TOPCON
POSITIONING SYSTEMS

Digital UHF II Radio Module

EXTERNAL DESIGN SPECIFICATION

Part Number 7010-xxxx
Rev. A

December, 2011

Table of Contents

Introduction

Overview

DUHFII is a half duplex, UHF Radio Modem with built-in GSM/GPRS (or CDMA, HSPA) module and Bluetooth transceiver developed to be integrated in a Topcon receiver. It takes incoming data from a Topcon receiver through the standard serial port (CMOS/TTL compatible), modulates it with GMSK, or 4FSK modulations and transmits it at RF power output levels from 10mW/10dBm to 1W/30dBm. With 4FSK modulation, it will deliver error-free data at up to 19.2 kbps over the air for the 25 kHz channel spacing and 9.6 kbps for 12.5 kHz.

The carrier frequency is the UHF commercial band of 400 MHz to 470 MHz. Channel spacing at 25 kHz, 20 kHz and 12.5 kHz are supported. The UHF transceiver is also capable of receiving RF signals through a 50 Ohm impedance external antenna port. These signals are demodulated and output to the Topcon receiver.

The modem requires a regulated DC voltage power supply from +6 to +14V$_{DC}$ with a maximum current draw of 1.1A at 6V$_{DC}$.

The incoming data could be also sent over the cellular network using built-in GSM/GPRS (or CDMA, 3G) module if such operation mode is selected.

The radio settings can be done through the built-in Command Line interface (CLI), or through the configuration and maintenance application software running on the PC – “TRU”.

Note: The cell module option is currently not available. References to the cell module option in this manual are for future configurations that have not been released.

Product Features

Operating Band, Channel Spacing, and Output Power

The following are its key benefits:

1. Single radio system covers the whole UHF frequency band from 400 to 470 MHz;
2. User selectable channel spacing (25kHz, 20kHz or 12.5kHz);
3. User selectable Output power level for base unit (10mW/10dBm and 1W/30dBm);
4. Programmable to limit operation to given frequency range or list of channels, given channel spacing, given output power, RX mode.

Modulation Technique

The design is based on high-level modulation techniques which include:

Modulation Technique	12.5 kHz	25 kHz
GMSK – Minimal Shift Keying with Gaussian Filtering 4.8 kbps 9.6 kbps	4.8 kbps	9.6 kbps
4FSK – Four Level Frequency Shift Keying 9.6 kbps 19.2 kbps	9.6 kbps	19.2 kbps

Physical Interfaces

Serial Data Interface

The serial Data Interface can be configured through the software to operate in half and full duplex operating modes. RTS, CTS, and CD signals should be reserved on-board for future support of full UART hardware handshake operation. This will provide the support of the wide range of different standard and none-standard, user specific, Data Link interfaces.

Link Status Indicators

External LED's are used for Link and Line status indication:

LED Name	Color	Description
TXA	Green	Active if modem transmits Data over radio link (min. light on 200ms)
RXA	Red	Active if modem receives Data over radio link (min. light on 200ms)
BLUETOOTH	Blue	Active if modem receives or transmits Data over Bluetooth interface

Power Interface

The power interface allows connection to an unregulated DC power source. The DC power source (third party or user supplied) must provide peak 7.0 Watts of DC power between 6 and 14VDC. The power interface is protected against reverse polarity connection, as well as protected against high-voltage transients.

RF Interface

The RF interface is a 50-ohm impedance matched standard MMCX connector as required by regulation. Switching from UHF to GSM/GPRS (or CDMA) operation mode and vice versa is provided on RF interface.

Before transmitting, always confirm that the antenna is connected.

Never transmit without the antenna or load connected.

Mismatching of impedance between the DUHF II, antenna, and cable will cause a lesser transmit power and result in a higher VSWR.

Bluetooth Interface

Bluetooth antenna connector of Radial UMP series (R107003010) is used for Bluetooth antenna attachment.

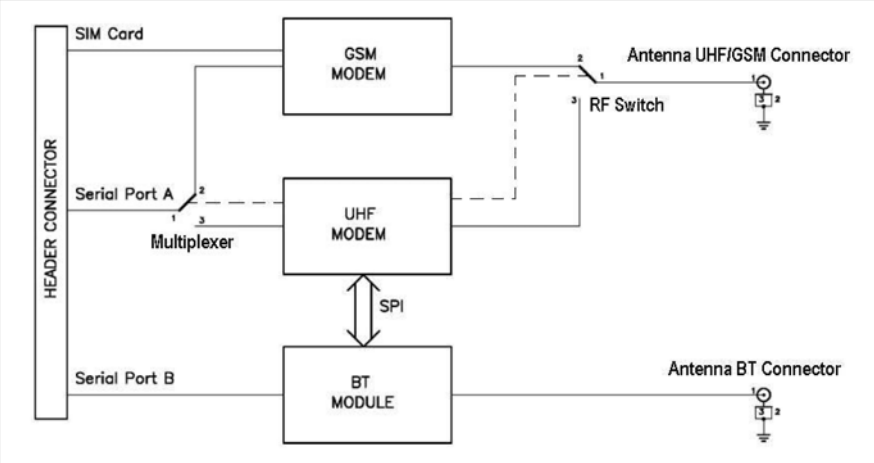
Hardware Architecture

Functional Requirements

The UHF Modem/Cell/BT Board consists of the following main sections:

- UHF modem Tx/Rx modem;
- GSM/GPRS, 3G, or CDMA modules;
- Bluetooth module.

The block diagram of the DUHFII is presented below. In the figure, consider GSM modem as referring to either GSM/GPRS or CDMA modules.



NOTICE

The GSM/GPRS (or CDMA) module installation is optional. The mechanical design and software tools provide easy way for GSM/GPRS module optional installation and configuration.

Electromagnetic Compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

Installation of Digital UHF II module into device shall comply with section 2.1091 of the FCC Rules. If not possible to ensure that the separation between the user and the UHF antenna is greater than 30 cm, the user manual shall contain a statement warning the user to stay away from the UHF antenna by 30 cm at least when the UHF radio is operating in transmit mode.

UHF and Bluetooth antennas shall be shielded from the Digital UHF II module by the construction of the device, so that not to cause harmful interference to the module.

