TEXAS INSTRUMENTS

S6500 Reader Synchronization

Application Note

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Radio Frequency Identification Systems

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TEXAS INSTRUMENTS

2nd Edition – AUG 2003

This is the second edition of this **S6500 Synchronization Application Note**.

It contains details about how to co-ordinate the RF transmissions of adjacent S6500 readers to minimise mutual interference and optimise read speed. It is applicable to the following TI products:

1. S6500 Reader Module (RI-STU-650A)
2. S6550 Housed Reader (RI-STU-655A)

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PREFACE

Read This First

About this Manual

This **S6500 Reader Synchronization Application Note** is written for the sole use by TI-RFid Customers who are engineers experienced with TI-RFid and Radio Frequency Identification Devices (RFID).

Conventions

Certain conventions are used in order to display important information in this manual, these conventions are:

WARNING:

A warning is used where care must be taken or a certain procedure must be followed, in order to prevent injury or harm to your health.

CAUTION:

This indicates information on conditions, which must be met, or a procedure, which must be followed, which if not heeded could cause permanent damage to the system.

Note:

Indicates conditions, which must be met, or procedures, which must be followed, to ensure proper functioning of any hardware or software.

Information:

Indicates conditions, which must be met, or procedures, which must be followed, to ensure proper functioning of any hardware or software.

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S6500 Reader Synchronization

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Abstract

The S6500 and S6550 high performance readers' RF signals can mutually interfere with one other when operated in the same area unless their operations are synchronized. This document discusses the issues surrounding synchronization, the different software and hardware options, and describes how to implement Buffered Read or Scan Mode with cascaded synchronization. To implement all the options described in the document, the readers must be firmware revision "03-10" or later

1 Synchronization

A single reader, on its own, doesn't require synchronization but where multiple readers are operating close together, the radio transmissions from their antennas may interfere with each another, such that the inlays are unable to completely understand the downlink information and miss-reads result. The degree of interference depends on a number of factors. These include:

- The size of the antennas
- The output power of the antennas
- The distances between antennas
- The presence (or absence) of shielding

As an example, the standard 30-cm square antenna (RI-ANT-T01A) connected to an S6500 reader, set at 4W, needs at around 4 m separation between it and the next antenna to ensure satisfactory operation.

Larger pairs of antennas, e.g. 60-cm x 80-cm used for access control gates, require to be separated by at least 8 m.

1.1 Synchronization Methods

A number of methods are available to us to co-ordinate the operations of multiple readers and minimize mutual interaction, when readers have to operate in closer vicinity that the distances given above:

1.1.1 Software Synchronization

This method can be used when multiple readers are connected to the same RS-485 communications bus. (An additional RS-485 port is standard on S6500 readers). As readers are individually addressable, the controlling (Host) computer is able to command each reader to transmit at a separate time, so that it is not possible for more than one reader to be transmitting at the same time. This technique can also be used when individual readers are connected point-to-point to separate Com ports on a Host Computer

Where your Host Computer doesn't have an RS-485 port, converters are available and Appendix A describes an RS-232 to RS-485 converter, while Appendix B suggests how a PCMCIA card can be used.

1.1.2 Multiplexing

In this method a single reader is connected through a switching box (MUX) to multiple antennas. The reader output is directed to each antenna in turn, again ensuring that only one antenna is ever transmitting at the same time. Multiplexors need to have solid state switching because of the frequency of operation - mechanical switches (relays) would soon wear out. Unfortunately solid state switching introduces losses and the reader power output is normally increased to compensate. As multiplexing divides the time available to read an inlay by the number of channels on the multiplexor, check that there is enough time for complete interrogation if there are fast moving inlays in your applications.

http://snyderelect.com

Figure 1. Three Channel Multiplexor

1.1.3 Shielding

Shielding does more than just prevent interference between readers. It is commonly employed when higher than normal power outputs are used. Shielding can attenuate the signals that would otherwise exceed those allowed under local PTT/FCC regulations.

