Product Guide: PRDSTU251C

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1 Quick Start Guide

This product is an RFID Reader using low frequency transmission techniques. Please follow the important notes below for proper installation and operation.

WARNING: High voltage on the antenna terminals can be harmful to your health! All active antenna parts must be adequately insulated.

1.1 ESD

This product is sensitive to and could be subject to electrostatic discharge (ESD). Handle all components that are connected to the reader in a static-safeguarded work area. Use grounding wrist straps for installation. For non-powered handling and repair, the product must be on a conductive mat. For powered handling and repair, a dissipative mat is highly recommended.

1.2 Operation

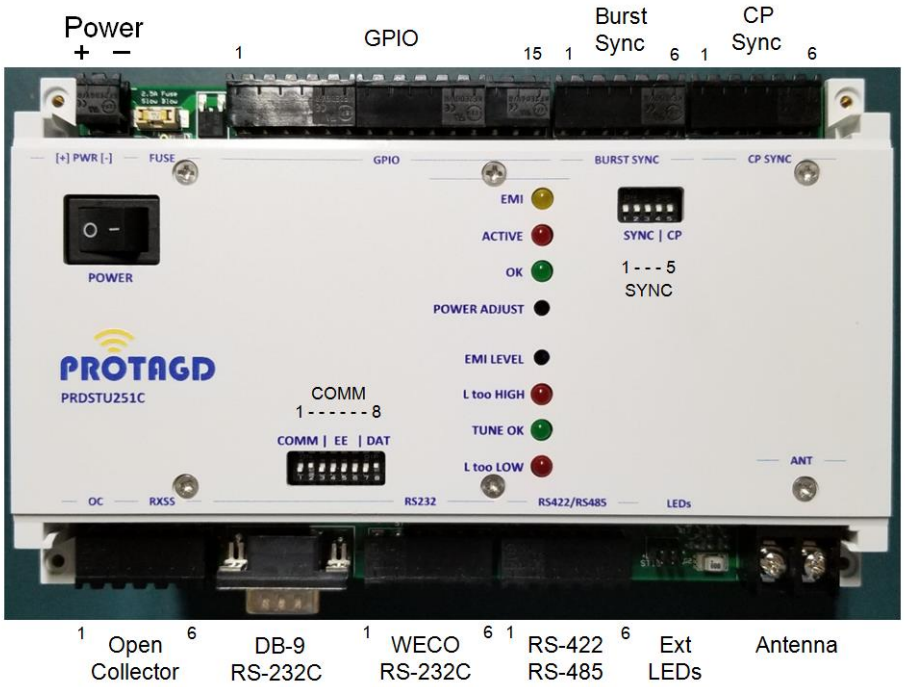
Exceeding the recommended operating conditions, especially supply voltage, supply current and antenna resonance voltage may cause permanent damage to the reader.

Connecting and disconnecting external devices (antenna, I/O ports, etc.) must be done with the supply voltage switched off!

For best performance the antenna and its leads should not cross the PCB area.

1.3 Getting started

1.3.1 Connectors



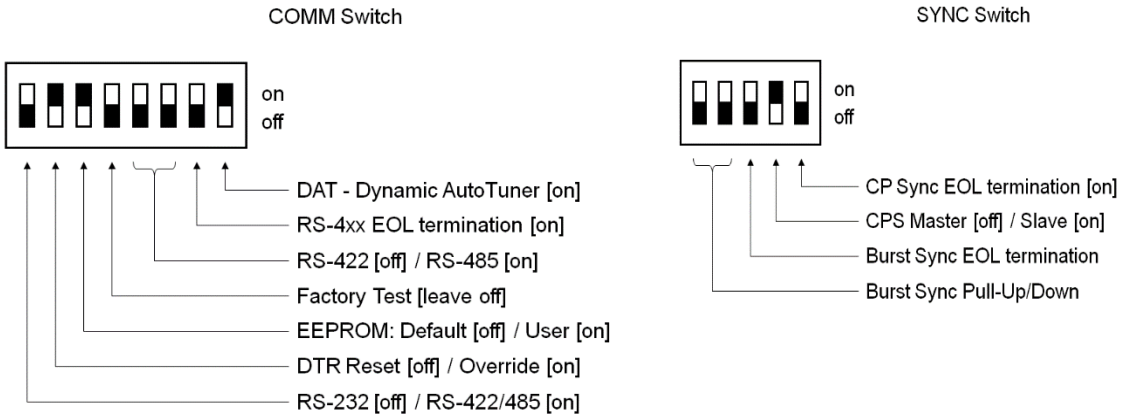
To gain access to the fuse and antenna connector please remove the upper and lower plastic cover strips by removing the four screws holding the front panel. The fuse is 2.5A slow blow, Little Fuse part # 045202.5MRL.

Connect a regulated DC power supply between 10 and 24V @ 2A minimum to the Power connector. Be sure to note the polarity. The STU251 contains an efficient DC-DC buck-boost converter which always outputs 12VDC to the Radio Frequency Module (RFM). To minimize heating, the optimum input voltage is 18V. If a switching power converter is used to supply the STU251 be sure its switching frequency is at least 400KHz; otherwise, it is likely to cause interference with the receiver.

Operating Range: -20C to +70C

1.3.2 Switches

The default switch settings are as follows: COMM 1-8: DTR override, RS-232 9600/8N1, Dynamic Auto Tuner ON. The SYNC switches 1-5 are set to NO sync, CP sync OFF. Factory EEPROM, ASCII Protocol, Normal Mode, Wireless synchronization. GPIOs are bits 0-3 inputs, 4-7 outputs and all logic high.



The antenna should be between 25µH and 30µH with a Q between 40 and 350 (Maximum antenna voltage, 380Vpeak)

Exceeding any of the recommended operating conditions (especially supply voltage, operating temperature and antenna resonance voltage; may cause permanent damage to the PRDSTU251.

The Reader itself generates heat; therefore, if incorporated into a housing the user must ensure (by proper design or cooling) that the temperature directly surrounding the reader does not exceed the operating temperature range specified above. Always ensure the reader is switched off when making or breaking connections to it. Care must be taken when handling the reader: high voltage across the antenna terminals could be harmful to your health. If the antenna insulation is damaged, the antenna should not be connected to the reader.

1.3.3 FCC/CCITT Regulation

An RFID system comprises an RF transmission device and is, therefore, subject to national and international regulations. Please obtain the necessary licenses for your RFID system as required by your country’s regulation.

2 Abbreviations

BCC	Block Check Character
COM	Communication (port)
CRC	Cyclic Redundancy Check
DC	Direct Current
EEPROM	Electrically Erasable Programmable Read-Only Memory
FW	Firmware
FSK	Frequency Shift Keying
HDX	Half Duplex
I/O	Input/Output
LED	Light Emitting Diode
LF	Low Frequency
N/A	Not Applicable
OOK	On-Off Keyed
PC	Personal Computer
PCB	Printed Circuit Board
PWE	Pulse Width Encoding
PWM	Pulse Width Modulator
Q	Quality Factor
RFID	Radio Frequency Identification
RFM	Radio Frequency Module
RFU	Reserved for Future Use
RO	Read Only
RS-232	Computer Serial Interface
RS-422/485	Computer Serial Interface
RW	ReadWrite
TI	Texas Instruments
UID	Unique Identification Number
USB	Universal Serial Bus

3 Conventions

Below conventions are used in this document to indicate vital information:

DANGER:

Care must be taken or a certain procedure must be followed to prevent injury or harm to your health.

CAUTION:

Information on conditions that must be met or a procedure must be followed to prevent permanent damage.

Note:

Condition that must be met or procedures must be followed to ensure proper functioning.

4 Introduction

4.1 Caution

Care must be taken when handling the S251. High voltage across the antenna terminals and some parts of the PCB could be harmful to your health. Please ensure proper antenna insulation.

