Engineering Ltd.

4. Approved by: David L. Bot
President
Bot Engineering Ltd.

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APPENDICES

1 SCOPE

This document is intended to provide specific information required to install and operate the Space-based Short Message System (SSMS) Terminal (Model CT2A). Variations in SSMS functionality are dependant on the service subscribed to. This manual is intended to be as generic to all SSMS variants (Model CT-2A-(xxx)) as possible; for additional service specific information, please contact the service provider in your region as indicated in Appendix C. Please note that this manual does not make any representations about the current licensing status of services using the SSMS terminal. For current information please consult the relevant licensing body as well as the listed service providers.

1.1 MODEL NOMENCLATURE

As the CT-2A-(xxx) transceiver can be configured to accommodate different services in different regions over different satellite systems, an identifier has been included in the model designation to describe the exact transceiver configuration. For example, the transceiver used for TMI communications TAMs (track and manage service) is identified as ‘CT-2A-TAMs’. The transceiver used for SpaceChecker’s Service is identified as ‘CT2A-SC’.

2 SSMS SYSTEM OVERVIEW

The SSMS is designed to provide low-cost data transmission with GPS location reporting in a compact low power package. The SSMS uses GPS satellite for location and timing information and L-Band satellite bandwidth for data communication. Data is sent from the SSMS transceiver to the L-band satellite to a satellite ground station/hub and then to the client. If the data needs to be transmitted beyond the ground station, data is be conveyed from the satellite ground station via an internet server using an internet account or via a secured TCP/IP based network). Conversely, the same network can be used to send data in the form of control information back to individual SSMS transceivers. The nature of the control data is service specific. The transceiver is a full duplex design using separate antennas to receive and transmit (See Figure 1). Please note that the system uses 2 antennas: the antennas are identical in outward appearance and form factor.