It also serves to prevent inlays that are passing outside the reading system from being read, and when antennas are close together, prevents the same inlay from being picked up on an adjacent antenna. Shielding can also act as a barrier to prevent metal sheets or other objects that have been left next to an antenna from affecting the performance. Because of the shape of an antenna's RF field (i.e. side lobes), the shielding has to be larger than the antenna. The metal mesh or sheet used for shielding will need to be approximately twice as high and wide as the antenna. It is not recommended to have the shielding too close to an antenna (less than 200 mm), as two unwanted features will occur:

- The Antenna will be de-tuned.
- The metal will absorb some of the power that should be radiating.

We can re-tune the antenna to compensate to some extent for the de-tuning but we can't easily do anything about the second point. It is best to have any shielding at least 200 mm from antennas, if performance degradation is to be avoided.

Figure 2. Shielding of an Airport Sortation System

1.1.4 Cascaded Synchronisation with Buffered Read or Scan Mode

When the S6500 is in 'Buffered Read' or ‘Scan Mode’, the reader is 'free-running', extracting the required data from inlays that pass the antenna. To avoid mutual interference between readers, these modes also incorporate (from firmware version 03-10) 'Cascaded Synchronization'. Using the reader's I/O, the output from a designated Master reader is connected to the input of the next Slave unit, whose output is connected to the next Slave etc - the last Slave's output being coupled back to the Master's input.

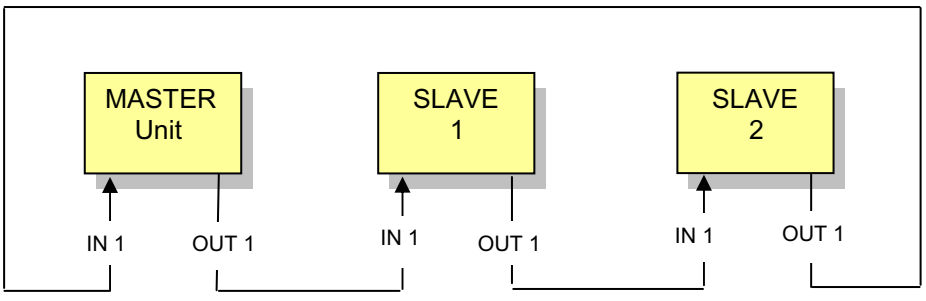


Figure 3. Cascaded Synchronization

The 'Master' reader is necessary to initiate the process following a RESET. The Master will complete its downlink protocol and immediately pass control to the next slave, who in turn will pass control on. This is the fastest method of operation involving multiple readers and ensures that only one reader is ever transmitting.

1.2 Cascaded Synchronization wiring

The opto-isolated Inputs and Outputs of the S6500 reader are used for the cascaded synchronization; so to preserve the integrity of the opto-isolation an external power supply is required.

