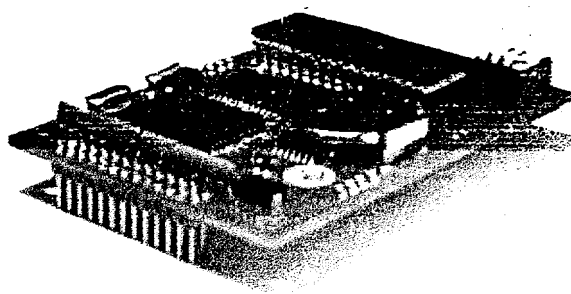


# Scorpion K4S Controller

5520 and 5521



## Introduction

The Scorpion K4S is the latest in the K4 range of credit-card-sized embedded control computers. Linked by a serial interface, the K4S may be programmed by virtually any computer running a terminal emulation program.

## The K4 Language

Quickly understood by anyone familiar with BASIC, Pascal or C, the K4 language offers a powerful, easy to use multi-tasking environment. As well as procedures, functions and both integer and floating point arithmetic, a wide range of Object-Orientated drivers are provided to simplify commonly required user interface and I/O operations. A full screen text editor is also provided.

## Control and Monitoring

Using the system bus and general purpose I/O channels, the K4S may be connected to up to 160 digital I/O channels and an unlimited number of analogue inputs and outputs. Selected digital channels may also be used for high speed pulse generation and analysis. The analogue channels can have 8 bit, 10-bit or 12-bit resolution.

## Communication

Three serial output ports and two serial input ports are available, these may be used to connect the K4S to computers, instruments, printers, modems and other K4S controllers using our multi-drop serial protocol.

## User Interface

The K4 language supports many types of both graphics and alphanumeric LCDs, as well as printers and a video display. The graphics LCD driver supports multiple windows, proportional fonts, word wrapping, justification and graphical operations, as well as 'active' bar charts and indicators. Combine this with support for multiple keypads (with up to 128 keys) the K4S can provide any application with a powerful user interface.

## Application and Data Storage

The K4S comes with either 32K (the 5520) or 128K (the 5521) of RAM on board and has language support for non-volatile RAM files, compressed data buffers and fast access tables. Applications can be up to 128K in size and may be stored in either EPROM or FLASH memory.

# The Scorpion K4 Language

## Language Keywords

### Control Flow

IF THEN ELSE WHILE DO UNTIL REPEAT FOREVER EVERY RETURN EXIT  
REGION CATCH THROW WAIT AWAIT

### Operators

( ) . AS INT AS FLOAT NOT ? ! \* / DIV MOD + - = <> >= <= AND  
OR EOR

### Assignment

MAKE NEW :=

### Printing

PRINT TO CR GOTOXY HOME CLS FONT LEFT RIGHT CENTRE PACKET  
DISPLAY COLOUR FILL ITALIC UNDERLINE PLAIN SIZE

### Structure

TO [ ] END LOCAL

### Multi-tasking

START STOP

### System

HELP DELETE EDIT LIST PROGRAM CALL

## Object Types

The key to the Scorpion K4S's rapid development cycle is the 'library' of user interface and I/O drivers built into the 'Object' system. This leaves you free to concentrate on your application without having to get involved in the details of writing hardware drivers.

### Input/Output

Digital Analogue Shaft RateGenerator PulseWidthIn  
PulseWidthOut FrequencyIn PulsesIn

### Communication

AsynchronousSerial InputBuffer OutputBuffer TerminalFilter  
Splitter ParallelPrinter I2Cbus

### Timing

RealTimeClock Instant Monostable Stopwatch RunTimeLog

### User Interface

GraphicsLCD Window AlphaLCD OnBoardLED Keypad Key Nudge  
Marker Bar Display NumberReader TeletextVideo

### Data Storage

FilingSystem DataFile TextFile Buffer TextBuffer Table  
SafeData Box

### System

K4 Debugger Task Semaphore

**Speed and Size**

The K4 language is interpreted, which means that programs take little memory. Things happen in the K4 language on a millisecond time scale. Since many commonly-required functions are implemented in the object system in machine code, the K4S can be surprisingly fast.