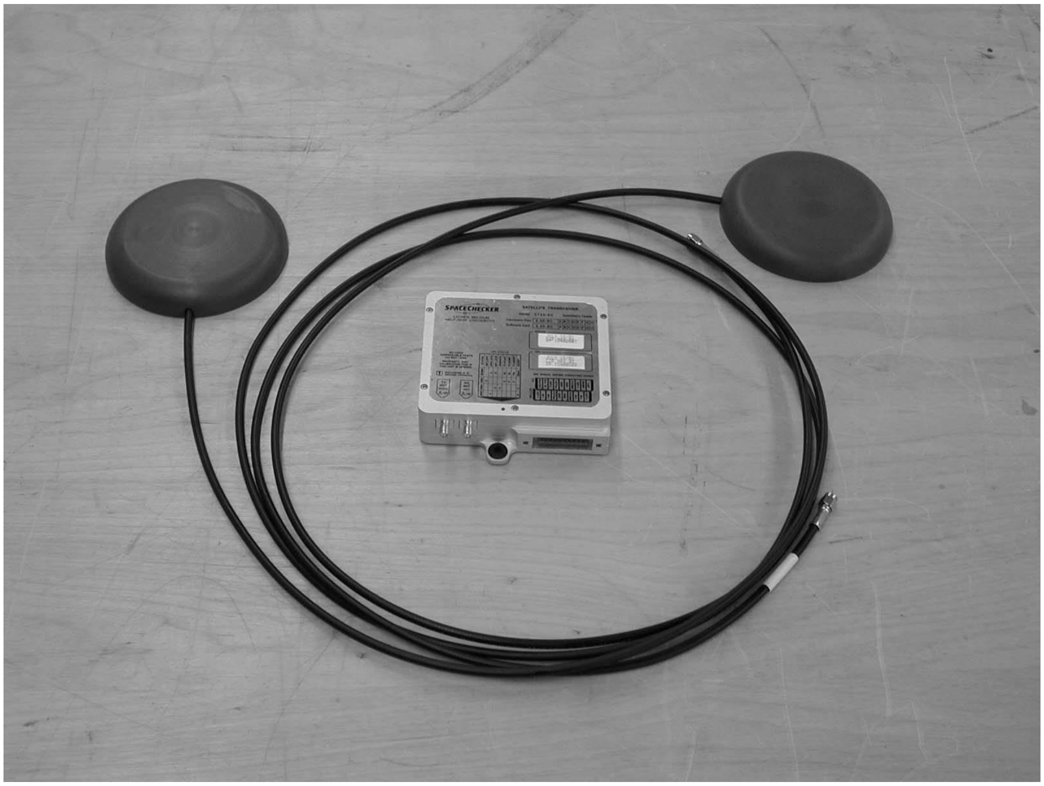


Figure 1

SSMS Transceiver and Antenna

As the CT-2A uses geo-synchronous L-band satellites, the service has a very short latency period operating in virtually real time. Due to sophisticated network design features, the transceiver makes very efficient use of available bandwidth providing extremely cost effective data transmission and producing a network with long term scaleability.

The transceiver unit can be adapted to transmit a wide variety of information using its own internal sensors, information provided by the GPS satellite system and EZ-LAN sensors. The table below indicates the type of information that the transceiver can transmit in the TAMS service.

Message	Description
Latitude	+90 N to –90 South
Longitude	+180 E to +180 W
Speed	Instantaneous Speed in KPH
Avg. Speed	Averaged speed in KPH
Direction of Travel	8 Cardinal Points (i.e. NE, NNE etc.)
6 MicroLAN Sensors	Switch inputs, ADC, Temperature
Low Battery Alarm	When Battery falls below 10.5 VDC
Sleep Mode	1 = battery power, 0 = External power
Door Switches	2 switches
Trailer Load Volume	In ¼ load Increments
Sleep Mode	1 = battery power, 0 = External power

Note: Optional sensors are needed for some of the above functions. The listof sensors are listed in the appendix to this manual.

3 TRANSCEIVER PHYSICAL CHARACTERISTICS

The SSMS transceiver consists of 3 parts: the transceiver, a TX antenna and an RX antenna. The transceiver may optionally be equipped with a user or manufacturer supplied battery and mounting bracket. For an actual size drawing of the transceiver (see Figure 2). The standard commercial transceiver is intended to be mounted in a dry location. A waterproof housing of slightly larger form factor is available upon special request. Interconnection to the antennas is via SMA connectors and to power and sensors via an edge connector. Section 4 of this document provides interconnection details for installation.