The DUHF II is classified as an intentional radiator of type radio transceiver. Conducted and radiated emissions of the standard DUHF II transceiver do not exceed the requirements of FCC part 90. OEM is responsible for full compliance of final product.

Electromagnetic Compatibility

Shielding Considerations

The DUHF II transceiver is designed to operate in proximity to noise generating circuitry. However, certain radiated or conducted frequencies may degrade the performance of the DUHF II transceiver or render it inoperable. When possible, provide well-grounded shielding between circuits that radiate, such as power supplies, voltage-controlled oscillators, crystal oscillators and the DUHF II transceiver.

Frequency Planning

Radiated and conducted signals to and from the DUHF II transceiver may cause problems due to interference. Proper attention to frequency planning may reduce interference from radiated or conducted frequencies that fall within the pass-bands of the filters at the IF frequencies.

It is recommended the use of upfront analysis of the product frequency plan (including harmonics) and then the use of a spectrum analyzer to determine the potential for interference within the pass-bands of the various front-end and band pass filters.

Frequencies ranging from 403 to 413 MHz may adversely affect GPS L2.

Do not use these frequencies with a Topcon GNSS receiver.

Mechanical Considerations

EMI interferers

The DUHF II transceiver is easily mounted inside new and existing products. The DUHF II transceiver is specifically designed for operation in harsh environments. For best performance, mount the radio away from potential EMI radiators and route RF signals apart from digital signals.

It is not recommend the bundling of the antenna interface cable with other signal cables internal to your product.

Shock and Vibration

Sensitive radio transceivers, such as the DUHF II transceiver, are susceptible to interference due to mechanical shock and vibration. To reduce the potential for electromechanical interference, a robust mounting scheme must be used when being integrated into other systems.

Thermal Transfer

The DUHF II transceiver requires additional thermal heat dissipation in order to supply maximum power out at elevated ambient temperatures and high duty cycles. The DUHF II transceiver has a thermal sensor and a firmware controlled limit switch. The DUHF II will shut down when the PCB temperature reaches 100°C to prevent permanent damage to transmitter. The DUHF II will produce approximately 6 Watts of heat at full RF power out.

Materials

The DUHF II transceiver is housed in a metal shield that is a conductor and is electrically connected to the ground and signal ground pins.

Command Reference

Introduction

This command reference describes in detail all the commands available in version 1.2a9 of the DUHFII firmware running on the Digital UHFII modems from Topcon Positioning Systems Inc. This reference provides a very limited amount of feature descriptions, explanations of the technologies, or configuration examples. For detailed information about the various features and technologies supported by DUHFII modems, see “Introduction” on page 1-1.

Intended Audience

This reference is intended for system engineers, system designers, and programmers who are communicating with the DUHFII modems using the command interface, and are designing or implementing applications that use the DUHFII commands.

Icons

This reference includes icons that appear in the left margin and are designed to help you clearly identify operating mode in which you can apply a particular command. The following icons are used throughout this reference:

Keys	Operating Mode
	Command applies in Factory mode only.
	Command applies in Dealer mode only.
	Command applies in User mode only.

Operating Modes

The DUHFII modem can be operated in ether of the following modes:

- Factory – This mode is intended for the factory floor only. In this mode, factory personnel can calibrate the modem and upload the factory firmware image and bootloader to it. The modem enters Factory mode initially and brings out of this mode after a normal country configuration file is uploaded.
- Dealer – This mode is intended for the dealers. In this mode, a dealer can load a dealer configuration file to the modem. This file contains a customized set of parameters that the dealer have selected to run on the modem. For details about the parameters available in this file, see “Configuration Files” on page 2-3. The modem enters Dealer mode after a country configuration file and brings out of this mode after a normal dealer configuration file is uploaded. Once the modem brings out of Dealer mode, it automatically goes into User mode.
- User – This mode is intended for the end-users. In this mode, a user can apply the parameters available in the dealer configuration file to the modem. For details about the parameters available in the dealer configuration file, see “Configuration Files” on page 2-3. Note that every DUHFII modem shipped to an end-user must be in User mode.

Firmware Images

The DUHFII modem stores two firmware images; a factory and a user image.

- The factory image is the factory-installed firmware that is permanently available on the DUHFII modem.
- The user image is the user-installed firmware that normally controls all modem operations, including its normal boot process. If the modem boot process with the user image fails for any reason, the modem can be booted with the factory image.

Initially, the modem is initialized with factory and user firmware images which are identical.

Configuration Files

The DUHFII modem stores three configuration files, specifically: factory configuration file, dealer configuration file, and country configuration file.

Factory configuration file

This file stores modem calibration parameters and is generated only by the test bench on the factory floor.

Dealer configuration file

The dealer configuration file limits the selection of frequencies, channel spacings and maximum output power for an end user. Note that the allowed frequencies are defined by a list of specified frequencies, not by the range.

```
typedef struct
{
        unsigned int freq;              // Hz
        short reserved;                 // = 0
        char spacing;                   // 0 - 25kHz, 1 - 12.5 kHz, 2 - 20 kHz
        char max_power;                 // dBm
} t_U_Channels;

typedef union
```

```
{
        t_U_Channels chan;
        unsigned int crc32;
} t_User_Channels;

typedef struct
{
        unsigned int DCFG;                  // 0x47464344 = DCFG signature
        unsigned short version;             // = 0
        unsigned short number_of_channels;  // 0-64 variable size structure
        char callsign[32];                  // zero terminated string
        t_User_Channels item[64];
        unsigned int crc32;                 // The CRC32 is a standard CRC with a
                                            // polynomial of 0x04C11DB7, an initial
                                            // value of 0xFFFFFFFF and an inverted
                                            // output. The same algorithm is used in
                                            // ZIP and RAR archives as well as in the
                                            // ITU V.42 standard.
} t_DealerConfig;
```

Country configuration file

The country configuration file limits the range of allowed frequencies depending on the allocation of RF bands in a specific country (region). It allows up to four contingent frequency ranges, each with its own maximum output power and channel spacings.

```
typedef struct
{
        unsigned int start_freq;            // Hz, 0 if unused
        unsigned int stop_freq;             // Hz, 0 if unused
        unsigned int spacing_enable_mask;   // 0x00000001 - 25kHz,
                                            // 0x00000002 - 12.5kHz,
                                            // 0x00000004 - 20kHz
        short reserved1;                    // = 0
        char reserved2;                     // = 0
        char max_power;                     // dBm, 10-30
} t_Freq_Ranges;

typedef struct
{
        unsigned int CCFG;                  // 0x47464344 = CCFG signature
        unsigned short version;             // = 0, incompatible modifications will have
                                            // different number
        unsigned short reserved;            // = 0
        t_Freq_Ranges band[4];              // fixed size, not used ranges should be
                                            // zero
```

```
    unsigned int crc32;                 // The CRC32 is a standard CRC with a
                                        // polynomial of 0x04C11DB7, an initial
                                        // value of 0xFFFFFFFF and an inverted
                                        // output. The same algorithm is used in
                                        // ZIP and RAR archives as well as in the
                                        // ITU V.42 standard.
} t_CountryConfig;
```

Commands

This section lists the commands and subcommands supported by the DUHFII modem.