Handle S251 according to ESD handling requirements.
Do not touch any part without taking appropriate precautions. Power down before connecting or disconnecting any module, connector or cable.

4.2 General

This document provides information about the S251C Reader. It describes the reader and how to install it.

4.3 System Description

An RFID system comprises a reader connected to a control device (usually a host computer) via an RS232, or an RS422/RS485 interface, an antenna and a transponder. It is used for wireless identification of LF transponders.

The reader sends a 134.2 kHz power pulse to a transponder, the energy of the generated magnetic field is stored in the capacitor in the transponder and when the power pulse has finished the transponder immediately sends its data back to the reader.

4.4 Product Description

The Reader is an integral part of an RFID system; it provides all of the RF and control functions required to communicate with HDX LF transponders. The main task of the Reader is to send a power pulse via the antenna to initialize the transponder, to demodulate the received identification signal and then send the data to a control device. It is also used for sending programming data to Read/Write including Multipage transponders.

The Reader is housed in an IP20 Polycarbonate box as shown Figure 4.1.

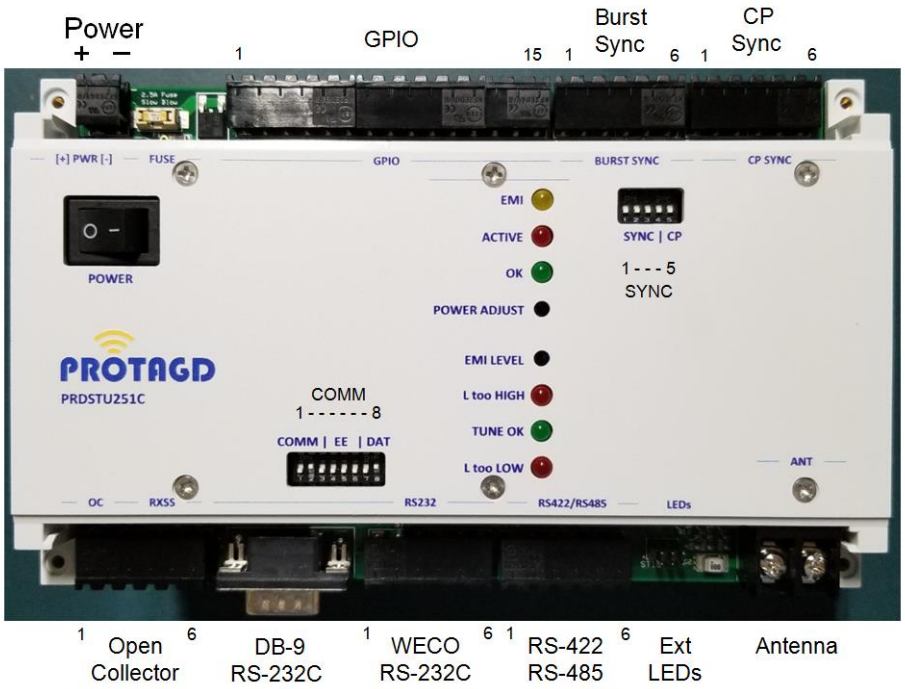


Figure 4.1. S251C Reader

If connected via an RS232 or an RS422/RS485 interface the computer sends commands to the reader using one of the two protocols used by the system (ASCII or TIRIS Bus Protocol), and the reader then communicates via its antenna with any transponders within that antenna's range. The antenna can be mounted up to 5 m (depending on the antenna) away from the reader.

The reader has the following connections/interfaces:

Communications interface: RS232, RS422 or RS485
8 general purpose I/O lines
2 Open Collector outputs
Synchronization bus
Carrier Phase Synchronization bus
Power connector
Indicator outputs connector
Antenna connector

There are two protocols that can be used with the S251C Reader, they are:

ASCII Protocol. This is a simple protocol that you can use to send ASCII character commands to the reader. It is possible to use a standard terminal emulator program to send ASCII commands. The ASCII protocol can only be used with RS232 or RS422.

TIRIS Bus Protocol. This is a binary protocol suitable for communication between a controlling device (for example: a PC) and one or more readers. For example with a single reader using an RS232 interface or up to 31 readers using RS422/485. The TIRIS Bus protocol can be used with RS232 or RS422/485.

If you are using one reader per controlling device you may choose the protocol that best suits your requirements. However, if you have more than one reader connected to a bus running under a controlling device then you must use the TIRIS Bus Protocol.

For details regarding these communications protocols, please refer to the relevant manual (11-06-21-037 [SCBU024] for the ASCII Protocol, 11-06-21-053 [SCBU026] for the TBP).

5 Hardware

This chapter describes the hardware of the S251C Reader. It tells you which modules together comprise the reader. It also describes the front panel (switches connections etc.) and specifies the electrical inputs and outputs.

5.1 General

This chapter describes the hardware comprising the S251C Reader and provides the electrical specifications.

5.2 Product Description

The S251C Reader is contained in a IP20 polycarbonate box that enables easy integration into standard racks and cabinets.

The reader is shown in Figure Figure 4.1.

The reader comprises two modules assembled together in a housing. The modules are:

Control Module which contains all the circuitry required to communicate via the interface to the computer and external devices, to provide synchronization, and to control the RFM. It includes a **Dynamic Auto Tuning** (DAT) function to automatically tune the antenna to resonance.

Radio Frequency Module (RFM) which contains all the analog functions of a TIRIS reading unit that are needed to initialize a TIRIS transponder and to detect its return signal.

There are 10 connectors on the S251, 7 WECO connectors, the antenna connector, a 9-pin sub-D RS232 connector, a 6-pin connector for the indicator outputs and a 2-pin connector for the antenna. The function of each pin on each connector (except the RS232 sub-D connector) is described in the following paragraphs. Their location is shown in Figure 5.1.

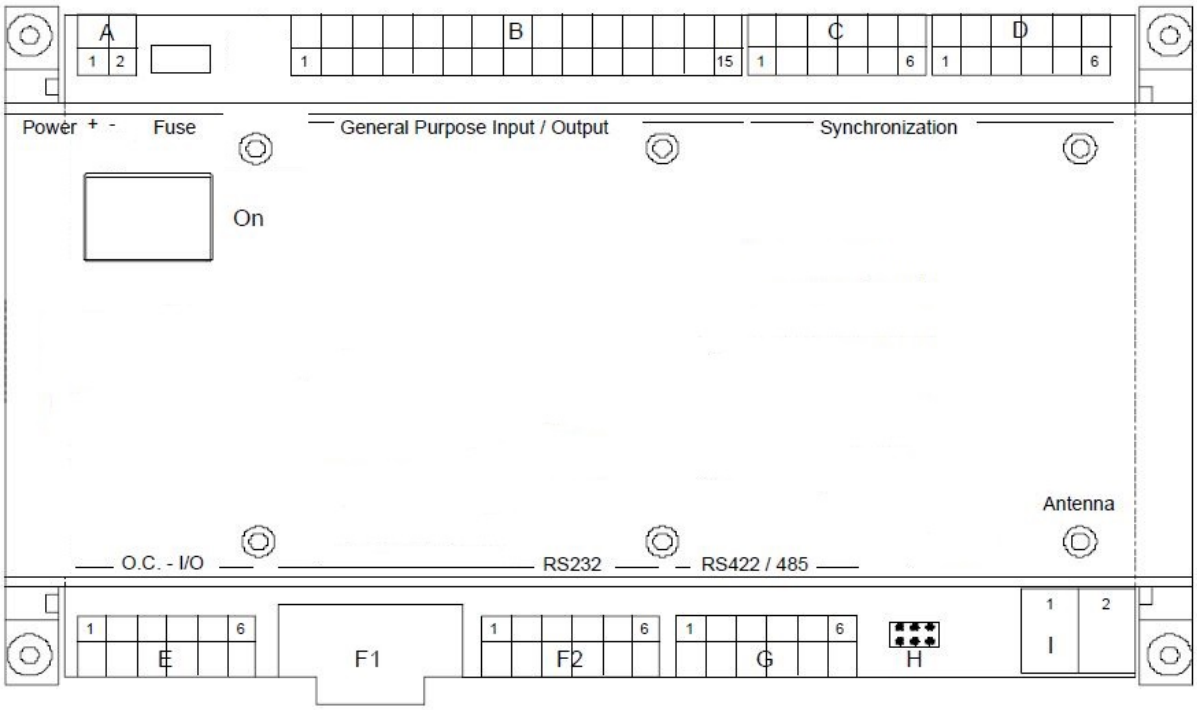


Figure 5.1. Connector Locations

To gain access to the fuse and connector J you must first remove the upper two screws holding the front panel on, remove the plastic cover strip and then replace the two screws. To gain access to the connectors H and I you must first remove the lower two screws holding the front panel on, remove theplastic cover strip and then replace the two screws.