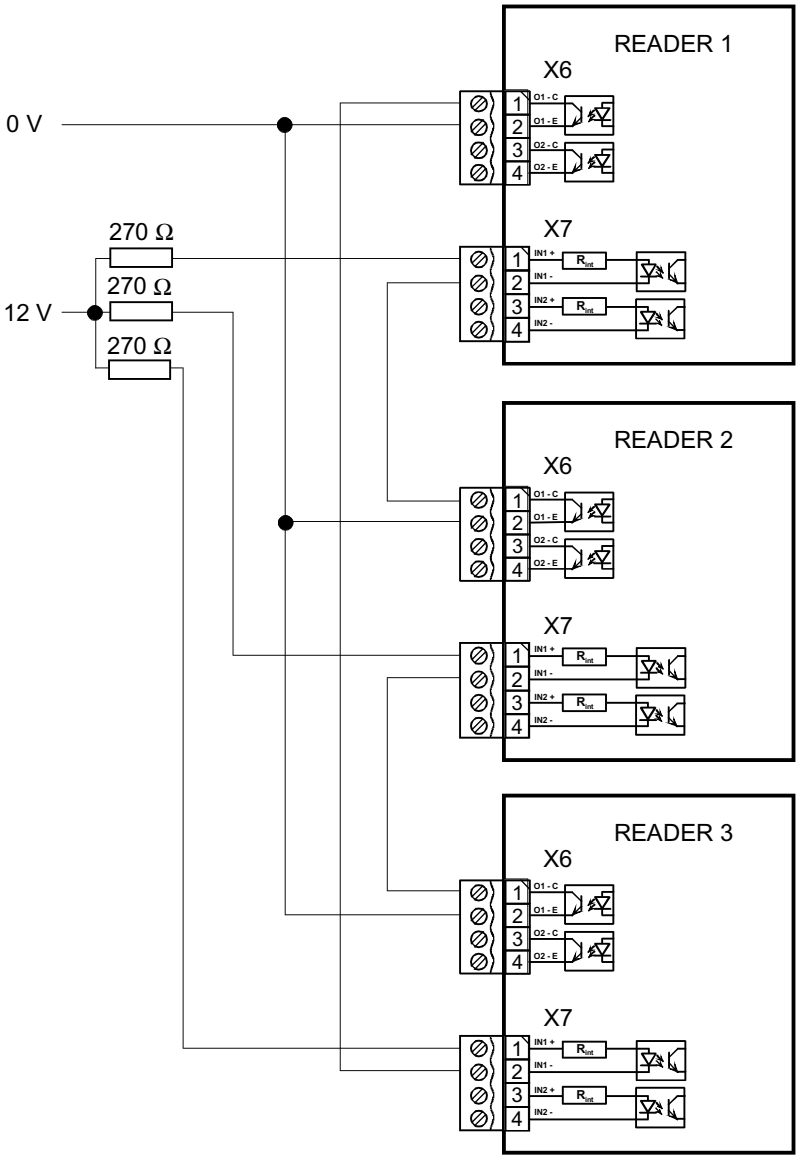


Figure 4. Cascaded Synchronization Wiring

Figure 4 shows the 270 Ω resistors required when a 12 VDC supply is used for the suggested circuit but when other voltages are used these values should be changed according to Table 1

Supply Voltage	Resistor Values
5 to 10	None required
11 to 15	270 Ω x 0.25 W
16 to 20	560 Ω x 0.25 W
21 to 24	820 Ω x 0.25W

Table 1. Dropping Resistor Values

1.3 Configuration Changes

Cascade synchronization is available in conjunction with Buffered Read Mode and with Scan Mode. In addition to the wiring, you will need to change the configuration parameters using S6_Util.exe (Version 1.30 or later). Figure 5 shows the configuration (CFG) blocks that are available under the 'Reader Setup' menu.