DATAMODE

Description:	Switches the modem to data mode.
Access:	write-only
Subcommands:	This command has no subcommands.
Usage Guidelines:	If the modem does not receive a command within 60 seconds, it will enter data mode. When the modem generates test signals (TSTSGL 1...TSTSGL 6), the modem will remain in command mode until you disable the test signals with the command TSTSGL 0.
Command Examples:	DATAMODE
History:	This command was introduced in the first release of firmware.

++++

Description:	Switches the modem to command mode.
Access:	write-only
Subcommands:	This command has no subcommands.
Usage Guidelines:	The guard time is 20 ms. You can also enter command mode by asserting a DTR line. To switch back to data mode, you must deassert the DTR line. A 60-seconds timeout is disabled while the DTR line is asserted.

Description:	Switches the modem to command mode.
Access:	write-only
Command Examples:	++++
History:	This command was introduced in the first release of firmware.

LINK

Description:	Reports the current configuration of the RF data link.
Access:	read-only
Subcommands:	MAP, RFSW, MOD, PROT, PWRB, PWRW, SPACE, CHAN, UCHAN, FREQ, SCRAM, FEC
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	LINK LINK SPACE 0
History:	This command was introduced in the first release of firmware.

LINK Subcommands:

MAP

Description:	Reports the channel map from the dealer list.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	LINK MAP
History:	This subcommand was introduced in the first release of firmware.

RFSW

Description:	Specifies the datalink type being used by the modem.
Access:	read & write
Values:	0 – UHF 1 – GSM/GPRS
Usage Guidelines:	This subcommand has no usage guidelines.

Description:	Specifies the datalink type being used by the modem.
Access:	read & write
Values:	0 – UHF 1 – GSM/GPRS
Command Examples:	LINK RFSW LINK RFSW 1
History:	This subcommand was introduced in the first release of firmware.

MOD

Description:	Specifies the modulation type being used by the modem.
Access:	read & write
Values:	5 – GMSK 6 – 4LFSK
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	LINK MOD LINK MOD 6
History:	This subcommand was introduced in the first release of firmware.

PROT

Description:	Specifies the radio protocol and whether the modem is configured to transmit or receive data.
Access:	read & write
Values:	7 – Trimble RX 8 – Trimble TX 11 – Trimble Repeater 12 – PDL RX 13 – PDL TX 14 – PDL RTR 15 – Satel RX 16 – Satel TX 17 – Satel Repeater 18 – Satel FCS On RX 19 – Satel FCS On TX 20 – Satel FCS On Repeater
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	LINK PROT LINK PROT 16
History:	This subcommand was introduced in the first release of firmware.

LINK Subcommands (Continued):

PWRB

Description:	Specifies the output power in dBm.
Access:	read & write
Values:	[10...30]
Usage Guidelines:	The restrictions from the country and/or dealer configuration files may apply. Although you may specify any output power within its range of allowed values, only the following values are factory-calibrated and thus recommended for use:10, 13, 17, 20, 23, 27, 30.
Command Examples:	LINK PWRB LINK PWRB 20
History:	This subcommand was introduced in the first release of firmware.

PWRW

Description:	Specifies the output power in mW.
Access:	read & write
Values:	[10...1000]
Usage Guidelines:	Reading will return a value rounded to the nearest integer value in mW. The restrictions from the country and/or dealer configuration files may apply. Although you may specify any output power within its range of allowed values, only the following values are factory-calibrated and thus recommended for use: 10, 20, 50, 100, 200, 500, 1000.
Command Examples:	LINK PWRW LINK PWRW 500
History:	This subcommand was introduced in the first release of firmware.

LINK Subcommands (Continued):

SPACE

Description:	Specifies the channel spacing in kHz.
Access:	read & write
Values:	0 – 25 kHz 1 – 12.5 kHz 2 – 20 kHz
Usage Guidelines:	The restrictions from the country and/or dealer configuration files may apply.
Command Examples:	LINK SPACE LINK SPACE 1
History:	This subcommand was introduced in the first release of firmware.

CHAN

Description:	Specifies the frequency channel.
Access:	read & write
Values:	[1...9601]
Usage Guidelines:	For 25 and 12.5 kHz spacings, the following formula is used to relate the frequency and its frequency channel: FRQ=410000000+(n-1)*6250, where n is the frequency channel. For 20 kHz spacing, the following formula is used to relate the frequency and its frequency channel: FRQ=410000000+(n-10001)*5000, where n is the frequency channel. The restrictions from the country and/or dealer configuration files may apply.
Command Examples:	LINK CHAN LINK CHAN 1
History:	This subcommand was introduced in the first release of firmware.

UCHAN

Description:	Selects channel settings from the dealer list.
Access:	read & write
Values:	[0...63]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	LINK UCHAN LINK UCHAN 12
History:	This subcommand was introduced in the first release of firmware.

LINK Subcommands (Continued):

FREQ

Description:	Specifies the channel frequency.
Access:	read & write
Values:	[390000000...480000000]
Usage Guidelines:	The frequency will be rounded to the nearest available channel depending on channel spacing. An actual frequency range will be defined by Country Configuration. The restrictions from the country and/or dealer configuration files may apply.
Command Examples:	LINK FREQ LINK FREQ 420000000
History:	This subcommand was introduced in the first release of firmware.