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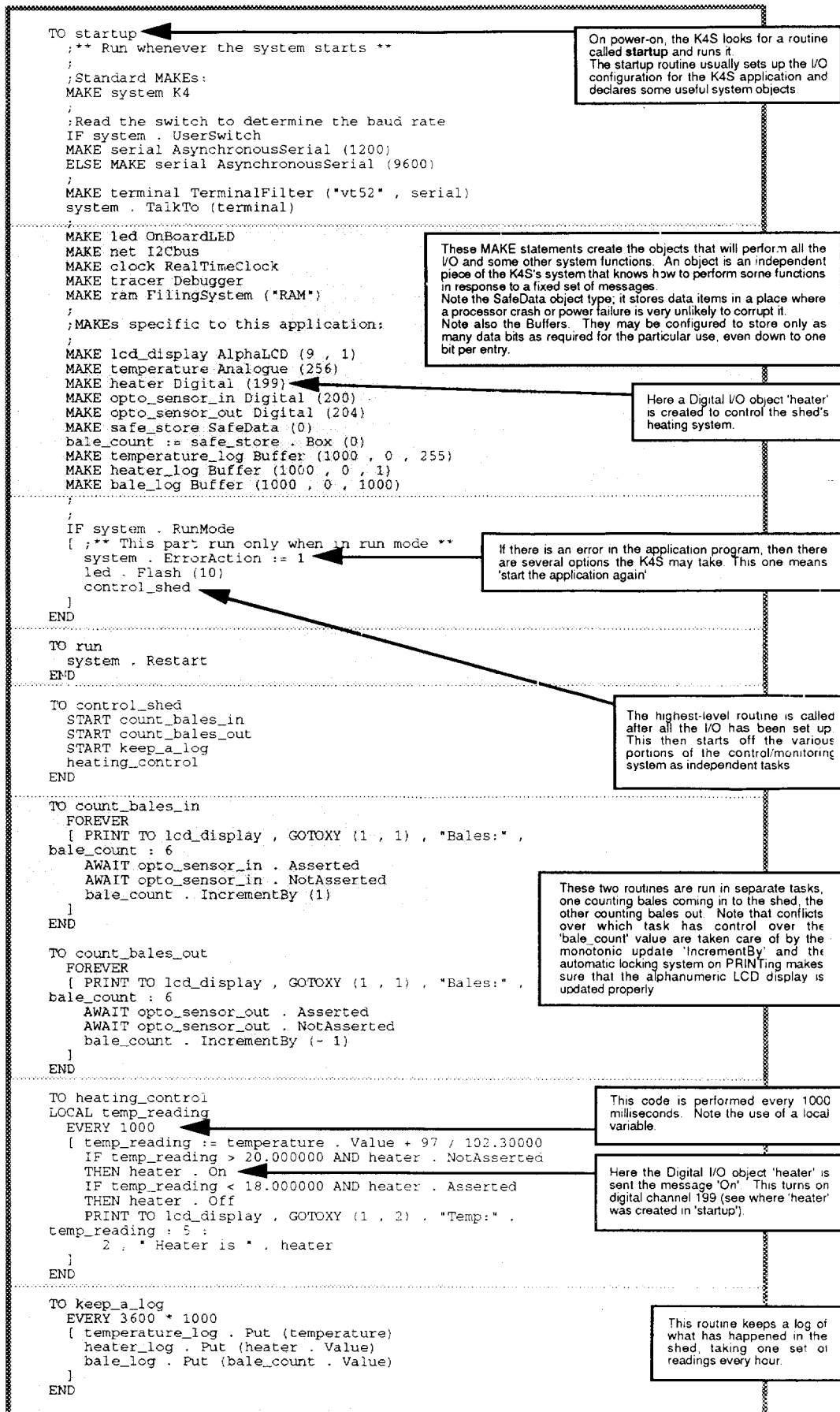
**Example Application Program**