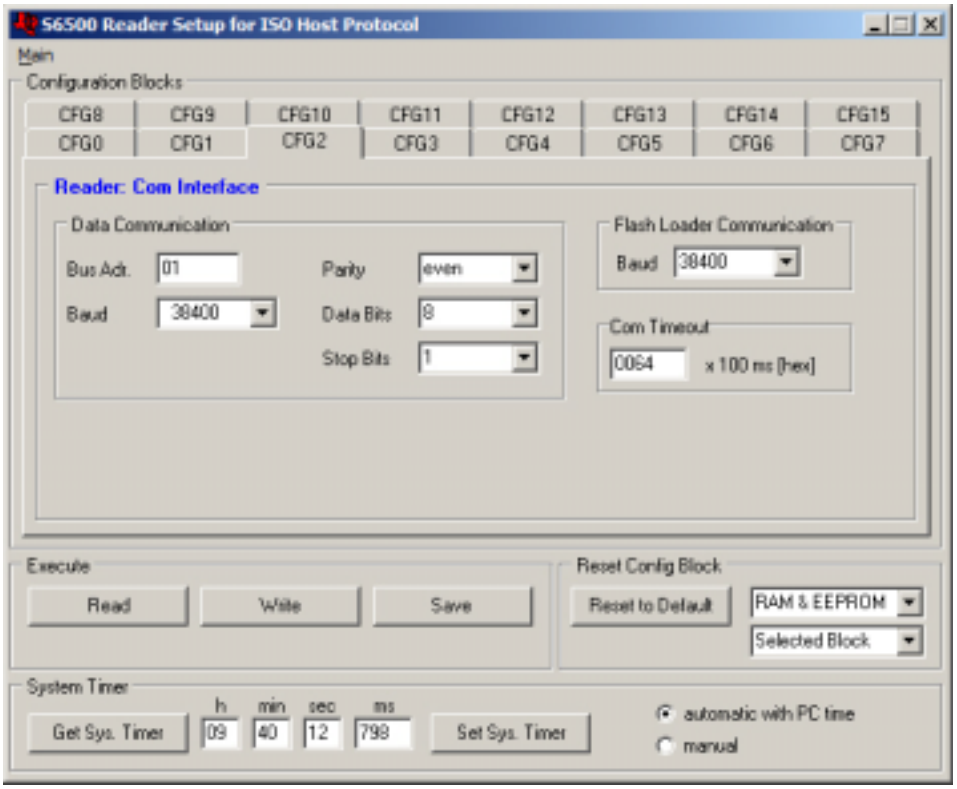


Figure 5. CFG2: Configuring the Bus Address

1.3.1 Changing the Reader's Address.

If you are using the RS-485 bus then each reader must have a unique address. Under Reader Setup tab 'CFG2' the reader address [Bus Adr.] can be changed. Like many configuration changes, the new address will not be active until after a reader RESET.

Note:

All these changes should be written to "RAM & EEPROM" to ensure they are not lost when the reader is RESET.

1.3.2 Setting-up Buffered Read Mode

When the reader is RESET after being configured as Buffered Read Mode, it will interrogate all inlays that enter the reading zone and extract, and store in the buffer, the information that you have defined in tab CFG11.

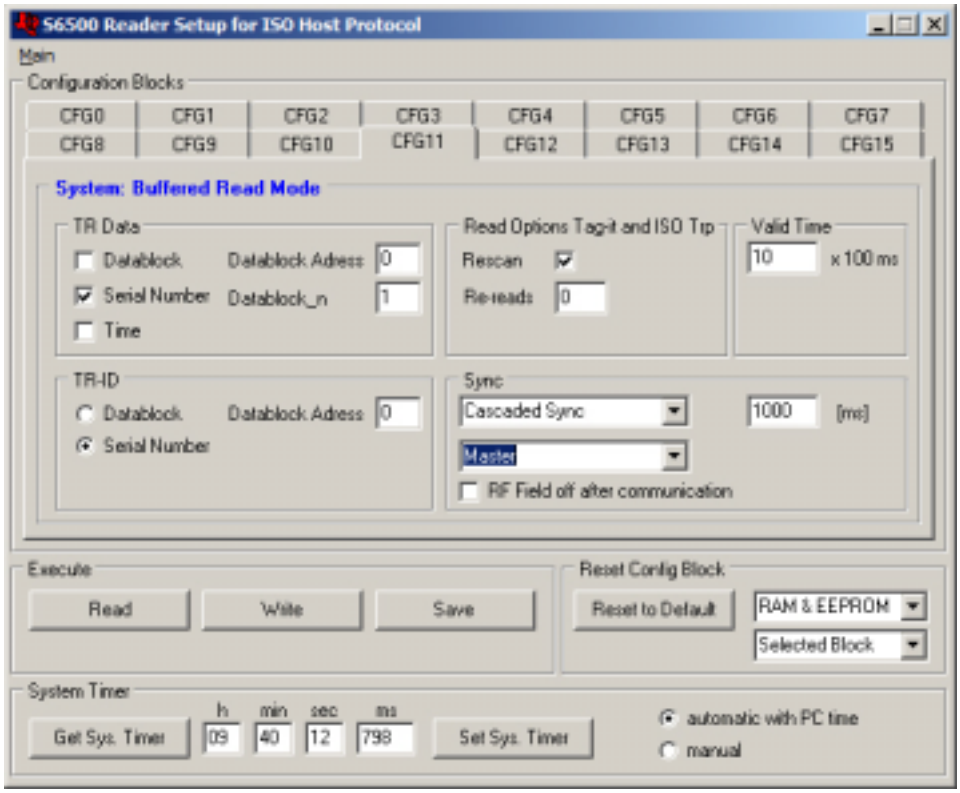


Figure 6. CFG11: Defining the Data to be Buffered

1.3.2.1 TR Data

Under this section we can decide what data we want to be stored in the buffer. We can ask for the Unique ID (UID), data blocks and Timer information. If we select Data blocks, we must give the address of the first block and the total number of blocks to extract.