SCRAM

Description:	Configures scrambling.
Access:	read & write
Values:	[0...255] 0 – disabled [1...255] – scrambling enabled
Usage Guidelines:	Scrambling is always enabled for TrimTalk. Scrambling is always disabled for Satel.
Command Examples:	LINK SCRAM LINK SCRAM 1
History:	This subcommand was introduced in the first release of firmware.

FEC

Description:	Configures forward error correction.
Access:	read & write
Values:	0 – disabled 1 – enabled
Usage Guidelines:	FEC is supported for PDL and Satel. FEC is always disabled for TrimTalk.
Command Examples:	LINK FEC LINK FEC 1
History:	This subcommand was introduced in the first release of firmware.

LINK Subcommands (Continued):

ATI

Description:	Displays the firmware and hardware details.
Access:	read-only
Subcommands:	ID, SN, HW, SW, BL
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	ATI
History:	This command was introduced in the first release of firmware.

ATI Subcommands:

ID

Description:	Displays the product ID.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ATI ID
History:	This subcommand was introduced in the first release of firmware.

SN

Description:	Displays the serial number.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ATI SN
History:	This subcommand was introduced in the first release of firmware.

ATI Subcommands (Continued):

HW

Description:	Displays the hardware revision.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ATI HW
History:	This subcommand was introduced in the first release of firmware.

SW

Description:	Displays the software revision.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ATI SW
History:	This subcommand was introduced in the first release of firmware.

BL

Description:	Displays the bootloader version.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ATI BL
History:	This subcommand was introduced in the first release of firmware.

ATI Subcommands (Continued):

STATE

Description:	Displays the current state.
Access:	read-only
Subcommands:	RSSI, BER, FREQ, CHAN, UCHAN, TEMP, MODE, BAND, PWRB
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	STATE
History:	This command was introduced in the first release of firmware.

STATE Subcommands:

RSSI

Description:	Displays the RSSI level.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	STATE RSSI
History:	This subcommand was introduced in the first release of firmware.

BER

Description:	Displays the bit error rate.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	STATE BER
History:	This subcommand was introduced in the first release of firmware.

STATE Subcommands (Continued):

FREQ

Description:	Displays the frequency.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	STATE FREQ
History:	This subcommand was introduced in the first release of firmware.

CHAN

Description:	Displays the channel number.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	STATE CHAN
History:	This subcommand was introduced in the first release of firmware.

UCHAN

Description:	Displays the user-selected channel number.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	STATE UCHAN
History:	This subcommand was introduced in the first release of firmware.

STATE Subcommands (Continued):

TEMP

Description:	Displays the modem temperature.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	STATE TEMP
History:	This subcommand was introduced in the first release of firmware.

MODE

Description:	Displays the current operating mode.
Access:	read-only
Values:	1 – Factory mode 2 – Dealer mode 3 – User mode
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	STATE MODE
History:	This subcommand was introduced in the first release of firmware.

BAND

Description:	Displays the current frequency and spacing limits.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	STATE BAND
History:	This subcommand was introduced in the first release of firmware.

STATE Subcommands (Continued):

PWRB

Description:	Displays the output power.
Access:	read-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	STATE PWRB
History:	This subcommand was introduced in the first release of firmware.

@ECHO

Description:	Configures echo for command mode.
Access:	read & write
Values:	ON – Echo on OFF – Echo off
Subcommands:	This command has no subcommands.
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	@ECHO ON
History:	This command was introduced in the first release of firmware.

DPORT

Description:	Displays parameters for the serial port in Data mode.
Access:	read-only
Subcommands:	RATE, BITS, PARITY, FLOW, STOP
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	DPORT
History:	This command was introduced in the first release of firmware.

DPORT Subcommands:

RATE

Description:	Configures the baud rate.
Access:	read & write
Values:	0 – equals MPORT RATE 1 – 1200 2 – 2400 3 – 4800 4 – 9600 5 – 14400 6 – 19200 7 – 38400 8 – 57600 9 – 115200
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	DPORT RATE 7
History:	This subcommand was introduced in the first release of firmware.

BITS

Description:	Configures the number of data bits.
Access:	read & write
Values:	7, 8
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	DPORT BITS 7
History:	This subcommand was introduced in the first release of firmware.

DPORT Subcommands (Continued):

PARITY

Description:	Configures the parity.
Access:	read & write
Values:	0 – none 1 – odd 2 – even
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	DPORT PARITY 1
History:	This subcommand was introduced in the first release of firmware.

FLOW

Description:	Configures the handshaking.
Access:	read & write
Values:	0 – none 1 – unused 2 – RTS/CTS
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	DPORT FLOW 2
History:	This subcommand was introduced in the first release of firmware.

STOP

Description:	Configures the number of stop bits.
Access:	read & write
Values:	1 – 1 stop bit 2 – 2 stop bits
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	DPORT STOP 1
History:	This subcommand was introduced in the first release of firmware.

DPORT Subcommands (Continued):

MPORT

Description:	Displays parameters for the serial port in Maintenance (command) mode.
Access:	read-only
Subcommands:	RATE, BITS, PARITY, FLOW, STOP
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	DPORT
History:	This command was introduced in the first release of firmware.

MPORT Subcommands:

RATE

Description:	Configures the baud rate.
Access:	read & write
Values:	0 – equals MPORT RATE 1 – 1200 2 – 2400 3 – 4800 4 – 9600 5 – 14400 6 – 19200 7 – 38400 8 – 57600 9 – 115200
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	MPORT RATE 7
History:	This subcommand was introduced in the first release of firmware.

MPORT Subcommands (Continued):

BITS

Description:	Configures the number of data bits.
Access:	read & write
Values:	7, 8
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	MPORT BITS 7
History:	This subcommand was introduced in the first release of firmware.

PARITY

Description:	Configures the parity.
Access:	read & write
Values:	0 – none 1 – odd 2 – even
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	MPORT PARITY 1
History:	This subcommand was introduced in the first release of firmware.

FLOW

Description:	Configures the handshaking.
Access:	read & write
Values:	0 – none 1 – unused 2 – RTS/CTS
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	MPORT FLOW 2
History:	This subcommand was introduced in the first release of firmware.