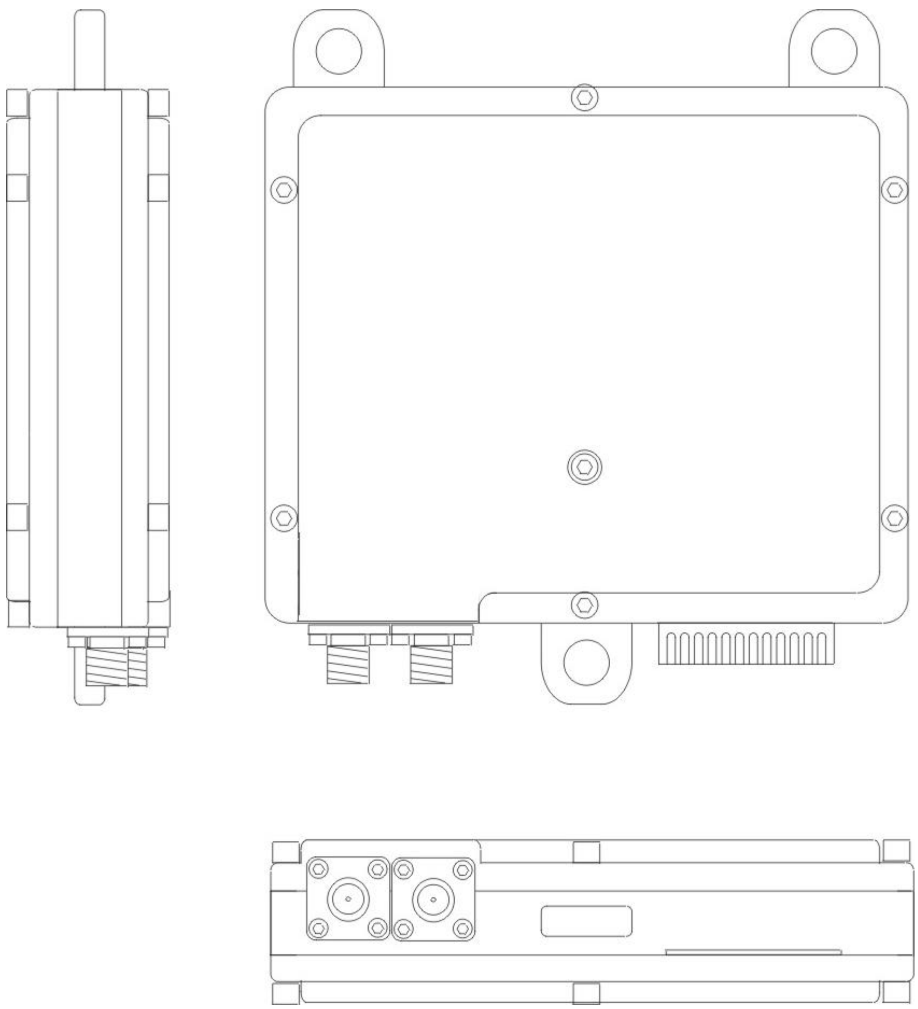


Figure 2

3.1 MODES OF OPERATION

The transceiver transmits data according to three possible modes:

- Scheduled Reporting

  The transceiver is designed to transmit data according to a programmed schedule. This could be every 15 minutes or up to once a day depending on the type of subscription provided and the services offered by the service provider.

- Event Response

  The transceiver will transmit when a critical sensor alarm point is exceeded or when other internal set points are triggered. As an example of an internal set point trigger, the transceiver could be configured to transmit data when the unit goes from ‘ready’ mode to ‘sleep’ mode. Sensor limits are set using optional EZ-LAN support software.

- User Request

  Data from the transceiver can be retrieved via a user-generated request via the internet interface.

The SSMS Terminal features a ‘sleep’ mode when it is running on battery power. When in ‘sleep’ mode, the SSMS will wake itself up according to the schedule and transmit its report. When in the ‘sleep’ mode, the SSMS will also wake itself up at increments (depending on the subscription and service provider) of the scheduled transmission time and look for – and if necessary respond to -event responses and polls.

Consequently, transceivers that are polled when in sleep mode will transmit with a delay dependant on the type of service to which the unit is subscribed. For exact times please consult your service provider. The ‘wake-up’ intervals are determined by the subscription type and is set by the service provider.

The transceiver has an additional battery saving mode that is activated when the battery drops below 10VDC. This function is designed to prevent battery damage caused by deep discharging the battery.

3.2 SENSOR INPUTS

External sensing is accomplished through EZ-LAN sensors. EZ-LAN employs simple twisted-pair cabling and inexpensive one-wire sensors. Each sensor has a unique Network Address code thereby allowing all devices to operate in parallel over a single twisted pair. The number of sensors that the SSMS transceiver can accommodate is determined by the service and installation specifications (Type of Sensor used, length of run, etc.). All sensor inputs to the transceiver are via the EZ-LAN buss.

3.3 SSMS SYSTEM LIMITATIONS/WARNINGS

The SSMS transceiver requires a line of sight view of the satellite for a sufficiently long period to generate GPS and L-band lock. As a result, if mission critical applications are envisioned, several precautions must be taken to ensure real-time communications capability, The user is urged to request the document GUIDELINES FOR DEPLOYMENT OF SSMS IN MISSION CRITICAL APPLICATIONS. Doc# SC-CT2A-CN-1. The TAMS service is intended as a commercial mobile asset management system and, as a result, rather simple installation guidelines can be followed as indicated in the sections that follow.

The SSMS transceiver is a low power RF device and is subject to health considerations as are all devices of this type. Although the device is of relatively low power and transmits for only brief burst (typically less than 1 second), it is not recommended that the antenna be placed in close proximity (less than 18”) to human beings for extended periods of time. Consequently, the transceiver and antennas must be properly installed before operation (See Section 4.3 Antenna Mounting and Installation).