1.3.2.2 Setting the System Timer

When 'Time' box in **TR Data** is checked, the current system timer value will be appended to the buffer. The system timer is not a Real-Time-Clock, and is not supported by battery back-up. This means that each time the reader is RESET, or the power cycled, the system timer will revert to "00.00.0000"

So when, after having completed the configuration, we RESET the reader to implement these changes, the timer value reverts to zero. For a system that requires accurate time stamping of readings, the Host computer will now (and following any power loss) have to send a 0x85 (Set System Timer) command to the reader.

1.3.2.3 TR-ID

In this section we can define the data used to identify the data set. It can be the Unique ID (UID) or one of the previously selected data blocks. If we decide to use a data block, its address must be defined in this section and must be within range of the previously selected blocks.

1.3.2.4 Read Options Tagit and ISO Trp

Some antenna systems do not have homogeneous RF fields and tags move in and out of reading zones as they pass through. The RESCAN option will try again to locate missing blocks of data until 'Valid Time' has expired.

If during a read operation the reading of a data block fails, REREAD will retry to read the block the defined number of times

1.3.3 Setting Up Scan Mode

When the reader is RESET after being configured as Scan Mode, it will interrogate all inlays that enter the reading zone and extract, and output on the asynchronous interface (RS-232 or RS-485), the information that you have defined in tab CFG12.