The pins are not individually numbered on the connectors themselves (just on Figure 5.1 for your convenience).

The connectors are all marked on Figure 5.1with a letter (from A to I) and are listed in Table 5.1: List of ConnectorsTable 5.1, which also shows the section that describes them.

Identifying Letter	Function	Section
A	Supply Connector	
B	General Purpose Inputs/Outputs	
C	Synchronization Interface	
D	Carrier Phase Synchronization Interface	
E	Open Collector Inputs/Outputs	
F1	RS232 Connector (9-pin Sub D)	
F2	RS232 Connector	
G	RS422/RS485 Connector	

H	Indicator Outputs	
I	Antenna Connector	

Table 5.1: List of Connectors

The Reader requires a single DC supply voltage (12 to 24 V) through a 2-pin connector marked with + for positive and – for negative.

Input Power	Operating Temperature Range
12 – 24V	-20°C to +70°C; see caution below

Table 5.2: Power Parameters

Caution
The reader itself generates heat, therefore if it is incorporated into a housing you must ensure (by proper design and/or cooling) that the temperature immediately surrounding the reader does not exceed the operating temperature range.

Pin	Signal	Description	Direction
1	+	Positive Supply	Input
2	-	Ground	Input

Table 5.3: Supply Connector

Parameter	Minimum	Maximum
Logic Supply Voltage VSL	12V	24V
Logic Supply Current ISL	-	2.5A

Table 5.4: Supply Connector - Specifications

The Reader has eight general purpose TTL-Level Inputs/Outputs. By means of the configuration set-up, they can be set in groups of four to be Input or Output. Furthermore, there is a reset connection and a 5 V regulated output.

The pin assignment is given in Table 5.5 and their specifications are given in Table 5.6.

Pin	Signal	Description	Direction
1	GP IO 7	General Purpose I/O 7	Input/Output

2	GP IO 6	General Purpose I/O 6	Input/Output
3	GP IO 5	General Purpose I/O 5	Input/Output
4	GP IO 4	General Purpose I/O 4	Input/Output
5	GP IO 3	General Purpose I/O 3	Input/Output
6	GP IO 2	General Purpose I/O 2	Input/Output
7	GP IO 1	General Purpose I/O 1	Input/Output
8	GP IO 0	General Purpose I/O 0	Input/Output
9	-	Not connected	-
10	IN1	Input 1	Input
11	IN0	Input 0	Input
12	RESET–	Reset	Input
13	VCC	Regulated 5 Volt dc Supply (see note)	Output
14	GND	Signal Ground	-
15	GND	Signal Ground	-

Table 5.5: General Purpose Inputs/Outputs

Caution
Do not connect any power supply to pin 13 as it would damage the reader. It is supplied internally, and must not be driven externally. The total consumption of the two VCC outputs (General Purpose Inputs/Outputs pin 13 together with Open Collector & I/Os – pins 2 & 3) must not exceed 500 mA loading on +5V (pin 1).

Parameter	Minimum	Maximum
GP IO Output Voltage @ 6 mA Low level High level	 - 3.15V	 0.9V 5.25V
General Purpose IO Output Current Low level High level	 - -	 25mA 16mA
GP IO 1 to 4 Total Output Current		10mA
GP IO 5 to 8 Total Output Current		10mA
Regulated 5 V Output Current		100mA

Table 5.6: General Purpose Inputs/Outputs - Specifications

The synchronization interface is used to establish hard wired synchronization with other readers through a single or double pair of wires. Its pin assignment is given in Table 5.7 and its specifications are given in Table 5.8.

Pin	Signal	Description	Direction
1	Sync Rx+	RS422/RS485 non-inverted synchronization data	Input
2	Sync Rx–	RS422/RS485 inverted synchronization data	Input
3	GND	Signal ground	-
4	Sync Tx+	RS422/RS485 non-inverted synchronization data	Output
5	Sync Tx–	RS422/RS485 inverted synchronization data	Output
6	GND	Signal ground	-

Table 5.7: Synchronization Interface

Parameter	Specification
Mode of Operation	Differential
Number of Drivers On Line	32
Number of Receivers On Line	32
Maximum Cable Length	1200 m
Maximum Data Rate	10 Mbits/s
Maximum Common Mode Voltage	+12 V / –7 V
Driver Voltage	High > +1.5V Low < –1.5V
Driver Load	60 mA
Driver Output Short Circuit Limit	150mA to GND 250mA to VCC
Receiver Input	12 K Ohms
Receiver Sensitivity	±200 mV
Receiver Hysteresis	60 mV

Table 5.8: Synchronization Interface - Specifications

The carrier phase synchronization interface is used to establish hard wired carrier phase synchronization with other readers through a single pair of wires. Its pin assignment is given in Table 2-9 and it's specifications are given in Table 2-10.

Pin	Signal	Description	Direction
1	Sync Rx+	RS422/RS485 non-inverted synchronization data	Input
2	Sync Rx–	RS422/RS485 inverted synchronization data	Input
3	GND	Signal ground	-
4	Sync Tx+	RS422/RS485 non-inverted synchronization data	Output
5	Sync Tx–	RS422/RS485 inverted synchronization data	Output
6	GND	Signal ground	-

Table 5.9: Carrier Phase Synchronization Interface

Parameter	Specification
Mode of Operation	Differential
Number of Drivers On Line	32
Number of Receivers On Line	32
Maximum Cable Length	1200 m
Maximum Data Rate	10 Mbits/s
Maximum Common Mode Voltage	+12 V / –7 V
Driver Voltage	High > +1.5V Low < –1.5V
Driver Load	60 mA
Driver Output Short Circuit Limit	150mA to GND 250mA to VCC
Receiver Input	12 K Ohms
Receiver Sensitivity	±200 mV
Receiver Hysteresis	60 mV

Table 5.10: Carrier Synchronization Interface - Specifications

Connector E provides two open collector connections to and from the reader, plus the RXSS output (used to set the local noise level), another 5V regulated output. Its pin assignment is given in Table 5.11and its specifications are given in Table 5.12.

Pin	Signal	Description	Direction
1	VCC	Regulated 5 Volt dc Supply (see note 1 below)	Output
2	OC1	Open collector 1	Output
3	OC0	Open collector 0	Output

4	GND	Signal ground	-
5	N/C		
6	RXSS	RXSS	Output

Table 5.11: Open Collector & I/Os

Parameter	Minimum	Maximum
Open Collector Voltage to GND	1.3 V	80 V
Open Collector Current		500 mA
Regulated 5 V Output	4.75 V	5.25 V
N/C		
RXSS	-	5.25 V

Table 5.12: Open Collector & I/O - Specifications

Notes:

The total consumption of the two VCC outputs (Open Collector & I/Os – pin 1 together with General Purpose Inputs/Outputs pin 13) must not exceed 500 mA.

Depending on the DIP-Switch configuration, the Reader will either communicate via the RS232, RS422 or RS485 interface.