A RF Radiation Exposure Evaluation Report for this device is available upon request under Doc# SC-CT2A-RFREP-1.

The SSMS transceiver and antennas have been qualified for use over the temperature range of –30 to +55C. The unit utilizes a unique self-calibrating function where the units carries out continuous self-calibration of critical operational parameters thereby ensuring reliable operation under all thermal; conditions. The unit also utilizes an over temperature shutdown circuit where operation above 80C is inhibited.

4 CT-2A TERMINAL INSTALLATION AND TESTING

4.1 CT-2A TRANSCEIVER KIT CONTENTS

The basic kit contains the following items:

- Antenna with integral connecting cable
- Transceiver unit
- Power/Sensor connecting cable
- Instructions

Additional items that may be obtained are:

- EZ-LAN Temperature, Motion, A/D converters and Door Sensors
- Waterproof Housing for Transceiver
- Antenna Mounting Kits

4.2 BATTERY CONSIDERATIONS

As implied above, the transceiver kit is not supplied with an external battery. This is the direct result of hazardous materials shipping regulations, battery aging and lifetime considerations. The transceiver is designed to operate from two types of power supplies: main and backup. The transceiver operates differently depending on which supply is being used to supply power. If the unit is operating from main power (e.g, an uninterruptible power supply - such as a battery being continuously charged by a alternator) the transceiver will operate continuously, receiving both GPS and satellite data.

In applications where main power is not available or is intermittently available, the transceiver makes use of power saving features. In these applications, when main power is not available the transceiver only draws significant power when making scheduled transmissions; when the unit is not transmitting the unit enters a very low power mode. The exact timetable is configurable to provide the best compromise between power savings and reporting frequency.

Typical vehicular applications use both main and backup supplies. This provides optimum performance when vehicle power is available and still provides the needed reporting capabilities when the vehicle's charging circuit is not operational. In general, the main supply consists of the vehicle

power (+12V in North America) and a +12v battery for the backup power. The backup battery is automatically charged from the vehicle power using circuitry which is internal to the transceiver. In order to meet specific user requirements, the backup power supply battery must be sized to match the event timetable and the required backup battery life. In the event that the battery voltage of the main and backup battery reaches the battery endpoint voltage (typically 10V), the unit disconnects from the battery source and inhibits all further transceiver operation until voltage is restored to usable levels. While a number of battery chemistries can be used with the transceiver, lead acid, gel electrolyte have been determined to provide the best compromise between cost, capacity and low temperature operation.

In order to size the 12V(nominal) backup battery an equation must be applied as follows:

battery capacity in Amp/Hrs = anticipated non-charge period in days X .05 X # of reports per day

4.3 ANTENNA MOUNTING AND INSTALLATION

The antennas is designed to be mounted on top of a mobile platform such as a trailer, vehicle roof or mast. The antennas should be mounted 1m (3') apart with a clear shot at the sky and no obstructions in the antenna's field of view. Failure to obtain a lock on the service providing or GPS satellites indicates an inappropriate mounting position..

The antenna can be mounted with the double-sided tape, epoxy or a urethane adhesive. The connecting wire should be secured at 20cm (approx. 10") intervals using cable clamps. It is important that the antenna mounting method withstand any foreseeable wind loading and is not in proximity (18") to human beings for prolonged periods of time.

4.4 TRANSCEIVER MOUNTING AND INSTALLATION

The transceiver is to be mounted inside. It is advisable that the unit be secured using the shock mounts incorporated into the transceiver. Figure 1. shows the mounting hole arrangement. A 'drip loop' should be used for the antenna cable to transceiver connection so that any condensate that might accumulate on the cable does not flow into the connector. The transceiver is provided with a 6ft power/sensor connecting cable.