MPORT Subcommands (Continued):

STOP

Description:	Configures the number of stop bits.
Access:	read & write
Values:	1 – 1 stop bit 2 – 2 stop bits
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	MPORT STOP 1
History:	This subcommand was introduced in the first release of firmware.

SAVE

Description:	Stores the current settings to Flash memory.
Access:	write-only
Subcommands:	This command has no subcommands.
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	SAVE
History:	This command was introduced in the first release of firmware.

RESTORE

Description:	Restores the default settings.
Access:	write-only
Subcommands:	This command has no subcommands.
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	RESTORE
History:	This command was introduced in the first release of firmware.

PROTIME

Description:	Configures the protocol timeout.
Access:	read & write
Values:	[10...255]
Subcommands:	This command has no subcommands.
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	PROTIME 15
History:	This command was introduced in the first release of firmware.

TCXO

Description:	Adjusts oscillator offset.
Access:	read & write
Values:	[0...32]
Subcommands:	This command has no subcommands.
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	TCXO 20
History:	This command was introduced in the first release of firmware.

ALC

Description:	Configures transmitter gains.
Access:	read-only
Subcommands:	A, B, D, X, Y
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	ALC
History:	This command was introduced in the first release of firmware.

ALC Subcommands:

A

Description:	Configures the pre-amplifier gain.
Access:	read & write
Values:	[0...31]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ALC A ALC A 12
History:	This subcommand was introduced in the first release of firmware.

B

Description:	Configures the amplifier gain.
Access:	read & write
Values:	[0...32]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ALC B ALC B 10
History:	This subcommand was introduced in the first release of firmware.

D

Description:	Configures the DAC gain.
Access:	read & write
Values:	[0...32767]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ALC D ALC D 15343
History:	This subcommand was introduced in the first release of firmware.

ALC Subcommands (Continued):

X

Description:	Configures the TX modulator offset.
Access:	read & write
Values:	[-4096...4095]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ALC X ALC X -4090
History:	This subcommand was introduced in the first release of firmware.

Y

Description:	Configures the TX modulator offset.
Access:	read & write
Values:	[-4096...4095]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ALC Y ALC Y 4090
History:	This subcommand was introduced in the first release of firmware.

CSAVE

Description:	Stores the current ALC values to the calibration table.
Access:	write-only
Subcommands:	This command has no subcommands.
Usage Guidelines:	Used for manual calibration.
Command Examples:	CSAVE
History:	This command was introduced in the first release of firmware.

TSTSGL

Description:	Configures test signals.
Access:	write-only
Values:	[0...6]
Subcommands:	This command has no subcommands.
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	TSTSGL 3
History:	This command was introduced in the first release of firmware.

FCS

Description:	Configures the protocol timeout.
Access:	read-only
Subcommands:	CHANCLR, NETID, RXLT, BI, BDT, CHANON, CHANOFF, RSSI
Usage Guidelines:	This command applies to Satel protocol only.
Command Examples:	FCS
History:	This command was introduced in the first release of firmware.

FCS Subcommands:

CHANCLR

Description:	Clears the channel list.
Access:	write-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	FCS CHANCLR
History:	This subcommand was introduced in the first release of firmware.

FCS Subcommands (Continued):

NETID

Description:	Configures network ID.
Access:	read & write
Values:	[0x0000...0xFFFF]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	FCS NETID 0x0000
History:	This subcommand was introduced in the first release of firmware.

RXLT

Description:	Configures the RX listen timeout.
Access:	read & write
Values:	[0...65535]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	FCS RXLT 30
History:	This subcommand was introduced in the first release of firmware.

BI

Description:	Configures the beacon interval.
Access:	read & write
Values:	[0...65535]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	FCS BI 50
History:	This subcommand was introduced in the first release of firmware.

FCS Subcommands (Continued):

BDT

Description:	Configures the beacon disable timeout.
Access:	read & write
Values:	[0...65535]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	FCS BDT 60
History:	This subcommand was introduced in the first release of firmware.

CHANON

Description:	Enables FCS for the selected channel.
Access:	write-only
Values:	[0...47]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	FCS CHANON 9
History:	This subcommand was introduced in the first release of firmware.

CHANOFF

Description:	Disables FCS for the selected channel.
Access:	write-only
Values:	[0...47]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	FCS CHANOFF 9
History:	This subcommand was introduced in the first release of firmware.

FCS Subcommands (Continued):

RSSI

Description:	Configures the RSSI threshold.
Access:	read & write
Values:	[80...118]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	FCS RSSI 95
History:	This subcommand was introduced in the first release of firmware.

ADDR

Description:	Displays Satel protocol routing.
Access:	read-only
Subcommands:	TXEN, RXEN, TXAUTO, RX2RS, TXP, RXP, TXS, RXS
Usage Guidelines:	This command applies to Satel protocol only.
Command Examples:	ADDR
History:	This command was introduced in the first release of firmware.

ADDR Subcommands:

TXEN

Description:	Configures address transmission.
Access:	write-only
Values:	1, 0
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ADDR TXEN 1
History:	This subcommand was introduced in the first release of firmware.

ADDR Subcommands (Continued):

RXEN

Description:	Configures address receiving.
Access:	write-only
Values:	1, 0
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ADDR RXEN 1
History:	This subcommand was introduced in the first release of firmware.

TXAUTO

Description:	Configures transmission address auto switch.
Access:	write-only
Values:	1, 0
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ADDR TXAUTO 1
History:	This subcommand was introduced in the first release of firmware.

RX2RS

Description:	Configures received address to RS port.
Access:	write-only
Values:	1, 0
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ADDR RX2RS 1
History:	This subcommand was introduced in the first release of firmware.

ADDR Subcommands (Continued):

TXP

Description:	Configures the transmission primary address.
Access:	read & write
Values:	[0x0000...0xFFFF]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ADDR TXP 0x0000
History:	This subcommand was introduced in the first release of firmware.

RXP

Description:	Configures the receiving primary address.
Access:	read & write
Values:	[0x0000...0xFFFF]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ADDR RXP 0x0000
History:	This subcommand was introduced in the first release of firmware.

TXS

Description:	Configures the transmission secondary address.
Access:	read & write
Values:	[0x0000...0xFFFF]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ADDR TXS 0x0001
History:	This subcommand was introduced in the first release of firmware.