There are two interface connectors either of which can be used for an RS232C connection. They are: a standard RS232 Interface 9-pin SUB-D male connector (F1 on Figure 5.1) or a 6-pin WECO connector (F2 on Figure 5.1). Both of these connectors allow communication between the reader and a controlling device. The pin assignment for the SUB-D connector is given in Table 5.13 and the pin assignment for the WECO connector is given in Table 5.14. Only one of these connectors (F1 or F2) can be used at a time. Hooking up both will kill RS232 communications.

Both, the ASCII and TIRIS Bus protocol can be used with the RS232 interface.

Pin	Signal	Description	Direction
1	-	Not connected	-
2	TxD	Transmit Data	Output
3	RxD	Receive Data	Input
4	DTR	Data Terminal Ready	Input
5	GND	Signal Ground	-

6	DSR	Data Set Ready	Output
7	-	Not connected	-
8	-	Not connected	-
9	-	Not connected	-

Table 5.13: RS232 Sub-D Connector

Pin	Signal	Description	Direction
1	RxD	Receive Data	Input
2	DTR	Data Terminal Ready	Input
3	GND	Signal Ground	-
4	TxD	Transmit Data	Output
5	DSR	Data Set Ready	Output
6	GND	Signal Ground	-

Table 5.14: RS232 WECO Connector

All interface parameters are according to the RS232 Specification and are not given in detail in this manual. The DTR line is used to reset the S251 remotely via RS232 if the ‘DTR RESET’ switch is off.

Depending on the DIP-Switch configuration, the Reader will communicate via the RS232, RS422 or RS485 interface. RS422/485 connections are made via the 6-pin WECO connector (G in Figure 5.1). Pin assignment is given in Table 5.15 and its specifications are given in Table 5.16.

Both, the ASCII and TIRIS Bus Protocol can be used with the RS422 interface.

The ASCII protocol (or any other full-duplex protocol) cannot be used with the RS485 interface.

Pin	Signal	Description	Direction RS422	Direction RS485
1	Rx+/Tx+	RS422/RS485 non-inverted data	Input	Input/Output
2	Rx–/Tx–	RS422/RS485 inverted data	Input	
3	GND	Signal ground	-	-
4	Tx+	RS422 non-inverted data	Output/High Impedance	-
5	Tx–	RS422 inverted data	Output/High	-

			Impedance	
6	GND	Signal ground	-	-

Table 5.15: RS422/RS485 Connector

Parameter	Specification
Mode of Operation	Differential
Number of Drivers On Line	32
Number of Receivers On Line	32
Maximum Cable Length	1200 m
Maximum Data Rate	10 Mbits/s
Maximum Common Mode Voltage	+12 V / –7 V
Driver Voltage	High > +1.5V Low < –1.5V
Driver Load	60 mA
Driver Output Short Circuit Limit	150mA to GND 250mA to VCC
Receiver Input	12 kOhm
Receiver Sensitivity	±200 mV
Receiver Hysteresis	60 mV

Table 5.16: RS422/RS485 Communications Interface - Specifications

This connector (H in Figure 5.1) is a 2x3-pin (double row) pin header connection which provides the LED output signals. Its pin assignment is given in Table 5.17and its specifications are given in Table 5.18.

Pin	Signal	Description	Direction
1	ACTIVE	Open collector output: RF Module transmitter signal	Output
2	VR270	Current limited output: (270 Ohms in series to +5V)	Output
3	O.K.	Open collector output: O.K. signal	Output
4	VR270	Current limited output (270 Ohms in series to +5V)	Output
5	RXSA	Receiver signal strength adjust output. Provided to monitor the receiver signal strength threshold level.	Output

6	GND	Signal ground	-

Table 5.17: Indicator Outputs

Parameter	Minimum	Maximum
Open Collector Voltage	-	10 V
Open Collector Current	-	80 mA
Maximum voltage at current limiting 270 Ohm resistor	-	5 V
Receiver signal strength output voltage (RXSA). Logarithmic output.	0.7 V	1.7 V

Table 5.18: Indicator Outputs – Specifications

Antenna Connector

The antenna must be connected to the reader via the antenna terminals. The pin assignment for the antenna connector is given in Table 5.19. If a custom designed antenna is used, it must be within the specifications defined in Table 5.20 in order to ensure that the dynamic autotuning facility functions correctly.

Pin	Signal	Description
1	ANT	Tx/Rx antenna
2	ANT	Tx/Rx antenna

Table 5.19: Antenna

Parameter	Minimum	Maximum
Antenna Resonance Voltage	-	380 Vpeak
Antenna Inductance	26.0 µH	27.9 µH
Antenna Q-factor	40	350

Table 5.20: Antenna – Specifications

Switches

There are two DIP switches on the S251C Reader, one is for the Control Module set-up and DAT control (8 switches), and the second one is for the synchronization settings (5 switches).

The Control Module set-up switches are listed in Table 5.21, the RS422/RS485/DAT settings are listed in Table 5.23, and the synchronization settings switches are listed in Table 5.23. The ON position and switch 1 are always shown in the switch bank, the switch is on when the switch is set to the up position.

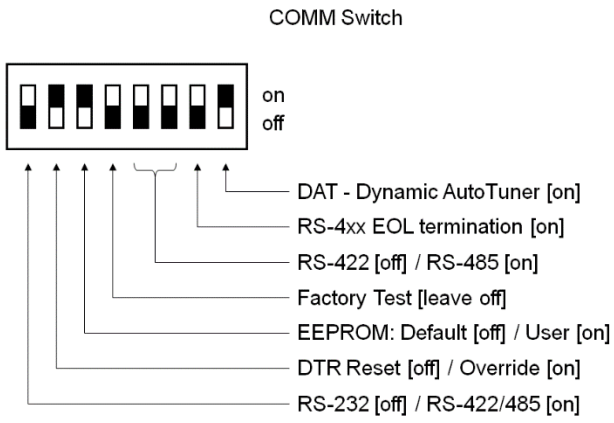


Figure 5.2: Control DIP Switches

Switch	OFF	ON
1 (left)	RS232	RS422 or RS485
2	S251C Reset on DTR low	No reset
3	EEPROM default	EEPROM User configuration
4	Leave OFF	Factory Test
5	RS422	RS485
6	RS422	RS485
7	No termination	RS4xx termination
8 (right)	No Auto Tuning	Dynamic Auto Tuning ON

Table 5.21: CTL Setup Switches

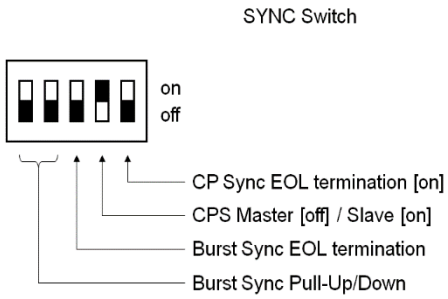


Figure 5.3: RS422/RS485/DAT Switches

Switch	OFF	ON
1	Sync RX+ no pull-up	Sync RX+ pulled up with 180 Ohms
2	Sync RX- no pull-down	Sync RX- pulled down with 180 Ohms
3	No End-of-Line termination	End-of-Line Termination ON
4	CP Sync MASTER Mode	CP Sync SLAVE Mode
5	No CP Sync End-of-Line Termination	CP Sync End-of-Line Termination ON

Table 5.22: RS4xx Termination Switches

Note: SW1 and SW2 must always be in the same position as each other, either both OFF or both ON.

Indicators

There are six LEDs on the front panel of the reader they are described in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

Indicator		Description
EMI		Indicates the presence of Electro Magnetic interference
TX Active		Indicates activation of the RF transmitter
Read OK		Indicates a response from a valid transponder
Antenna Tuning	L↑	Antenna out of tune, inductance too high
	OK	The DAT has tuned the antenna to maximum resonance voltage

	L ↓	Antenna out of tune, inductance too low

Table 5.23: Indicators

The TX Active and Read O.K. LED lines are also made available for external use if required.