The cable consist of 3 twisted pair groups (e.g. 6 Wires). The cable should be wired according to the following color coding:

Pair	Color	Function/Description
1	Black	Ground
	Green	EZLAN 1 wire sensor input – paired with Black ground wire
2	Black	Ground
	Red	Backup Battery + 12VDC – Charged from Main supply
3	Black	Ground
	White	Main supply + 12VDC – transmits when voltage changes 0-12VDC or 12-0VDC

Note: all grounds should go to a common point. A good vehicle chassis ground is essential for reliable operation. The transceiver is reverse polarity protected and will not operate if the power +/Ground connections are reversed. If desired, an external 5A fuses may be used if needed for vehicle protection against shorts in the power cable. The transceiver unit is protected by internal resettable fuses. If the internal protective fuse trips, it may take a few minutes before the fuses reset.

The user may also supply an edge connector to facilitate interconnect with the terminal. In this case the user is responsible to ensure that the wire connections are correctly matched to the connector . The connector designation and recommended wire color is as follows:

A1-RESERVED	B1-RESERVED
A2-RESERVED	B2- RESERVED
A3-RESERVED	B3- +12v MAIN (White)
A4-RESERVED	B4-+12v MAIN (White)
A5-RESERVED	B5- GND (BLACK)
A6-RESERVED	B6- GND (BLACK)
A7-RESERVED	B7- +12 BACKUP (Red)
A8-RESERVED	B8- +12 BACKUP (Red)
A9-RESERVED	B9- RESERVED
A10- RESERVED	B10- EZLAN (Green)

Note: the reserved connections are used for non-TAMS applications.

4.5 EXTERNAL SENSOR DESCRIPTION AND INSTALLATION

The EZ_LAN is a low-cost and highly reliable method of connecting sensors to micro-controller based equipment. The connection is via twisted pair wires: one for sense and one for ‘return’ or ground. The sensors use the conventional EZ-LAN protocol where less than 0.8 V indicates a logic zero and greater than 2.2V indicates a logic ‘1’. Sensors are identified by a unique internal 48 bit number that is laser configured into the sensors. The sensors are extremely low power and are powered entirely from the twisted pair wires.

The SSMS-TAMS Transceiver currently supports three types of EZ-LAN EZ-LAN sensors: Digital Thermometer, Dual Addressable Switch, and Quad A/D Converte. As an A/D converter is supported almost any sensor potentially can be adapted to work with the transceiver. The Digital Thermometer supports a single temperature channel that can measure temperatures from -55 °C to 125 °C in 0.5 °C increments.

The Dual Addressable Switch supports two channels. Each channel possesses a current state bit plus an activity latch bit. The activity latch bit can be used to determine whether the switch has changed state from the last time the switch was read.

The Quad A/D Converter supports four high-impedance inputs with programmable input ranges of 2.56V or 5.12 volts and resolutions of 1 to 16 bits.

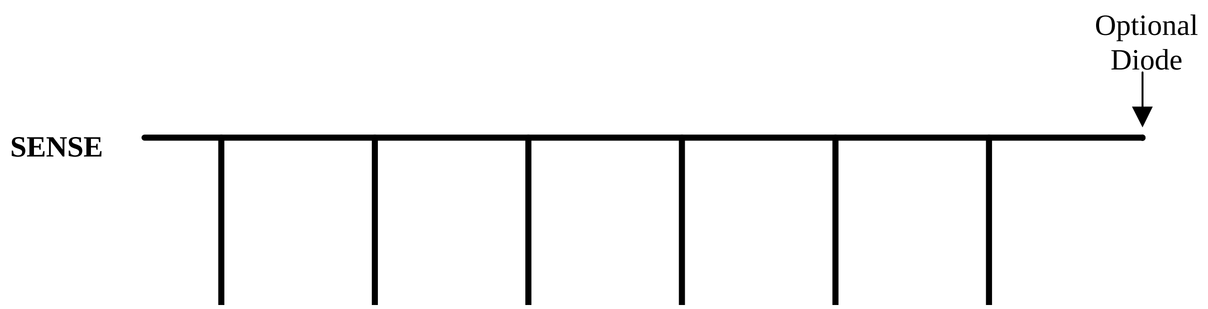
Sensors are provided with detailed installation instructions. These instructions are available at www.mobilacomm.com.

