# Cobra VG330 Single-Chip

# Hardware Reference Platform

# Technical Manual

**Cobra VG330 Single-Chip**
**Hardware Reference Platform**
**Technical Manual**

**Document No. RM230001-02**



**Medical Disclaimer**

Vadem's products are not authorized for use in life support devices or systems or in any medical applications and cannot be used in such applications without the written consent of the President of Vadem.

# Preface

This manual is the primary reference and user's guide for the Vadem Cobra VG-330 Single-Chip Hardware Reference Platform, commonly referred to as Cobra in this manual.

## Audience

This document assumes that you have some familiarity with personal computers, microprocessors, and related support devices. The people who benefit from this book are:

- Managers and engineers who are considering the use of Cobra in a portable design.

## Related Publications

*VG330 Product Data Manual—DM330001*

*VG330 OEM BIOS Specification—DM330002*

*VG330EVAL Evaluation Kit User's Manual—DM330003*

*VG330ADPT BIOS Adaptation Kit Data Manual—DM330004*

*VG330 Debugger Utility User's Manual—DM330005*

*VG330 Configuration Utility User's Manual—DM330006*

*VG330 Product Functional Description—FD330001*

*VG330ICE In-Circuit Emulator Product Brief—PB330001*

*VG330BIOS Single-Chip Firmware Product Brief—PB330002*

*VG330EVAL Evaluation Board Product Brief—PB330003*

*VG330 Single-Chip Platform Product Brief—PB330004*

*VG330ADPT BIOS Adaptation Kit Product Brief—PB330005*

*VG330 Power Management White Paper—WP330001*

*Cobra Software User's Guide*

## Conventions Used in This Manual

The first time a word or phrase is defined in this manual, it is *italicized.*

The following signal naming conventions are used throughout this manual:

- ♦ A level-significant signal that is true or valid when the signal is LOW is preceded with an asterisk (*) or slash (/).
- ♦ An edge-significant signal that initiates actions on a HIGH-to-LOW transition is preceded with an asterisk (*) or slash (/).

The word *assert* means to drive a signal true or active. The word *deassert* means to drive a signal false or inactive.

Hexadecimal numbers are indicated by the suffix “h”— for example 0Ah. Binary numbers are indicated by a subscripted “2” following the number—for example, $0011.0010.1100.1111_2$.

# Contents

# Cobra VG330 Single-Chip Hardware Reference Platform

This document describes an application of Vadem's technology capabilities to a portable, low-power system, the Cobra VG330 Single-Chip Hardware Reference Platform, commonly referred to in this document as Cobra.

## 1.1 Introduction

Vadem provides enabling technology for hand-held electronic data processing products. It has expertise in single-chip microcomputers and power-management for low-power handheld products. Vadem has designed a custom, low-power single-chip solution for OEMs wishing to create battery-efficient handheld systems. This can reduce the time-to-market for creation of new leading-edge portable data products.

Vadem's technological knowledge, backed by experience and numerous successful designs, can help you quickly bring to market low power, highly integrated competitive products. Vadem can provide you with the tools needed to enter a market fast.

Cobra is only one example of many different solutions, applications, and operating systems which can be built on Vadem's single-chip platforms.

## 1.2 Features

Cobra has the following features:

- Vadem VG330 single-chip PC platform
- A total of 2 MByte of DRAM consisting of a single 1M x 16 DRAM
- 4 MBytes of FLASH EPROM, consisting of two 1M x 16 FLASH devices
- Power Supply Unit
- LCD display
- Digitizer/touch panel using 10-bit serial A/D converter
- VG330 Firmware/BIOS
- Graphical OS Software & Applications
- PC Card Slot
- Enclosure and hardware
- Infra-red communications transceiver

## 1.3 System Architecture

Vadem' s approach for Cobra was to develop a small, handheld client device to provide email, web browsing, and general interconnectivity with few device resources.

Cobra contains bundled firmware and application software, allowing a “plug ‘n play” solution for internet and world-wide-web access.

The application software consists of:

- HTML 2.0-compatible Web Browser
- E-mail
- Usenet

You can customize Cobra with an API for lower-level firmware and use standard development tools based on DOS to develop your own applications. This toolkit approach of a well-documented API plus standard DOS development tools allows easy application development for the OEM consumer. The standard software development tools allow you to compile, assemble, link, locate, and debug using DOS. You can link into the libraries provided by Vadem, form an executable file for the VG330, and put the image into ROM.

A version of the kernel can run on top of DOS, so while you are prototyping, you can develop all the applications for DOS, and prototype with them. After you have finished debugging, you can use the same API that you use on the kernel,  then use the new kernel libraries that do not have DOS function calls to eliminate the overhead associated with DOS.

## 1.4 Design Objectives

Cobra was developed with two specific objectives:

- Provide OEM developers with full schematics and documentation for a working design
- Show that a working device can be built, using 2-AA batteries, in a most compact design, with a low bill of materials costs

Cobra can be used as a baseline development architecture for a system running the an operating system that allows hardware management as well as connection to an internet mediation server.