Potentiometers

There are two potentiometers that can be adjusted through the reader front panel, they are: the RF Power Output potentiometer and the EMI/Sync. Level potentiometer.

RF Power Adjustments

The potentiometer can be used to adjust the internal oscillator pulse width and thus the generated antenna voltage/field strength. Turning the potentiometer clockwise causes the field strength to be increased.

EMI/Sync. Level Adjustment

This potentiometer allows the receiver signal strength threshold level to be adjusted for wireless synchronization. Turning the potentiometer clockwise results in maximum sensitivity.

There is one fuse on the S251C, that is a 2.5A slow-blow fuse. If the fuse should blow, replace it with a Little Fuse part # 045202.5MRL.

Mechanical Information

The mechanical dimensions and weight are given in Table 5.24.

Parameter	Value
Height	120mm
Width	120mm
Length	200mm
Weight	900g

Table 5.24: Mechanical Parameters

6 Synchronization

If you are using more than one reader in an application, it may mean that you need to synchronize their operation so that they do not interfere with each other. This chapter describes the various synchronization options.

6.1 Introduction

Where multiple readers are operating in the same area, it is necessary to coordinate the activities of those readers to avoid mutual interference. This is known as synchronization. Synchronization in this context means that the readers in your application are controlled in such a way that they do not interfere with each other.

There are several types of synchronization that can be used depending on the situation in a particular application, for example: the type of transponder, the type of operation performed on that transponder (Charge-only read, General read, Program page, Lock page), the size of the antennas and the speed of the transponder. The different kinds of synchronization are described in section 6.2. Once you've chosen which synchronization method you want to use, refer to the document for the PRDMBxB document on the website to see how to wire the sync connectors.

The distance that reader antennas have to be separated before the need for some method of synchronization is required, varies with local conditions, for in addition to purely airborne (radiated) interference, signals can travel from one reader to another via metal structures (conducted). Metal structures can include the frames of metal buildings, reinforcing bars in concrete floors and power or data cables.

6.2 Types of Synchronization

The S251C Reader can be configured to synchronize in a number of different ways by programming the EEPROM, and then flipping switch 3 of the 8-bit DIP switch to ON.

- No Synchronization (6.2.1)
- Wireless Synchronization (6.2.2)
- Wired (6.2.3)
- Combined Wireless/Wired (6.2.4)
- Master/Slave Synchronization (6.2.5)
- Carrier Phase Synchronization (6.2.6)

6.2.1 No Synchronization

This option is only used in conjunction with Software synchronization, or if there is only a single reader. No sync and Master/Slave sync without acknowledgment are the fastest methods of reading transponders.

If all readers are connected by the same RS485 data network, coordination of the readers can be controlled directly by the Host Computer. For example, the Host Computer may issue a Broadcast command for all readers to simultaneously

perform a read cycle and buffer the result. Another technique possible using the data network is to issue individual commands to each reader in turn. This technique is used when writing data to Multipage Transponders (MPTs). Where a PLC has a number of point-to-point connections to readers, it is also possible to coordinate the activities via the ladder logic. With Software synchronization all readers will be simultaneously transmitting, or each reader individually operating. In both cases the readers can be configured to have No Synchronization.

6.2.2 Wireless synchronization

Wireless synchronization can be used to control the coordination of readers, with standard antennas, provided the electrical noise in the environment is low for the type of antenna in use and the noise levels are constant.

Wireless synchronization is only valid for charge-only reading of transponders.

During operation, when the reader detects noise above the adjusted background level it assumes that it is another reader and “backs-off” for a set period before commencing its own cycle. Wireless synchronized readers can read together or alternately.

Advantages:

- There are no wires to run.
- All readers are autonomous (no Master unit).
- Enables Hand held readers to co-exist with fixed units (using wireless synchronization).

Disadvantages:

- In noisy environments, there is too much sensitivity with larger antennas (G04 and larger custom antennas) to allow accurate setting of the background levels.
- It is not suitable for operations other than Charge-only read.
- It cannot be used when other readers are writing information to transponders.
- Where the environmental conditions change, for example: a ground loop antenna’s characteristics are changed by a vehicle over it, the synchronization adjustment could be wrong.

6.2.3 Wired Synchronization

Wired Synchronization works in the same way as wireless synchronization with the exception that the reader obtains its information about the presence of another reader through a hard wired connection and not via the antenna.

Advantages:

- It is a Peer-to-Peer network and does not need a Master unit.
- It uses a single twisted pair cable.

Disadvantages:

- It is only suitable for charge-only reading of transponders.

- It cannot be used when other readers are writing information to transponders.
- If the power fails at any of the readers the bus fails.

6.2.4 Combined Wireless/Wired Synchronization

When this option is selected, groups of reader connected by the wired synchronization cabling can synchronize with other groups of wired synchronization readers, or with individual readers, by using wireless synchronization.

The advantages and disadvantages of both wireless and wired synchronization as given above still apply.

6.2.5 Master/Slave Synchronization

Master/Slave Synchronization is probably the most commonly used form of synchronization. One reader is configured to be the **Master** and this reader then controls all the other readers, which are configured as Slaves.

There are three variants:

- Master/Slave Synchronization without Acknowledgment,
- Master/Slave Synchronization with Acknowledgment
- Triggered Synchronization.

M/S Synchronization without Acknowledgment

This method of synchronization is the fastest method of reading transponders and was originally developed for reading tagged vehicles at speed. It assumes that all readers are on the same synchronization bus and the readers would not, for example, recognize a handheld reader that is trying (probably unsuccessfully) to perform a reading.

Advantages:

- Uses a single twisted pair cable.
- Has the fastest read rate.
- The Master can be used for Charge-only read or Write/Program.

Disadvantages:

- All readers must be on the same synchronization bus.
- If the Master fails, all units stop.
- Slave units cannot be individually tested without the Master running.
- Slaves must perform exactly the same RF-Task as the Master (read the same page, write the same data to a transponder).

M/S Synchronization with Acknowledgment

In Master/Slave Synchronization without acknowledgment, if a slave reads a transponder and the master doesn’t, the slave may miss the next pulse while it is processing the reading from that transponder. In Master/Slave with Acknowledgment the Master has to wait until all slaves have completed their current cycle before initiating the next cycle. This is achieved by using a 4 wire synchronization bus (twin twisted pair) with the slave transmit lines coupled back to the Master receive lines.

This method has the following advantages over Master/Slave without Acknowledge

- All units can Write/Program transponders (providing they do it together).
- They wait for the slowest to complete.

Disadvantages:

- The cable is a twin twisted pair.
- The readers cannot be too close if writing is performed, because of the possibility of corrupted data. This restriction also includes the paged read of multipage transponders.

Triggered Synchronization

Triggered Synchronization is a Master/Slave Synchronization Bus where there is just a pulse signal. All readers are configured as masters, but it is only one unit or a trigger pulse source that issues the synchronization pulse at suitable intervals for the required operations on the transponder.

The more complex version of this is known as a Timing Bus, when different time windows are defined for different operations to be carried out, for example: If multiple readers are required to read addressed pages of Multipage transponders, then to write data back to the transponders, the timing bus would start a read window lasting 90 ms then initiate a time window of 320 ms for a write operation. In this way the differing times required for the two operations can be accommodated. At the same time the readers would be instructed thru the communication interface, about which command to execute during each window. Therefore the slaves have to receive their command before the master.

Advantages:

- The master unit has total control over the coordination of the connected devices and can allow ‘windows’ for particular operations.
- Reading and Writing can be accommodated, if there is sufficient separation to prevent data corruption during the Write process.

Disadvantages:

- Cannot be used for addressing MP transponders if readers are close together as addressing conflicts can arise.
- Carrier Phase synchronization cannot be used.