4.5.1 Wiring Specifics

For short runs (<30m or 60' approximately) the sensors may be connected using standard twisted-pair (e.g. telephone) cable. For longer runs, or when sensors do not function correctly it is recommended that Category 5, twisted-pair (typical capacitance 50 pF/m) be used. The cabling must be twisted pair, parallel wires are not acceptable due to the susceptibility to inductive coupling from EMF sources. It is acceptable to utilize shielded cable but the capacitance restrictions shown above should be observed.

Sensors are connected in parallel as per Figure 3. The TAMS Service will accommodate a maximum of 6 sensors. The transceiver auto-senses the type of sensor and replaces appropriate bits in the report's temperature payload section with the appropriate sensor data .

It is important to connect the sensor in the correct orientation (e.g ground to ground, sense to sense). Failure to do so will not affect the transceiver but may damage the sensor.



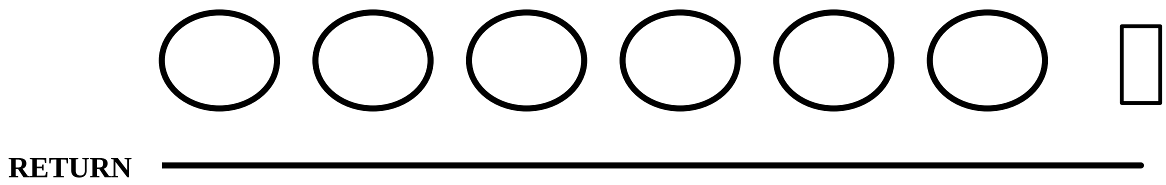


Figure 3
MicroLAN Connection Example

If runs of greater than 100m are anticipated, the cable end should be terminated using a Schottky diode (i.e 1N5819). The cathode side (band end) of the diode should be connected to the sense line, the anode to the ground line.

For application notes regarding EZ-LAN connection please refer to the “EZ-LAN design Guide”. This document is available at the Mobilacomm Website.

4.5.2 Sensor Allocation to Return Link Message

The return link message consists of 15 bytes. The bits allocated to returning EZ-LAN sensor information start at byte 8 and are illustrated by the following table (the blank cells represent data not directly associated with the EZ-LAN Sensors and are not discussed here) :

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
8						DA	MA	
9			R	R	R	R	R	R
10	R	R	R	R	R	R	R	R
11	R	R	R	R	R	R	R	R
12	R	R						

The “DA” and the “MA” bits in byte 8, are the Door Alarm and the Motion Alarm bits respectively. The first Dual Switch is always allocated to servicing the Door Alarm and Motion Alarm bits.

The state of the Door Alarm (DA) is determined by the current state and the activity latch state of channel A on the first Dual Switch found on the 1- Wire Bus. The Door Alarm State as a function of the current state and activity latch is illustrated by the following truth table:

Door Alarm	Activity Latch	Door State
0	0	0
1	1	0
1	0	1

1	1	1

Where an Activity Latch of 0 indicates the sensor has not changed since it was last read and a Door State of 1 indicates the door is open. The state of the Motion Alarm is determined solely by the state of the activity latch on channel B of the first Dual Switch found on the EZ-LAN Bus. In other words, if the state of channel B is different from the last time is was read then the Motion Alarm bit is set to 1. If has not changed since the last time it was read then it is set to 0. The 24 bits identified as "R", the Report Bits, in bytes 9 through 12 of the return link message are allocated based on which sensors appear on the EZ-LAN Bus. The number of Report Bits allocated per sensor type and the format of the respective bits are as follows. For temperature sensors, 4 bits are allocated, with the value of the bits representing the following temperatures.

Value	**Temp. ° C**	**Temp. ° F**
0	<= -13	<=8.6
1	–11	12.2
2	-9	15.8
3	–7	19.4
4	–5	23
5	–3	26.6
6	–1	30.2
7	1	33.8
8	3	37.4
9	5	41
10	7	44,6
11	9	48.2
12	11	51.8
13	13	55.4
14	>= 15	59
15	Error	Error

For Dual switches, 2 bits are allocated with the left bit representing the current state of channel B and the right bit representing the current state of channel A.