What follows is a very short example of an application on the K4S: a farmer has a shed in which are stored bales of straw, and valuable stock is kept which must not be allowed to get cold. There are two conveyors continuously loading bales into and out of the shed. The K4S performs the following functions:

- Keeps a count of how many bales are currently in the shed
- Controls the shed's heating system
- Keeps a log of the environment and its own actions

**Points to note**

- Meaningful names are just as good as comments. Comments are declared with a semi-colon (;).
- Variables, routines and objects are all in lower case, eg. temp\_reading, lcd\_display.
- K4S keywords are shown in upper case, eg. TO, END, IF, THEN.
- Object types and messages to objects are capitalised, eg. Buffer, AlphaLCD, Put, Asserted.
- A dot (.) means send the following message to the preceding object. It may return a result.



## Hardware

### K4S I/O Channels

The bare K4S has 21 I/O 'channels'. Five of these are dedicated to the main serial port; the other 16 are general purpose. The table below lists the capabilities of these channels, each may take on one of the bulleted (•) functions at any time. Functions separated by an ampersand (&) can be used together.

Channel	Functions
1-5	•RS232 Port 1
6	•RS232 Port 2 Data output (inv or non-inv TTL levels, up to 2400 baud, 1200 guaranteed) •Pulse generation to 1.7 KHz, 0.4 $\mu$ S resolution •Digital I/O (pulled high 100K $\Omega$ )
7	•RS232 Port 3 Data output (inv or non-inv TTL levels, up to 2400 baud, 1200 guaranteed) •Pulse generation to 1.7KHz, 0.4 $\mu$ S resolution •Keypad address line 2 & Alphanumeric LCD data line 6 •Digital I/O (pulled high 100K $\Omega$ )
8	•RS232 Port 2 Data input (inv or non-inv TTL levels, up to 2400 baud, 1200 guaranteed) •Pulse width measurement down to 286 $\mu$ S, 0.4 $\mu$ S resolution •Pulse counting •Frequency measurement to 3.4KHz, 20ppm precision •Digital I/O (pulled high 100K $\Omega$ )
9	•RS232 Port 2 Handshake input (inv or non-inv TTL levels) •Alphanumeric LCD 'E' •Digital I/O (pulled high 100K $\Omega$ )
10	•RS232 Port 3 Handshake input (inv or non-inv TTL levels) •LTC1290 /CS •Keypad address line 3 & Alphanumeric LCD data line 7 •Digital I/O (pulled high 100K $\Omega$ )
11	•RS232 Port 2 Handshake output (inv or non-inv TTL levels) •Alphanumeric LCD 'RS' •Digital I/O (pulled high 100K $\Omega$ )
12	•I <sup>2</sup> C Bus Clock •Digital I/O (not pulled up)
13	•I <sup>2</sup> C Bus Data •Digital I/O (pulled high 10K $\Omega$ )
14	•I <sup>2</sup> C Bus Data Direction (For extending the bus, not normally used) •Digital I/O (not pulled up)
15	•Keypad return line •LTC1290 /CS •Digital I/O (pulled high 100K $\Omega$ )
16	•On board LED •Digital I/O (pulled high by an LED and 3K3 $\Omega$ )
17	•NMI (Non-Maskable Interrupt line - not currently used by the language, but available to machine code users, pulled high by 100K $\Omega$ )
18	•IRQ (Interrupt request - not currently used by the language, but available to machine code users) •LTC1290 Dout •Digital I/O (pulled high 100K $\Omega$ )
19	•Memory Ready - used by devices attached to the System Bus •LTC1290 /CS •Digital I/O (pulled high 100K $\Omega$ )
20	•Keypad address line 0 & AlphanumericLCD data line 4 & LTC1290 Din •Digital I/O (pulled high 100K $\Omega$ )
21	•Keypad address line 1 & AlphanumericLCD data line 5 & LTC1290 SCLK •Digital I/O (pulled high 100K $\Omega$ )

## Expanding the K4S

Many more functions may be added to the K4S via the I<sup>2</sup>C bus, Expansion bus, UPP and the LTC1290. These are described below.