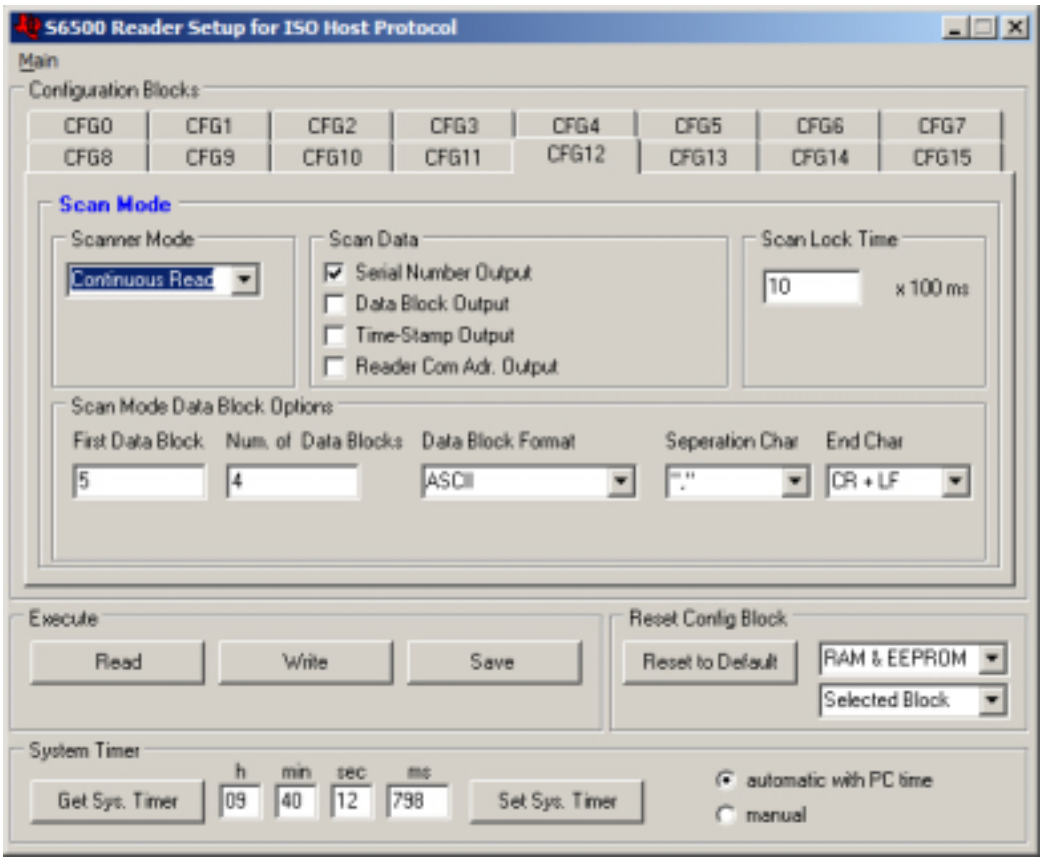


Figure 7. CFG12: Defining the Scan Mode Data

The fields are very similar to Buffered Read, except that you also need to specify the data separation and de-limiting characters.

Note:

The Casacade Synchronization for Scan Mode, is set-up in CFG11 (Buffered Read).

1.3.4 Setting Up the Cascaded Synchronisation

Under section 'Sync' (CFG11), Cascaded synchronization can be enabled and a reader defined as Master or Slave. Any reader on the network can be Master but conventionally, the first reader on the network (nearest the PC) is normally Master. Each cascaded group of readers needs a Master to initiate the 'round-robin' procedure following a RESET or a power cycle.

'RF field off after communication' should be ticked if there is only a small distance between systems. If the antennas are over 5m apart, the RF field can be left on for all but the largest antennas.

1.3.5 Changing to the Required Read Mode

Now that the data required and synchronization has been defined, we can switch to the required Read Mode. This is done under tab CFG10. Figure 7 shows the drop-down options. Once Buffered Read Mode or Scan Mode is selected, as soon as the reader is RESET or the power cycled, the reader will start operating autonomously, assembling successful readings in its buffer or outputting the data over the serial interface.

If you expect multiple inlays to be present in the field at the same time, you should also enable 'Anti-collision Mode'