For A/D Converters, 8 bits are allocated per channel except in the special case where 4 separate A/D Converters are present on the EZ-LAN Bus. When 4 A/D Converters are present on the EZ-LAN Bus, 8-bits are allocated to the first two A/D converters and 4 bits are allocated to each of the last two A/D converters.

The rules for the allocation of the 24 Reports Bits based on sensor type are summarized as follows:

1. Temperature sensors are the highest priority for allocation, followed by Dual Switches and then by A/D Converters. Remember that the first Dual switch is always allocated to servicing the Door Alarm and Motion Alarm so you need al least two Dual switches, before any of the 24 Report bits are allocated to a Dual switch.

2. If there is there is one A/D Converter, after allocating bits for Temperatures sensors and Dual Switches, as many channels as bits available for that A/D Converter are allocated. For example, if there was only one A/D converter on the EZ-LAN Bus (and no other sensors) then 8 bits would be allocated for the first three channels of the one A/D Converter.

3. If there is more than one A/D Converter and less than 4 A/D Converters, after allocating bits for Temperature sensors and Dual Switches, 8 bits are allocated for the first channel of each A/D Converter.

4. If there are only 4 A/D Converters on the EZ-LAN Bus, 8-bits are allocated for the first channel of the first two A/D Converters and then 4 bits are allocated for each for the first channels of each of the other two A/D Converters.

The effect of these allocation rules on the format of the return link message is demonstrated by the following examples:

Example 1

The EZ-LAN Bus has 6 Temperature sensors (T1-T6) only. The return link message bits are allocated as below:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
9			T1	T1	T1	T1	T2	T2
10	T2	T2	T3	T3	T3	T3	T4	T4
11	T4	T4	T5	T5	T5	T5	T6	T6
12	T6	T6						

Example 2

The EZ-LAN Bus has 1 Temperature Sensor (T1), 3 Dual Switches (D1-D3), and two A/D converters (A1, A2). The return link message bits are allocated as below:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
8						D1	D1	
9			T1	T1	T1	T1	D2	D2
10	D3	D3	A1	A1	A1	A1	A1	A1
11	A1	A1	A2	A2	A2	A2	A2	A2
12	A2	A2						

Example 3

The EZ-LAN Bus has 2 Temperature Sensors (T1, T2) and one A/D Converter (A1-0 is channel 0., A1-1 is channel 1 on the same A/D converter). The return link message bits are allocated as below:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
9			T1	T1	T1	T1	T2	T2
10	T2	T2	A1-0	A1-0	A1-0	A1-0	A1-0	A1-0
11	A1-0	A1-0	A1-1	A1-1	A1-1	A1-1	A1-1	A1-1
12	A1-1	A-1						

Example 4

The EZ-LAN Bus has 4 A/D Converters only (A1-A4). The return link message bits are allocated as below:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
9			A1	A1	A1	A1	A1	A1
10	A1	A1	A2	A2	A2	A2	A2	A2
11	A2	A2	A3	A3	A3	A3	A4	A4
12	A4	A4						

4.6 STEP BY STEP SYSTEM SETUP

A. Connect Main Power and optional backup power, using the color codes identified previously.

B. Attach RX and TX antennas to the SMA connectors as indicated on the housing. For quick reference the TX antenna, connector is located closest to the edge of the housing. IF THE ANTENNAS ARE REVERSED, THE UNIT WILL NOT OPERATE.

C. With the successful completion of the above steps the LED indicator will demonstrate the following behavior:

The green LED on the transceiver indicates the unit's status during start-up and transmission. When the transceiver is in the sleep mode the status LED is turned off to conserve power.