6.2.6 Carrier Phase Synchronization

In some applications it is necessary to use several charge-up antennas close to each other. In this circumstance, the magnetic charge-up fields generated by different antennas superimpose on each other and may cause a beat effect on the magnetic charge-up field, due to the slightly different transmission phases of different Power readers. This effect will not occur when the transmitters of different readers are operated from the same oscillator signal.

This is Carrier Phase Synchronization where all of the readers in a system use the same oscillator. Carrier Phase synchronization must be used whenever Gate or Stick antennas are facing each other and if they are inside the distances D1 or D2

as given in Table 3-1 (Figure 3-1 shows the places to measure D1 and D2). This ensures that there will not be any “beat effect” between the antennas.

Note: Remember that putting two antennas close together also changes antenna inductance, so that the antennas may no longer be tunable to resonance.

Figure 6.1 Distance between antennas (top view)

Antenna Type	Distance D1 [m]	Distance D2 [m]
RI_ANT_S02 <=> RI_ANT_S02	0.8	1.0
RI_ANT_G01 <=> RI_ANT_G01	1.7	1.5
RI_ANT_G02 <=> RI_ANT_G02	1.3	1.0

Table 6.1: Distances between antennas

7 Installation

This chapter provides you with the information that you need to know in order to install the reader.

This chapter also describes how to incorporate the various synchronization options.

7.1 Introduction

Note: Always ensure that the reader is switched off when adding or removing connections to it.

7.2 General

The S251C Reader has been designed with easy installation in mind. The following information provides you with any details such as switch settings and so on that you will need to know.

7.3 Mechanical Mounting

a. If you are mounting the reader on a DIN rail TS35, clip the reader into the bottom of the rail and then snap it into the top.

b. If you are mounting the reader onto a wall where there is no vibration, snap in the four mounting adapters and screw the reader to the wall using M4 screws.

or

c. If you are mounting it onto a wall where it may be subject to vibration, open the reader, drill thru the marked mounting holes and screw the reader to the wall using M4 screws and the appropriate washers.

WARNING

CARE MUST BE TAKEN WHEN HANDLING THE S251. HIGH VOLTAGE ACROSS THE ANTENNA TERMINALS COULD BE HARMFUL TO YOUR HEALTH. IF THE ANTENNA INSULATION IS DAMAGED THE ANTENNA SHOULD NOT BE CONNECTED TO THE S251.

7.4 Power Supply

Connect a Regulated dc power supply (between 12 and 24 V providing a minimum of 2A) to the reader – the polarity of the connection is shown on the front panel of the reader.

We recommend that you use a linear power supply. If this is not possible and you wish to use a switch-mode power supply, DO NOT use one that operates below 200 kHz. (switched mode power supplies that operate below 200 kHz might interfere with transponder signals and thus reduce the reading range).

7.5 Communication

Follow the instructions given in the section that describes the communications set-up that you have decided to use in your system: Section 7.5.2 for RS232, Section 7.5.3 for RS422 and Section 7.5.4 for RS485.

7.5.1 Configuration

CTL Setup 8-bit DIP Switch determines the mode of operation of the control module when power is applied to the control module. When CTL Setup Switch 3 (counting from the left) is in the OFF position, standard TIRIS default parameters are used, these are:

- ASCII protocol
- 9600 baud, eight data bits, no parity, one stop bit, Xon/Xoff enabled
- Normal Mode
- Wireless synchronization
- I/O 0 to 3 defined as input
- I/O 4 to 7 defined as output and logic high
- Hardware interface RS232C

If CTL Setup Switch 3 is in the ON position, customer specific parameters are used to operate the Control Module. These application specific parameters are stored in the serial EEPROM on the Control Module.

Note: The setting of CTL Setup Switch 3 is only checked after power on.

You can use a Software Utility Program to configure your reader. The Texas Instruments S2000 Utility can be used to set EEPROM parameters.

In order to configure the reader for customer specific parameters you must connect the reader via the RS232 port (connector F1 or F2) to your host and get connection using the TIRIS standard parameters (with CTL Setup switch 3 in the OFF position). Change the default parameters to the customer specific parameters and save them. Set CTL Setup switch 3 to the ON position and reset the reader. The reader will then work with the customer specific parameters.

7.5.2 RS232

Either connect a 9-pin SUB-D female plug to the SUB-D connector, or connect up the 6-pin WECO connector marked “RS232” on the reader’s front panel, the pin signals are given in Table 7-1 or Table 7-2.

Pin	Signal	Description	Direction
1	-	Not connected	-
2	TxD	Transmit Data	Output
3	RxD	Receive Data	Input
4	DTR	Data Terminal Ready	Input
5	GND	Signal Ground	-
6	DSR	Data Set Ready	Output
7	-	Not connected	-
8	-	Not connected	-

9	-	Not connected	-

Table 7.1: RS232 Sub-D Connector

Pin	Signal	Description	Direction
1	RxD	Receive Data	Input
2	DTR	Data Terminal Ready	Input
3	GND	Signal Ground	-
4	TxD	Transmit Data	Output
5	DSR	Data Set Ready	Output
6	GND	Signal Ground	-

Table 7.2: WECO Connector

Activation

The Data Terminal Ready signal (DTR) is connected to the reset/watchdog circuit of the S251C Reader. This ensures a PC controlled microcomputer initialization before the default Read Mode is started.

When power is applied to the reader the Data Set Ready signal (DSR) of the RS232-C interface is activated.

7.5.3 RS422

Connect the WECO (marked RS422/485) connector as shown in Table 7.3. Set the 8-bit DIP Switch 1 = ON, And switches 5,6 = OFF,OFF for RS422. If you are only using one reader the line terminal switch 7 must be switched to ON, if you are using more than one reader only the last reader in the line must be switched to ON (all other readers to OFF).

Pin	Signal	Description	Direction RS422	Direction RS485
1	Rx+/Tx+	RS422/RS485 non-inverted data	Input	Input/Output
2	RS-/Tx-	RS422/RS485 inverted data	Input	Input/Output
3	GND	Signal Ground	-	-
4	Tx+	RS422 non-inverted data	Output/High Impedance	-
5	Tx-	RS422 inverted data	Output/High Impedance	-
6	GND	Signal Ground	-	-

Table 7.3: RS422/RS485 Connector

7.5.4 RS485

Connect the WECO (marked RS422/485) connector as shown in Table 7.3. Set the 8-bit DIP Switch 1 = ON, And switches 5,6 = ON,ON for RS485. If you are only using one reader the line terminal switch 7 must be switched to ON, if you are using more than one reader only the last reader in the line must be switched to ON (all other readers to OFF).

7.6 Synchronization

7.6.1 Software Controlled

There is no special wiring required for this type of synchronization. Make sure that you set the software configuration to No Sync when you are configuring the reader.

7.6.2 Wireless Synchronization

There are no switch or jumper settings for wireless synchronization. Make sure that you set the software configuration to wireless synchronization when you are configuring the EEPROM in the reader.

7.6.3 Wired and Combined Wireless/Wired Synchronization

Figure 7.1 shows in which way the S251C Reader must be connected for a wired and a combined wireless/wired synchronization. Make sure that you set the software configuration to match when you are configuring the reader. Table 4-4 explains the setting of the Synchronization DIP switches 1, 2 & 3.