ADDR Subcommands (Continued):

RXS

Description:	Configures the receiving secondary address.
Access:	read & write
Values:	[0x0000...0xFFFF]
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	ADDR RXS 0x0002
History:	This subcommand was introduced in the first release of firmware.

TXDELAY

Description:	Configures transmit delay.
Access:	read & write
Values:	[0...65535]
Subcommands:	This command has no subcommands.
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	TXDELAY 20
History:	This command was introduced in the first release of firmware.

HELP

Description:	Displays commands and their description.
Access:	read-only
Subcommands:	This command has no subcommands.
Usage Guidelines:	This command has no usage guidelines.
Command Examples:	HELP
History:	This command was introduced in the first release of firmware.

XMOD

Description:	Uploads firmware and configuration files to the modem using the X-Modem protocol.
Access:	read-only
Subcommands:	IMAGE, FACTIMAGE, LOADER, DDFG, DCCFG, DFCFG
Usage Guidelines:	To start uploading, you need to supply this command with the corresponding subcommand.
Command Examples:	XMOD
History:	This command was introduced in the first release of firmware.

XMOD Subcommands:

IMAGE

Description:	Uploads user firmware.
Access:	write-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	XMOD IMAGE
History:	This subcommand was introduced in the first release of firmware.

FACTIMAGE

Description:	Uploads factory firmware.
Access:	write-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	XMOD FACTIMAGE
History:	This subcommand was introduced in the first release of firmware.

XMOD Subcommands (Continued):

DDCFG

Description:	Uploads dealer configuration in TPS format.
Access:	write-only
Usage Guidelines:	Successful loading will switch the modem from dealer to user mode.
Command Examples:	XMOD DDCFG
History:	This subcommand was introduced in the first release of firmware.

DCCFG

Description:	Uploads country configuration.
Access:	write-only
Usage Guidelines:	Successful loading will switch the modem from factory to dealer mode.
Command Examples:	XMOD DCCFG
History:	This subcommand was introduced in the first release of firmware.

DFCFG

Description:	Uploads factory calibration settings.
Access:	write-only
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	XMOD DFCFG
History:	This subcommand was introduced in the first release of firmware.

BOOT

Description:	Reboots the modem.
Access:	write-only
Subcommands:	IMAGE, CFG
Usage Guidelines:	This command has no usage guidelines.

Description:	Reboots the modem.
Access:	write-only
Command Examples:	BOOT
History:	This command was introduced in the first release of firmware.

BOOT Subcommands:

IMAGE

Description:	Reboots the modem and selects a copy of firmware.
Access:	write-only
Values:	0 – Factory firmware 1 – User firmware
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	BOOT IMAGE 1
History:	This subcommand was introduced in the first release of firmware.

CFG

Description:	Reboots the modem and selects a configuration.
Access:	write-only
Values:	0 – Factory configuration 1 – User configuration
Usage Guidelines:	This subcommand has no usage guidelines.
Command Examples:	BOOT CFG 1
History:	This subcommand was introduced in the first release of firmware.

Specifications

Board Specifications

General	
Radio interfaces	UHF 400 – 470 MHz Bluetooth (optional) GSM/GPRS 850/900/1800/1900 (optional) CDMA 1xRTT 800/1900 (optional) HSPA 850/900/1700/1900/2100 (optional)
Simultaneous operation	Bluetooth / UHF - yes Bluetooth / GSM (CDMA, HSPA) – yes UHF / GSM (CDMA, HSPA) - no
Bluetooth	TAYUO YUDEN EYSF3CAVX 2.0+EDR
GSM/GPRS	Motorola G24
CDMA	Motorola C24
HSPA	Motorola H24

Compliance	FCC 47CFR PT 15.247 FCC 47CFR PT 90 IC RSS 119 ETSI EN 300-113-2 V1.6.1 (in enclosure only) EN 300 328 (in enclosure only) ETSI EN 301 489-1 V1.9.2 ETSI EN 301 489-5 V1.3.1 ETSI EN 301 489-17 V2.1.1
Interface	
Antenna connector UHF/GSM/ CDMA/HSPA	MMCX, Molex 73415-1001 or similar
Antenna connector Bluetooth	RADIALL R107 003 010
Interface	RS-232
Data Speed of Interface	300 to 115200 bps
Interface Connector	2x26 (pinout see below)
Operating Voltage	6-14 Vdc
UHF Transceiver	
Operating Frequency Range	400 – 470 MHz
Modulation Technique	GMSK, 4FSK
Protocol	Satel (without FCS)
Configuration	Programmable to limit operation to given frequency range or list of channels, given channel spacing, given output power, RX mode
Max. Distance Range	15 miles/24 km
Occupied Bandwidth (Channel Spacing)	25 kHz, 20 kHz or 12.5 kHz (user selectable)
Data Rate (@25 kHz Channel Spacing)	9600 bps –GMSK 19200 bps –4FSK
Data Rate (@20 kHz Channel Spacing)	4800 bps –GMSK 9600 bps –4FSK
Data Rate (@12.5 kHz Channel Spacing)	4800 bps –GMSK 9600 bps –4FSK
System Gain (Antenna gain is not included): GMSK 4FSK	 149 dB (for 25 kHz Channel Spacing) 152 dB (for 12.5 kHz Channel Spacing) 147 dB (for 25 kHz Channel Spacing) 150 dB (for 12.5 kHz Channel Spacing
Roaming Speed	60 mph/96 km/h
End to End delay	60 ms
Power Consumption at	6 V 8.4 V 12 V
Max power consumption in RX mode, W	1.8 1.9 2.3