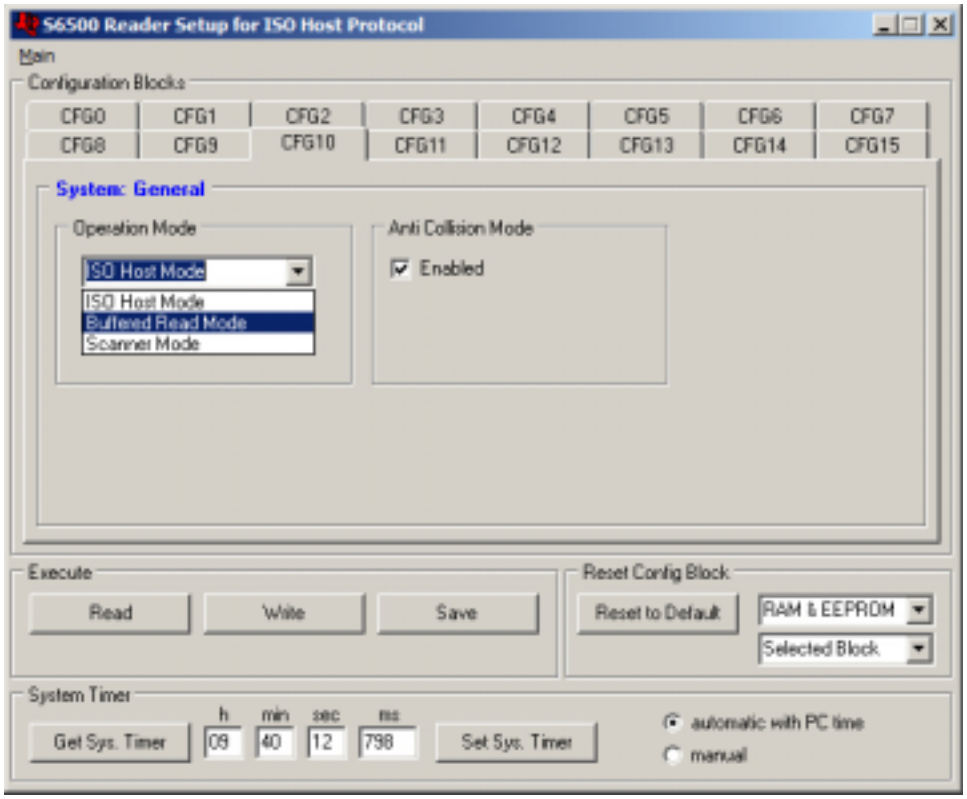


Figure 8. CFG10: Enabling the Required Read Mode

1.4 Polling for data (Buffered Read Mode Only)

Once running, the reader should be polled with an 0x21 (Read Buffer) command and if data is returned, a 0x32 (Clear data buffer) command should be sent to delete the data in the buffer. Figure 8 shows a sequence of requests and responses between a Host Computer and a reader.