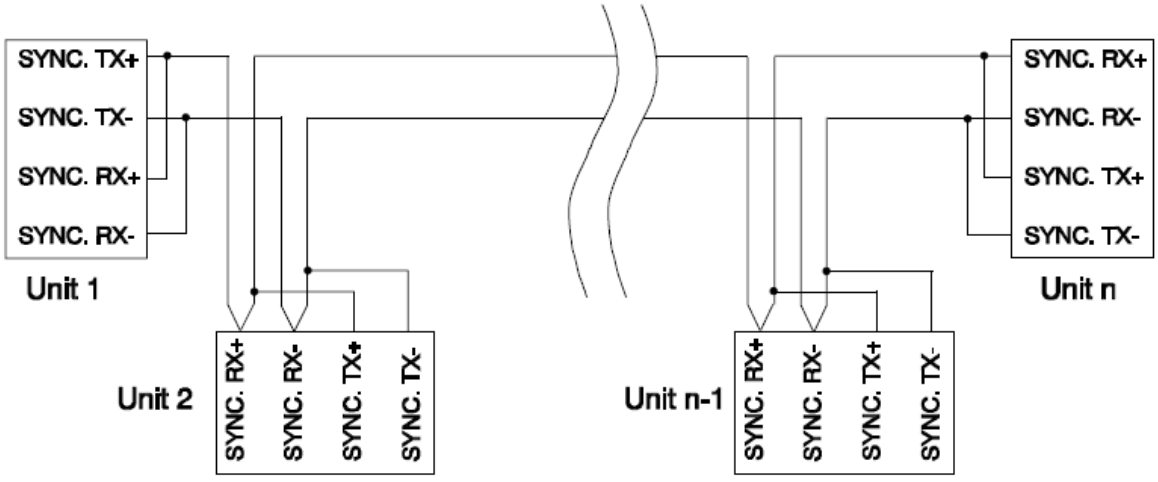


Figure 7.1 Wired & Combined Wireless/Wired Sync. Interface

5-bit Dip Switch	UNIT 1	UNIT 2 … UNIT -1	UNIT n

SW1	ON	OFF	ON
SW2	ON	OFF	ON
SW3	ON	OFF	ON (see note)

Table 7.4: Wired & Combined Wireless/Wired Synchronization

Note: If the distance between Unit 1 and Unit n is less than approximately 400 m, 5-bit DIP Switch SW3 can be left OFF.

7.6.4 Master/Slave (without acknowledgment) & Triggered Synch.

Figure 7.2 shows the way that the Readers must be connected for master/slave synchronization without acknowledgment; and triggered synchronization. Make sure that you set the software configuration to Master or Slave (according to Table 7.5 and Table 7.6) acknowledgment) when you are configuring the reader.

Table 7.5 and Table 7.6 show the settings of the Line termination DIP switches.

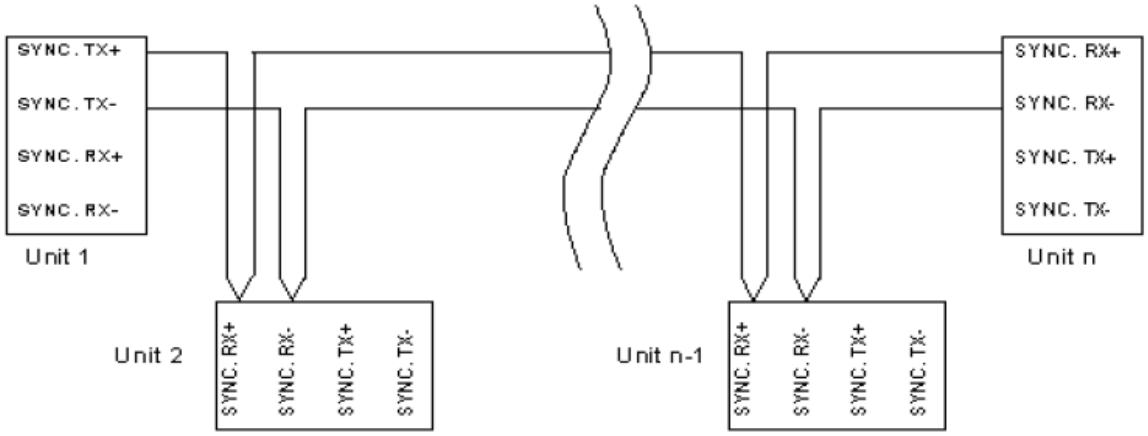


Figure 7.2 Master/Slave Sync. Interface Connection (without Ack.)

5-bit Dip Switch	UNIT 1 (Master)	UNIT 2 … UNIT -1 (Slaves)	UNIT n (Slave)
SW1	ON	OFF	ON
SW2	ON	OFF	ON
SW3	ON	OFF	ON (see note)

Table 7.5: Master/Slave Synchronization without Acknowledgement

Note: If the distance between Unit 1 and Unit n is less than approximately 400 m, 5-bit DIP Switch SW3 can be left OFF.

5-bit Dip Switch	UNIT 1 (Trigger Unit)	UNIT 2 … UNIT -1 (Master)	UNIT n (Master)
SW1	Termination not required	OFF	ON
SW2	Termination not required	OFF	ON
SW3	Termination not required	OFF	ON (see note)

Table 7.6: Triggered Synchronization

7.6.5 Master/Slave (with acknowledgment)

Figure 7.3 shows the way that the Readers must be connected for master/slave synchronization with acknowledgment. Make sure that you set the software configuration to Master or Slave (according to Table 7.7) when you are configuring the reader.

Table 7.7 shows the setting of DIP switch switches 1, 2 & 3.

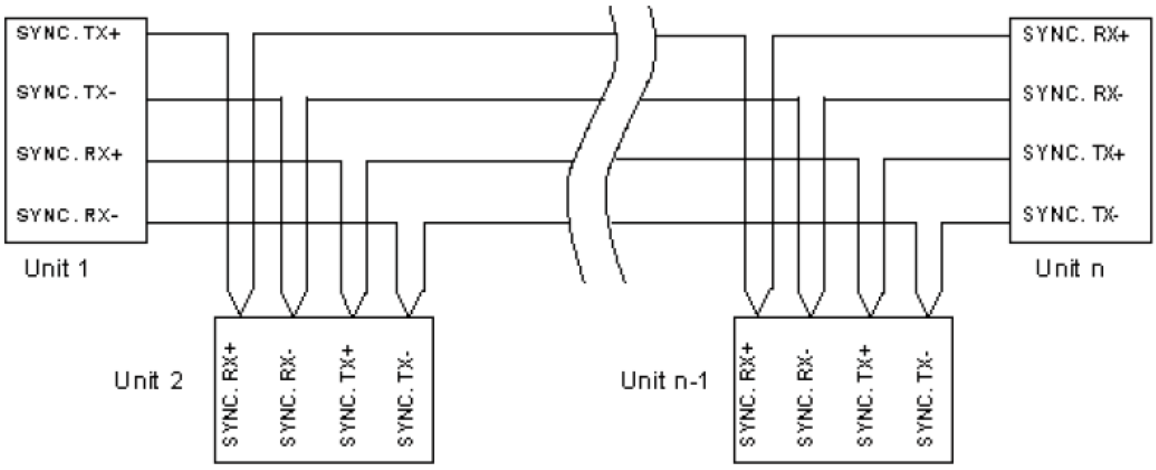


Figure 7.3 Master/Slave Sync. Interface Connection

Termination Dip Switch	UNIT 1 (Master)	UNIT 2 … UNIT -1 (Slaves)	UNIT n (Slave)
SW1	ON	OFF	ON
SW2	ON	OFF	ON
SW3	ON	OFF	ON (see note)

Table 7.7: Master/Slave Synchronization with Acknowledgement

Note: If the distance between Unit 1 and Unit n is less than approximately 400 m, DIP switch SW3 can be left OFF.

7.6.6 Transmitter Carrier Phase Synchronization (CPS)

To allow you to overcome the beat effect, the pulse width modulated oscillator signal is accessible at the CPS connector D. All readers to be driven by one oscillator must have their CPS connectors connected as shown in Figure 7.4.

DIP switch Synchronization-SW4 determines whether the internal oscillator or the external oscillator signal is used. When the DIP switch Synchronization-SW4 is OFF, the internal oscillator is used and the reader is referred to as an oscillator MASTER. When the DIP Switch Synchronization-SW4 is ON, the external oscillator signal is used and the reader is referred to as an oscillator SLAVE.

Note: Only one oscillator MASTER is allowed per synchronized system.