Max power consumption in TX mode with 1W output, W	6.5	6.5	7.0
Max current in RX mode, A	0.3	0.23	0.17
Max current in TX mode, A	1.1	0.78	0.5
Compliance	FCC Part 90 IC RSS 119 ETSI EN 300-113-2 V1.6.1 ETSI EN 301 489-1 V1.9.2 ETSI EN 301 489-5 V1.3.1 ETSI EN 301 489-17 V2.1.1		
UHF Transmitter			
Output Power	10, 13, 17, 20, 27, 30 dBm (user selectable)		
Output Power Control Accuracy	±1.5 dB (at normal test conditions) +2.0 dB and -3.0 dB (under extreme test conditions)		
Nominal Output Impedance	50 Ohm VSWR 2.0:1		
Carrier Frequency Stability	±1.5 ppm initial stability over temp with ±3 ppm aging/year		
Max. Frequency Error	±1.5 kHz (at normal test conditions) ±2.5 kHz (under extreme test conditions)		
Adjacent Channel Power	Below -37 dBm		
Spurious Emission (Conducted and Radiated) frequency range 9 kHz – 1 GHz frequency range 1 GHz – 12.75 GHz	 Below -36 dBm Below -30 dBm		
Type of Emission	F1D FCC Part 90 §90.210(c) for 25 kHz Channel Spacing §90.210(d) for 12.5 kHz Channel Spacing ETSI EN 300-113-1 V1.5.1 Clause 5.1.4 Clause 8.6.1		
UHF Receiver			
Nominal Input Impedance	50 Ohm		
Receiver Sensitivity for GMSK (@ BER <1x 10^{-4}, over temperature -30°C to +60°C)	-119 dBm for 25 kHz Channel Spacing -122 dBm for 12.5 kHz Channel Spacing		
Receiver Sensitivity for 4FSK (@ BER <1x 10^{-4}, over temperature -30°C to +60°C)	-117 dBm for 25 kHz Channel Spacing -118 dBm for 20 kHz Channel Spacing -120 dBm for 12.5 kHz Channel Spacing		
Dynamic Range	-119 to -1 dBm for GMSK -117 to -1 dBm for 4FSK		
Max. Input Signal Level	-1 dBm		

Spurious Emission (Conducted and Radiated) frequency range 9 kHz – 1 GHz frequency range 1 GHz – 12.75 GHz	 Below -57 dBm Below -47 dBm
Environmental	
Temperature: FCC/ETSI compliant operation range	-25 to +55 ºC
Temperature: operation range	-30 to +60 ºC
Temperature: storage	-40 to +85 ºC

Interface Connector

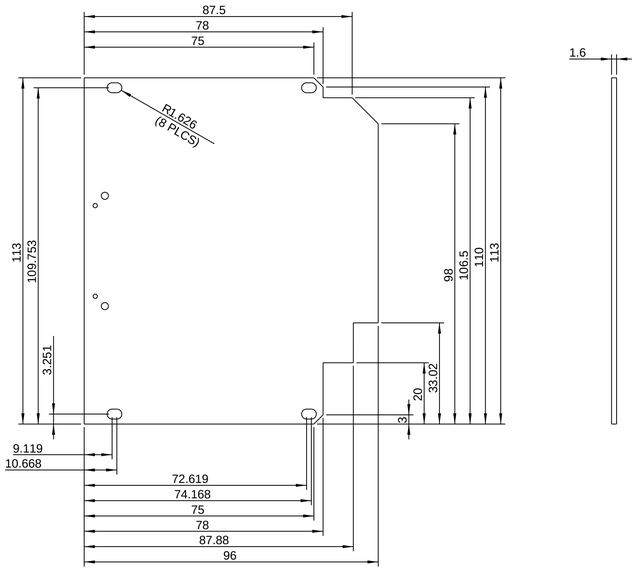
The main interface connector is a 56-pin header connector of FX5 series, HIROSE FX5-52P-SH (71).

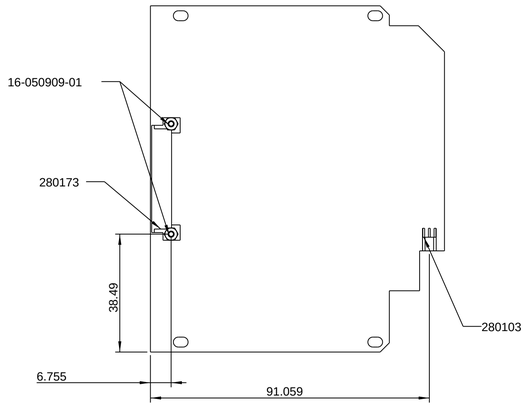
Pin	Name	In/Out	Level	Description
A1	GND	-	GND	
A2	GND	-	GND	
A3	POWER_IN	In	+6...14 Vdc	Power Supply
A4	POWER_IN	In	+6...14 Vdc	Power Supply
A5	SPI_CSB	In	TTL	SPI Chip Select (Active Low, Not Connected)
A6	SPI_MISO	Out	TTL	Data from Bluetooth to Host (Not Connected)
A7	SPI_CLK	In	TTL	CLOCK from Host to Bluetooth (Not Connected)
A8	RED	Out	HighZ/+3.3Vdc	RXA LED Anode
A9	GRN	Out	HighZ/+3.3Vdc	TXA LED Anode
A11	RTSA	Out	TTL	Asserted by Radio Modem Clear To Send (CTS) data flow control signal wired to RTS input on Topcon Receiver (Serial Port A): • 0VDC = Modem's Transmit buffer not full, continue data transferring • 3.3VDC = Modem's Transmit buffer full, stop data transferring
A12	CTSA	In	TTL	Asserted by Topcon Receiver data flow control signal to Request To Send (RTS) data over Serial Port A: • 0VDC = Receive Data from Modem is enabled • 3.3VDC = Receive Data from Modem is disabled