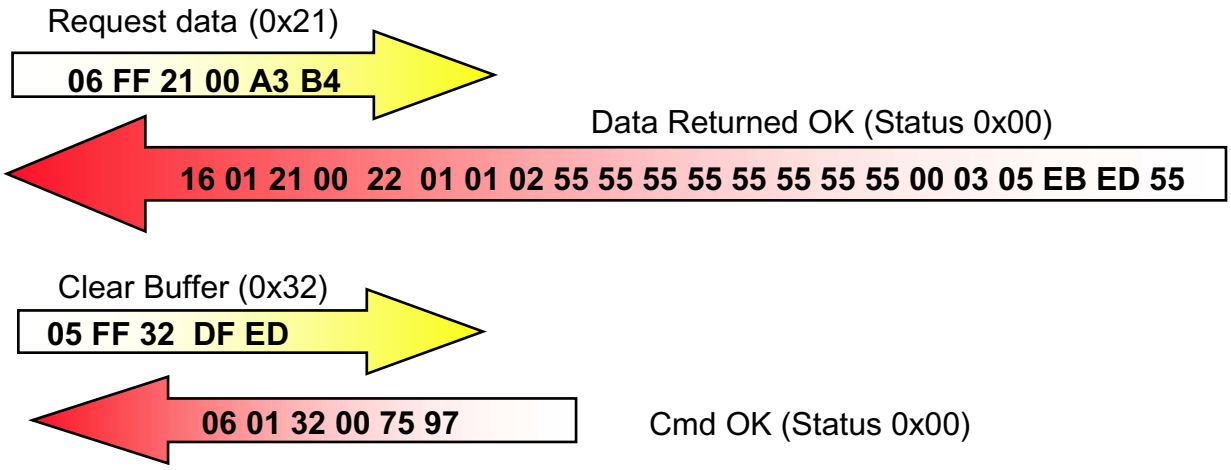


Figure 9. Polling for Data

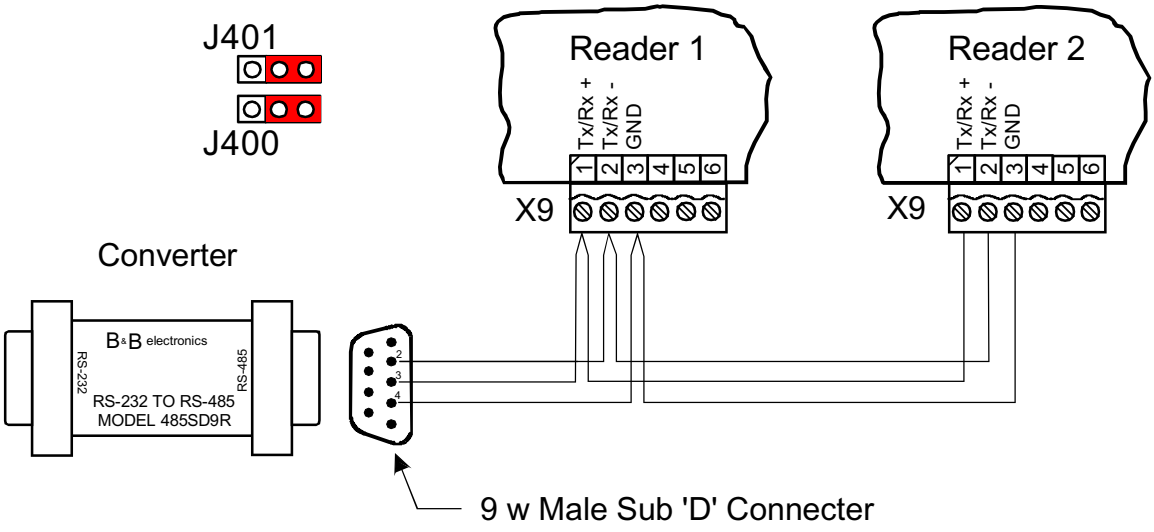
Appendix A. RS-232 to RS-485 Converter

RS-232 to RS-485 Converter (9 way)

Line driven converters like the one shown in the figure below, take their power from the RS-232 handshake lines and have automatic line control that enables the drivers only when transmitting.

Figure 10. RS-232 to RS-485 Converter

The readers should be wired as shown in the figure below. For RS-485 communications jumpers J400 and J402 must be set and, although not normally needed by this convertor for short to medium cable lengths (< 400 m), J403 may be required to terminate the line for very long cables.



http://www.bb-europe.com

Figure 11. RS485 Wiring using 9 way Converter

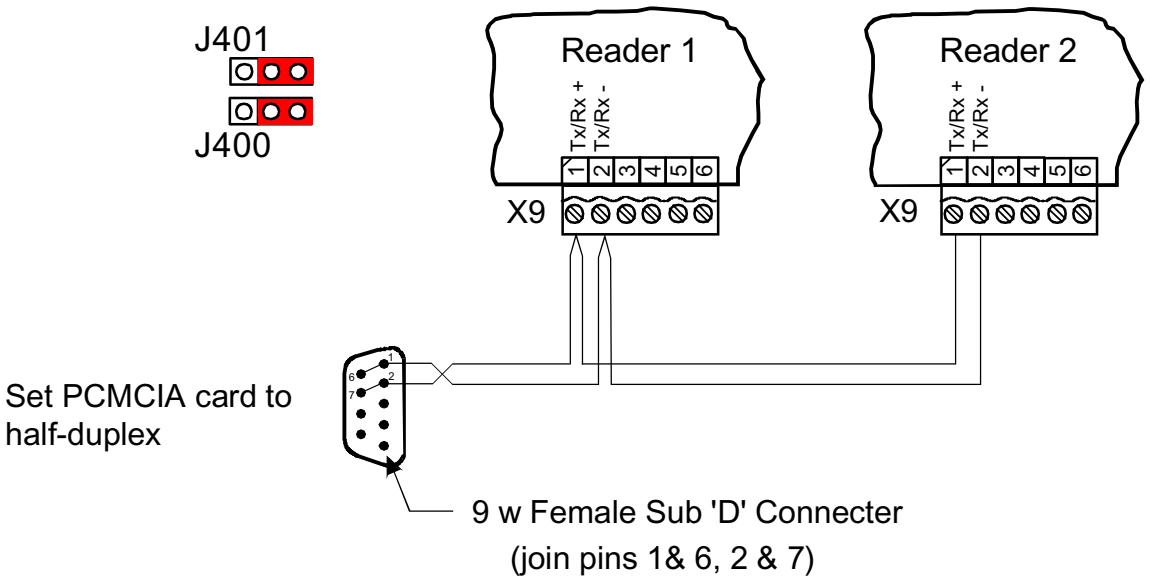
Appendix B RS-485 PCMCIA Card

Using a PCMCIA Card for RS-485 Communications

An alternative to using an RS-232 to RS485 converter is to use a pcmcia RS-485 card, similar to the Brainboxes one shown in the figure below:

Figure 12. RS-485 PCMCIA Card

The readers should be wired as shown in the figure below. For RS-485 communications jumpers J400 and J402 must be set and if the reader is the last on the bus, J403 may be required for cable termination.



http://www.brainboxes.com

Figure 13. Wiring the RS-485 PCMCIA Card