When the transceiver is initially powered up check that the unit gives the following indications in the following order:

1. LED Solid
Transceiver has power but has not locked to either the GPS or service providing satellites

2. LED blinks once per second
Transceiver is locking on to the service providing satellite. Note that the transceiver may lock on to either satellite type depending on which signal the transceiver finds first (i.e Indications 3. May precede 2). The time the transceiver takes to lock onto a satellite is variable – expect 1-10 minutes.

3. LED blinks once every 2 seconds
Transceiver is locking on to GPS satellite.

4. LED goes off
Transceiver has locked onto both satellites

5. LED blinks once per installed sensor.
The transceiver will blink once per installed sensor to a maximum of 6 blinks (TAMS Service). This is a system check of the sensors functionality and occurs prior to transmission (expect 1-2 minutes after the LED has gone off).

6. LED gives 3 fast blinks
The transceiver is about to transmit.

7. LED gives 5 fast blinks
Transmission is successful.

8. LED gives 10 fast blinks
Transmission failed.

This cycle should be completed within 10 minutes when the unit is first powered up. The unit will then transmit according to the service that the unit has been subscribed to. The time required to complete a transmission cycle should be considerably reduced from the initial power up cycle. Variations in cycle time are dependent on the unit's ability to lock to either of the satellites.

D. After transmission has been successfully completed, the internet account should be checked to verify the units operation. Sensor functionality should be checked at this time. A reading of 127º indicates that a sensor is not connected or is not being read. IN THE EVENT THAT A TRANSMISSION DID

NOT OCCCUR, THE LED BLINK SEQUENCE MAY BE USED TO DETERMINE THE LIKELY CAUSE AS INDICATED IN THE FOLLOWING TABLE.

E. Note that during first start up, main power MUST be applied to the transceiver, failing to do so will result in the unit immediately entering low power mode without a obtaining a clock calibration. In this case, the unit will miss the next timetable event during which correct timing will be restored and normal timetable events executed.

5 TROUBLE SHOOTING

The table below describes the status indication.

LED Indicator	Service Satellite	GPS Satellite	Transceiver Function
Solid	Blocked	Blocked	None
Blinks (1s on, 1s off)	Blocked	Available	None
Blinks (2s on, 2s off)	Available	Blocked	None
Off	Available	Available	Ready
1 fast Blink per sensor (Max. 6)	Available	Available	Sensor Check
3 Fast Blinks	Available	Available	About to transmit
5 Fast Blinks	Available	Available	Transmit OK.
10 Fast Blinks	Indeterminate	Indeterminate	Transmit Failed

Appendix A

SPECIFICATIONS

Specifications	Description
Power Source	
	10.0 – 18 VDC (external – battery supplied by end-user)
Power Consumption	
Transmit Mode	2.5 A (<1 second bursts)
Receive Mode	200 mA (Standby mode when not on battery power)
Sleep Mode	1 mA (When on battery power)
Battery Saving Mode	100 uA (When battery voltage drops below 10.5VDC)
Positional Accuracy	
Horizontal	<10 meters RMS (without SA)
Vertical	<25 meters RMS (without SA)
Velocity	0.2 mile/hour RMS (0.2 meter/sec RMS) between 10 and 950 mph constant velocity)
Satellite Lock Times	
Hot Start	30 seconds, typical (Same location, last fix less than 4 hours, no removal of power)
Warm start	1 minute, typical (no removal of power)
Cold start:	2.5 minutes typical (power removed)
Sensors	
Type	EZ-LAN type (sense line and return). Sensor power is external (via connection) 0-6V.
Range & Resolution	Dependant on Sensors selected – see spec sheet
Operating Voltage	EZLAN supply 0-5V: < 0.8V =Logic0 >2.2V=Logic1
Environmental	
Operating	-30°C to +55°C, Water Resistant (Not Waterproof)
Storage	-50°C to +70°C,
Physical	
Dimensions: Transceiver	11.3cm x 10cm x 3cm (4.45" x 4.0" x 1.10")
Dimensions: Antennas	11.2cm Dia x 2.0cm (4.5" Dia. x 3/4")
Weight	Transceiver: 290g, Antenna 170g.
Material	Antenna: RV stabilized PVC, Transceiver; Passivated Aluminum