Cobra highlights the power, size and integration capabilities of Vadem's low cost single-chip processors, and demonstrates how easy it is to build a light weight, portable, pen-based personal information manager using Vadem technology.

Cobra combines the state-of-the-art technologies of Vadem's VG330 single chip computer with a PC Card and a Graphical User Interface (GUI) with pen input. It shows how easy it can be to create a PDA (Personal Digital Assistant), a PIM (Personal Information Manager), a PDT (Portable Data Terminal), or a general purpose Electronic Organizer. The system demonstrates that a design can achieve powerful functionality while retaining the low cost and low power requirements for hand-held devices.

Cobra uses a pen-input, graphical user interface (GUI) based operating system together with Vadem firmware. The system runs applications such as a web browser, graphical e-mail, and usenet.

Vadem's objective for this design is to demonstrate the ability to build a light weight, cost-effective, personal information manager running on two AA batteries. Vadem's patented power management technology and system level integration are among the critical factors that contribute to the design's success.

Cobra is provided with a generic case; however, OEMs are free to choose their own case design. There are few ICs required on the board because most of the system level components are already integrated into Vadem's VG330. As a result, the design achieves reduced power consumption and compact size.

Cobra demonstrates Vadem's ability to design a product with increased levels of functionality, while maintaining the low cost and low power consumption requirements for hand-held devices.

## 1.5 Block Diagram

Figure 1.1 is a high-level Cobra block diagram.