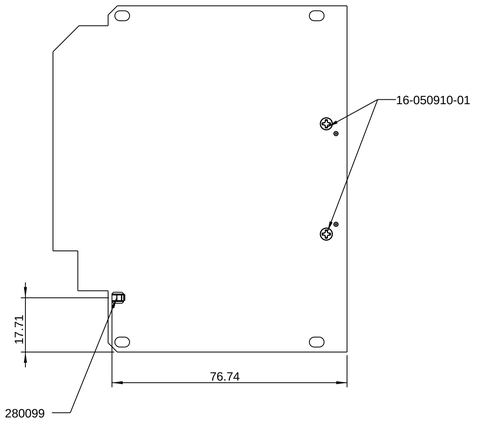
Pin	Name	In/Out	Level	Description
A13	RTSB	Out	TTL	Asserted by Bluetooth transceiver Clear To Send (CTS) data flow control signal wired to RTS input on Topcon Receiver (Serial Port B): • 0VDC = Bluetooth Transmit buffer not full, continue transmitting • 3.3VDC = Bluetooth Transmit buffer full, stop data transferring
A14	CTSB	In	TTL	Asserted by Topcon Receiver data flow control signal to Request To Send (RTS) data over Serial Port B: • 0VDC = Receive Data from Bluetooth is enabled • 3.3VDC = Receive Data from Bluetooth is disabled
A15	GND	-	GND	
A18	SIMRST	Out	Logic	SIM Reset active LOW
A19	SIMCLK	Out	Logic	SIM Clock
A20	SIMPRES	In	Logic	SIM Presence active LOW
A22	PWR_ON	In	0...+3.3 Vdc	Radio modem ON/OFF control • 0VDC = OFF • 3.3VDC = ON
A23	POWER_IN	In	+6...14 Vdc	Power Supply
A24	POWER_IN	In	+6...14 Vdc	Power Supply
A25	GND	-	GND	
A26	GND	-	GND	
B1	GND	-	GND	
B2	GND	-	GND	
B3	POWER_IN	In	+6...14 Vdc	Power Supply
B4	POWER_IN	In	+6...14 Vdc	Power Supply
B5	SPI_MOSI	In	TTL	Data from Host to Bluetooth (Not Connected)
B6	RESET_BT	In	TTL	Reset of Bluetooth module (Active High, Not Connected)
B8	BLUE	Out	HighZ/+3.3Vdc	Bluetooth LED Anode
B9	GND	-	GND	
B11	TXA	Out	TTL	Data TO Topcon Receiver FROM radio modem
B12	RXA	In	TTL	Data FROM Topcon Receiver TO radio modem
B13	TXB	Out	TTL	Data TO Topcon Receiver FROM Bluetooth
B14	RXB	In	TTL	Data FROM Topcon Receiver TO Bluetooth
B15	GND	-	GND	
B16	PROG	In	0...+3.3 Vdc	Must be normally UNCONNECTED or higher than +3.0VDC. Connect to ground to update the program flash.
B18	SIMDATA	In/Out	Logic	SIM serial data

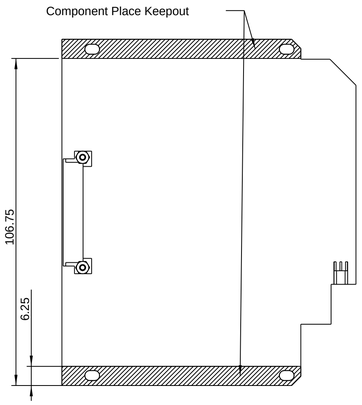
Pin	Name	In/Out	Level	Description
B19	SIMVCC	Out	+2.85...+3.1 Vdc	SIM VCC
B20	GND	-	GND	
B21	3V3	Out	+3.3 Vdc	Power Supply +3.3 Vdc, 20 mA
B23	POWER_IN	In	+6...14 Vdc	Power Supply
B24	POWER_IN	In	+6...14 Vdc	Power Supply
B25	GND	-	GND	
B26	GND	-	GND	

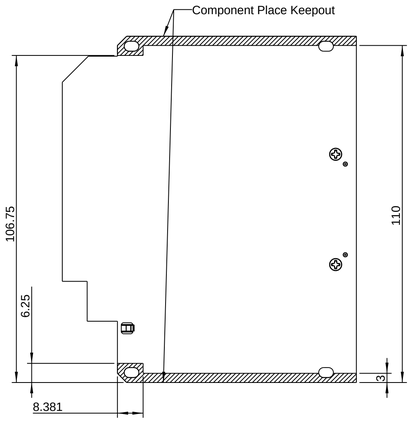
Revisions				
Zone	Rev	Description	Date	Approved

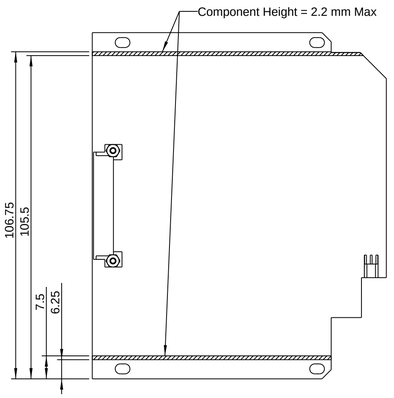


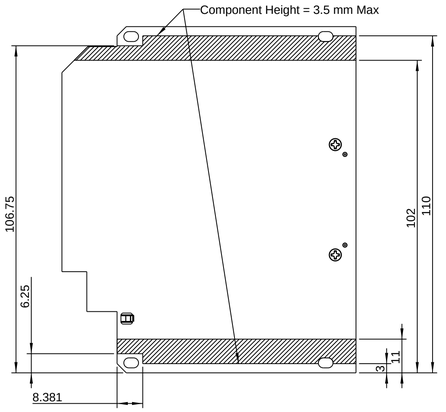


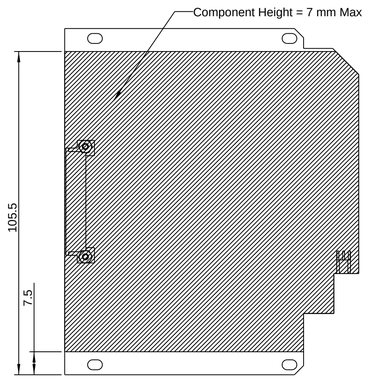


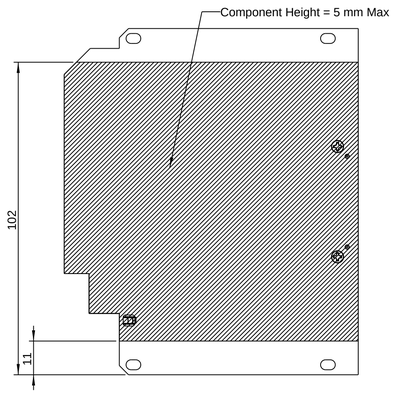












DIMENSIONS ARE IN MILLIMETERS FIRST ANGLE PROJECTION	CONTRACT NO	TOPCON POSITIONING SYSTEMS
	INDL DSGNR	
TOLERANCES DECIMALS ANGLES	ENGR	DUHFII Modem Layout
	DRAWN TOPCON	SIZE A1 / FSCM NO. / DWG NO. / REV 1
	CHECKED	
	DO NOT SCALE DRAWING	SCALE 1:1 / SHEET 1 of 1