### I<sup>2</sup>C Bus

The I<sup>2</sup>C bus (pronounced 'I Squared C') is a two-wire network which can control many devices. On the K4S, the I<sup>2</sup>C bus makes available the following functions, which are supported by the language, but are not part of the basic K4S hardware.

- 128 digital I/O channels.
- 32 analogue inputs channels and 8 analogue output channels (8 bit resolution).
- A real time clock/calendar.
- A teletext video display.
- The language also supports a parallel printer, alphanumeric LCDs, and keypads, all based on I<sup>2</sup>C Digital I/O channels.

In addition, the language provides direct access to the I<sup>2</sup>C bus so that unsupported devices may be controlled.

### System Bus

This is the K4S's raw processor bus, running at ~2.4 MHz, to which the UPP, Expansion Bus and other devices may be attached.

### Expansion Bus

This is a software-controlled I/O expansion port made by the addition of a few cheap ICs, attached to the system bus. It allows a graphics LCD and large keypad to be attached to the K4S. It will also drive alphanumeric LCDs.

### UPP

The HD63140 UPP (Universal Pulse Processor) is an IC which may be attached to the K4S's System Bus. On the K4S, the UPP makes available the following functions which are supported by the language but are not part of the basic K4S hardware.

- Up to 16 pulse counting inputs (100KHz max)
- Up to 8 shaft encoder inputs (200KHz max)
- Up to 6 frequency measurement inputs (100KHz max, 25 ppm precision)
- Up to 6 pulse width measurement inputs (5µs resolution)
- Up to 11 Pulse generation outputs (5µs resolution)
- 10 analogue inputs (10 bit resolution)
- Up to 16 digital I/O channels.

### LTC1290

The LTC1290 is a 12-bit analogue-to-digital convertor IC that may be attached to the K4S using the general I/O lines. The LTC1290 is supported by the K4 language's Analogue object, but does not form part of the basic K4S hardware. Up to 3 LTC1290 ICs may be connected at any one time, each providing 8 analogue inputs with 12-bit resolution.

### Real Time Clock/Calendar

The K4S has a socket for a real time clock/calendar IC. The language supports this device over dates ranging from 00:00:00 on January 1st 1990 until the year 2024, taking account of leap years. The K4S's on-board battery keeps the clock's date and time correct even when the unit is unpowered.

### Watchdog

The K4S has an on-board watchdog circuit that will normally restart the K4S's application program if the processor 'crashes'.

## Characteristics

### Absolute Maximum Ratings

Quantity	Symbol	Min	Max	Unit
Supply Voltage	Vcc	-0.3	+7.0	V
Operating Temperature	Topr	0	70	°C
Storage Temperature	Tstg	-55	150	°C
Input Voltage (all lines)	Vin	Vss-0.3	Vcc+0.3	V