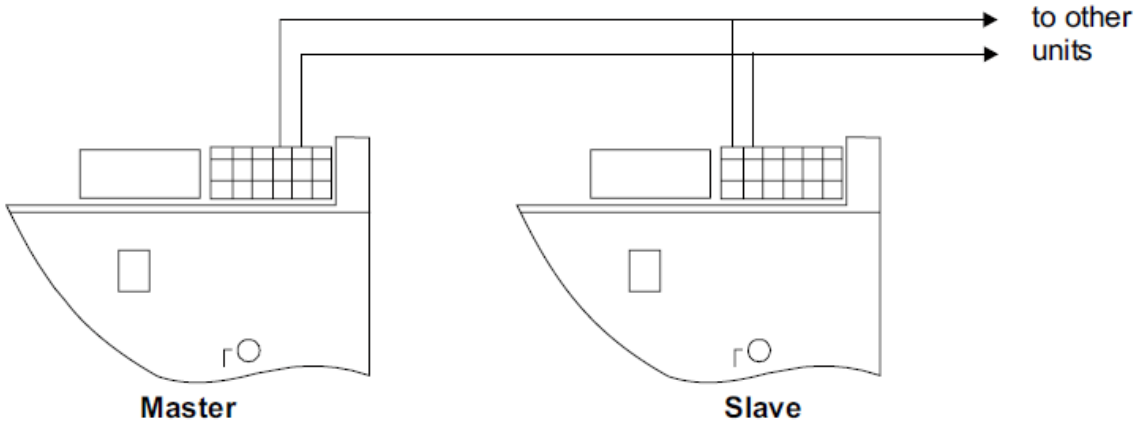


Figure 7.4 Carrier Phase Sync. Interface Connection

The Master CPS unit has to have the 5-bit DIP Switch 4 set to OFF. All other 5-bit DIP Switch 4 (Slaves) has to be set ON. The last unit has to have Switch 5 ON for line termination.

7.7 General Purpose Input/Outputs

The S251C Reader has 8 connections that can be defined as either inputs or outputs (TTL level). These input/outputs must be configured in groups of 4 as shown in Table 7.8.

I/O				I/O			
0	1	2	3	4	5	6	7
I	I	I	I	I	I	I	I
I	I	I	I	O	O	O	O

O	O	O	O	I	I	I	I
O	O	O	O	O	O	O	O

Table 7.8: General Purpose Inputs/Outputs

7.8 LED Outputs

The signals used for the indicator LEDs (Read O.K. and Transmitting) are available at Indicator Outputs connector (H), they can be used to drive external LEDs or buzzers, they must be connected as shown in Figure 7.5. Ensure that the values given Table 5.18 are not exceeded.

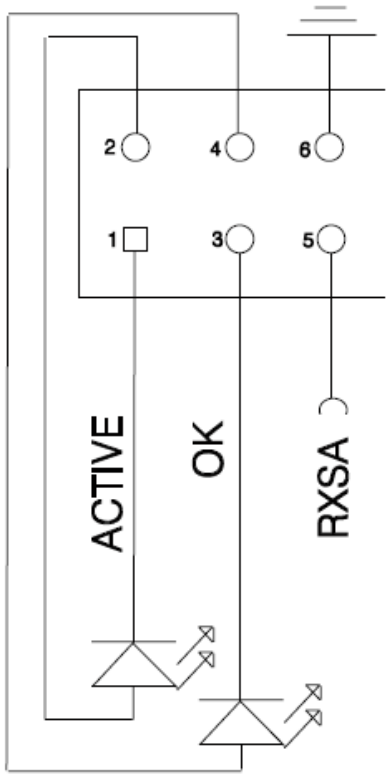


Figure 7.5 Connecting the LED Outputs

7.9 Reset

The S251C Reader provides a connection for an external reset on pin 12 of the General Purpose Input/Output connector B. This pin can be used reset the S251C Reader externally. You can apply an external reset to the reader by connecting a push-button to the connectors as shown in Figure 7.6.

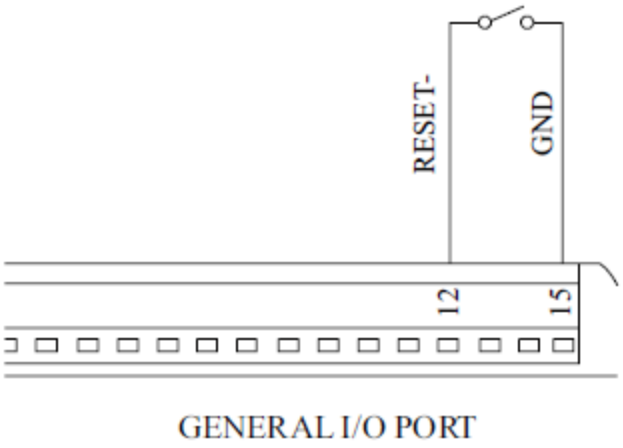


Figure 7.6 RESET Push-Button Wiring

7.10 Antenna

The S251C Reader can be used together with the Protagd antennas PRDANTG02E and PRDANTS02C. If you wish to use it with your own design antenna that antenna must conform to the specifications given in Table 7.9.

Note: The Stick Antenna (PRDANTS02C) must only be used together with a reader supply voltage up to 12 V. If you use this antenna with a higher reader supply voltage the antenna becomes too warm which effects the antenna's Q.

Parameter	Min.	Max.
Antenna Resonance Voltage	-	380 Vpeak
Antenna Inductance	25µH	30 µH
Antenna Q-factor	40	350

Table 7.9: Antenna Specification

The antenna must be connected to the terminals marked Antenna on the S251C.

7.11 RF Power Output Adjustment

Use the RF Power Output Adj. potentiometer to adjust the internal oscillator pulse width and subsequently the antenna output voltage to conform to your local regulations. Turning the potentiometer clockwise causes the field strength to increase.

7.12 EMI/Sync. Level Adjustment

EMI/Sync Level Adjustment potentiometer to adjust the receiver signal strength threshold for the wireless synchronization. Turning the potentiometer clockwise results in a maximum sensitivity.

If wireless synchronization is used, it is important that the EMI/Sync level Adj. potentiometer is correctly adjusted. This is one of the final adjustments to the reader and is done on site in the final location once the antenna has been tuned and ALL THE OTHER READERS ARE SWITCHED OFF.

Turning the potentiometer adjusts the receiver signal level threshold and you must set the reader's 'base level noise' in its final location, so that any signal larger than the base level triggers the synchronization algorithm.

Send a single 'X' (execute command) to the reader to stop any continuous reading, and then turn the potentiometer clockwise until the yellow LED is fully lit. Slowly adjust the potentiometer back until the LED just goes out. Adjustment is then complete.

8 Regulatory Notes

Prior to operating the PRDSTU251C, the required relevant government agency approvals must be obtained. Sale, lease or operation in some countries may be subject to prior approval by government or other organizations.

8.1 Europe

The equipment complies with the Radio Equipment Directive (RED) 2014/53/EU. when used for its intended purpose.

A CE Declaration of Conformity for the RFM is available from Protagd.

Any device or system incorporating this module in any other than the originally tested configuration needs to be verified against the requirements of the Radio Equipment Directive (RED) 2014/53/EU. A separate Declaration of Conformity must be issued by the system integrator or user of such a system prior to marketing it and operating it in the European Community.

It is the responsibility of the system integrators to get their complete system tested and obtain approvals from the appropriate local authorities before operating or selling the system.

8.2 USA

The PRDSTU251C is considered by the Federal Communications Commission (FCC) to be a "subassembly". As such, no prior approval is required to import, sell or otherwise market them in the United States. To form a functioning radio frequency system, the Reader must be connected to a suitable antenna and power supply.

Such a system containing the PRDSTU251C may have to comply with the limits pursuant to part 15 of the FCC rules. It is the responsibility of the system integrators to get their complete system tested and to obtain approvals from the appropriate local authorities before operating or selling this system.

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