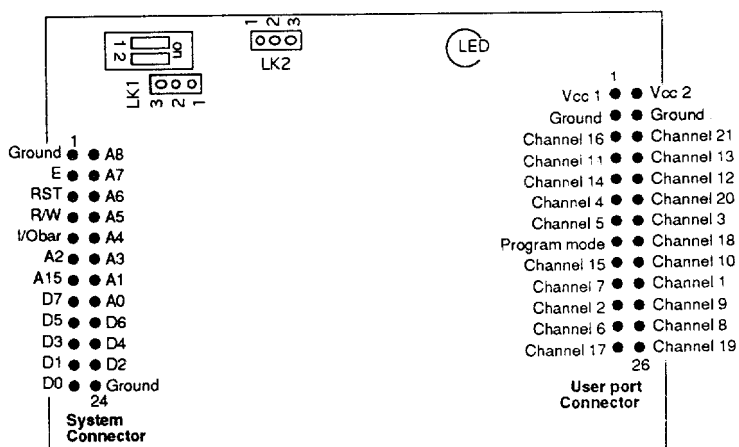
### Electrical Characteristics

Quantity	Symbol	Test condition	Min	Typ	Max	Unit
Supply Voltage	Vcc		4.6		5.5	V
Operating Current	Iin			25		mA
Doze Mode Current	Id			6		mA
Standby Current (Sleep Mode)	Is			10		µA
Output High Voltage	Voh	Ioh = -200µA	2.4			V
Output Low voltage	Vol	Iol = 1.6mA			0.4	V
Input Leakage Current*	Iin	Vin = 0.5 - Vcc - 0.5 V			1.0	µA
Input "High" Voltage	Vih		2.0			V
Input "Low" Voltage	Vil				0.8	V
Darlington Drive** (All on-board channels except 3,4,5,18,19,20)	-Ioh	Vout = 1.5V	1.0		10.0	mA

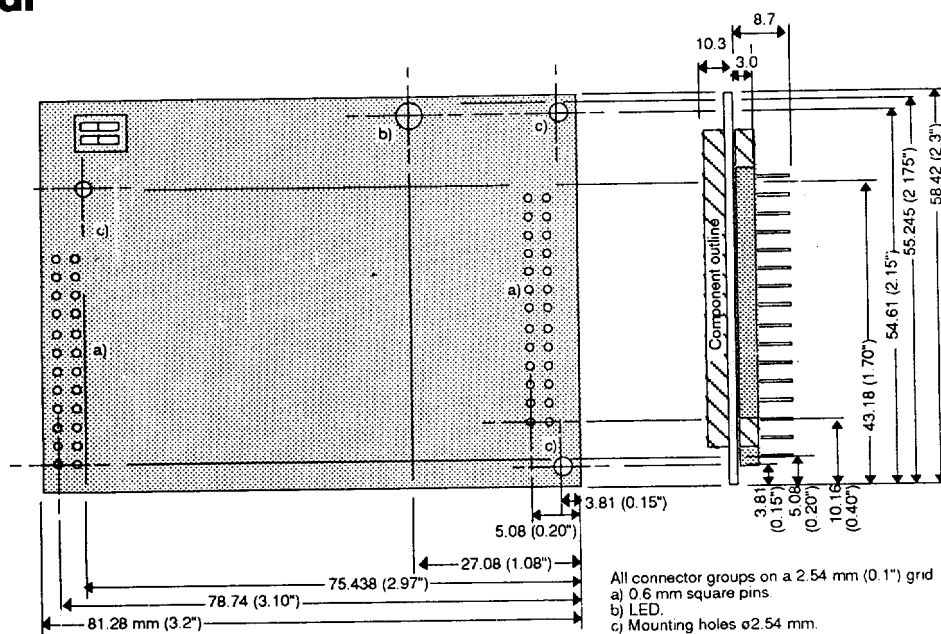
\*This must be modified by the fact that all channels are pulled to Vcc by 100KΩ, except channels 5, 12 and 14 which are not pulled at all, channel 13 which is pulled high by 10KΩ and channel 16 which is pulled high by an LED and 3KΩ.

\*\*These outputs can drive NPN darlington transistor bases directly.

## Pinout



## Mechanical



**Weight:** 36 grams  
(46 grams with EPROM and Real Time clock chip )

**Dimensions:** 82mm by 59mm by 24mm

## Getting started

To start evaluating the K4S you will need:

- A computer emulating a VT100 or VT52 terminal at 1200 or 9600 baud
- A K4S controller
- A K4 Language EPROM or FLASH language kit
- A K4 Application board
- A suitable power supply
- K4 Introductory Manuals

See the 'Entry Packs' section for information on getting started with K4S.