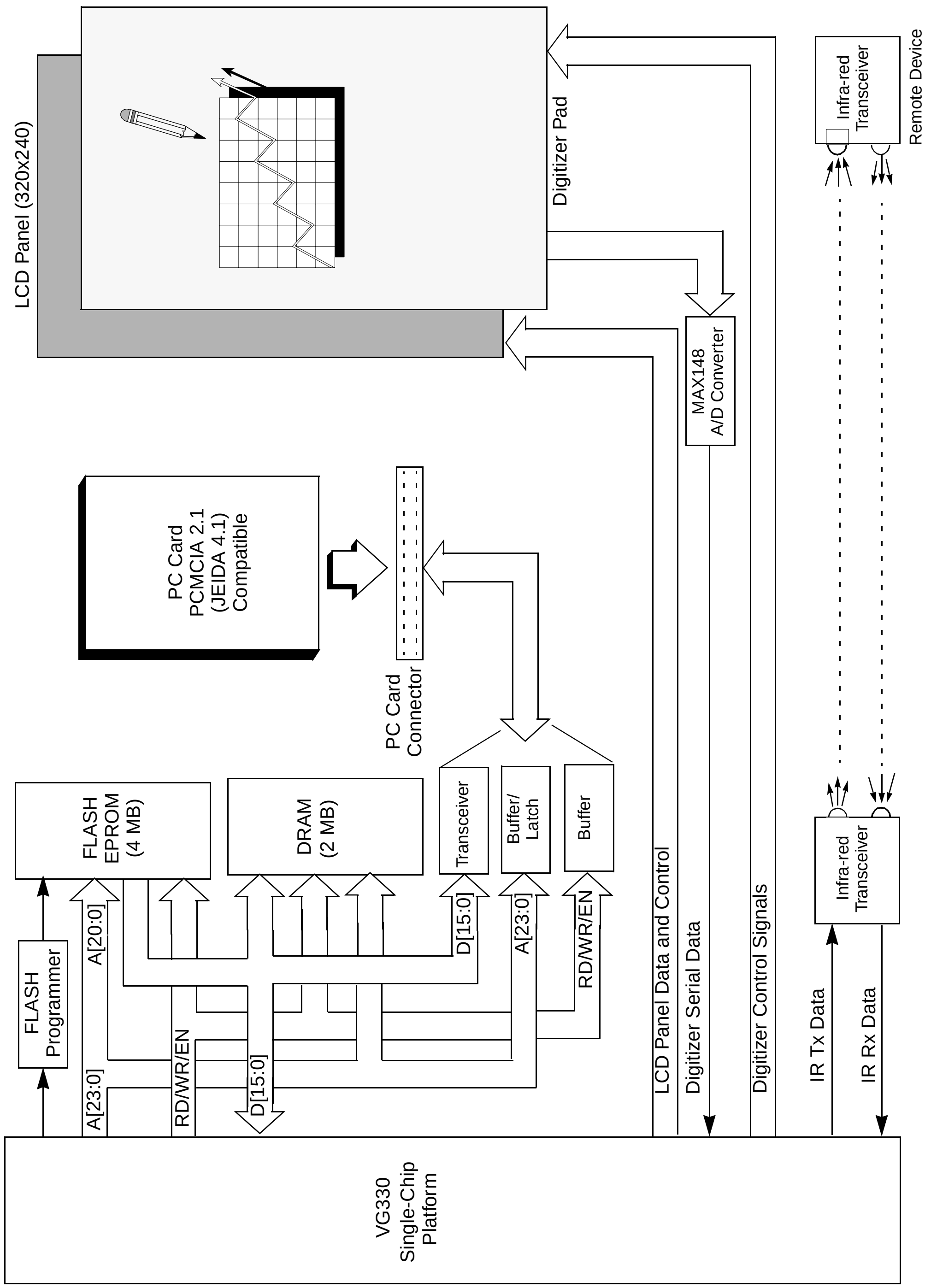
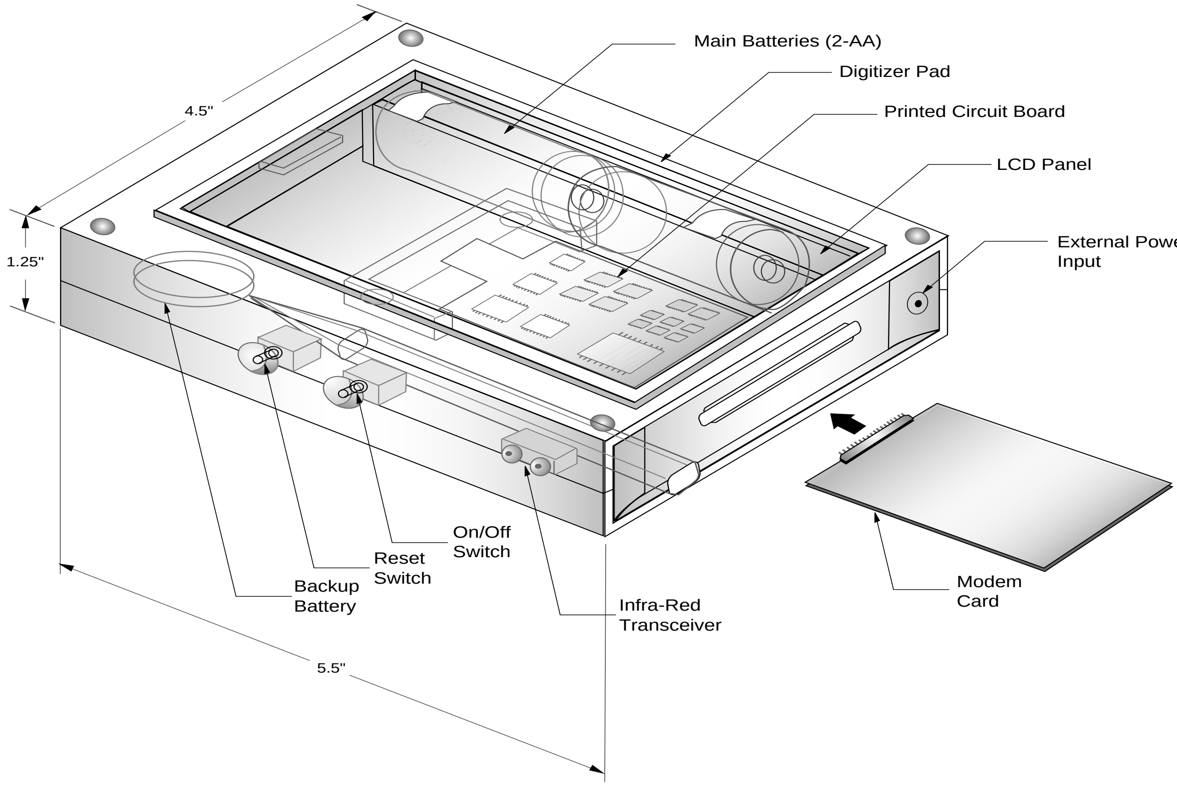



Figure 1.1
Cobra Block Diagram

## 1.6 Demonstration Kit

Cobra's main components are shown in Figure 1.2.

Figure 1.2
Demonstration Unit




Cobra contains the following items:

- Enclosure
- PCB
- Operating System in FLASH ROM
- Modem Card for Internet Access
- Two AA Batteries
- This Technical Manual
- Vadem VG330 Data Manual

## 1.7 Operating Cobra

Cobra is easy to use. Follow these steps to prepare it for use:

1. Install two fresh AA batteries.
2. Install the modem PC Card card in the PC Card slot.
3. Push the ON button.
4. Follow the instructions on the LCD screen.

## 1.8 Hardware Description

Cobra includes a PCB with its components and a small form factor digitizer tablet overlaid on an LCD. The LCD/Digitizer can be replaced by an LCD/Digitizer of the customer's own choosing, allowing any size to be considered.

### 1.8.1 Printed Circuit Board (PCB)

The Cobra PCB contains the following principal hardware elements, as shown in Figure 1.3 and Figure 1.4.

- Vadem VG330 single-chip PC platform
- 2 MByte of DRAM
- 4 MBytes of FLASH memory configured as two 1M x 16 flash ROMs,
- Power Supply Unit
- LCD display
- Digitizer/touch panel using 10-bit A/D converter
- VG330 Firmware/BIOS
- PC Card Slot

Figure 1.3
Cobra PCB (top)

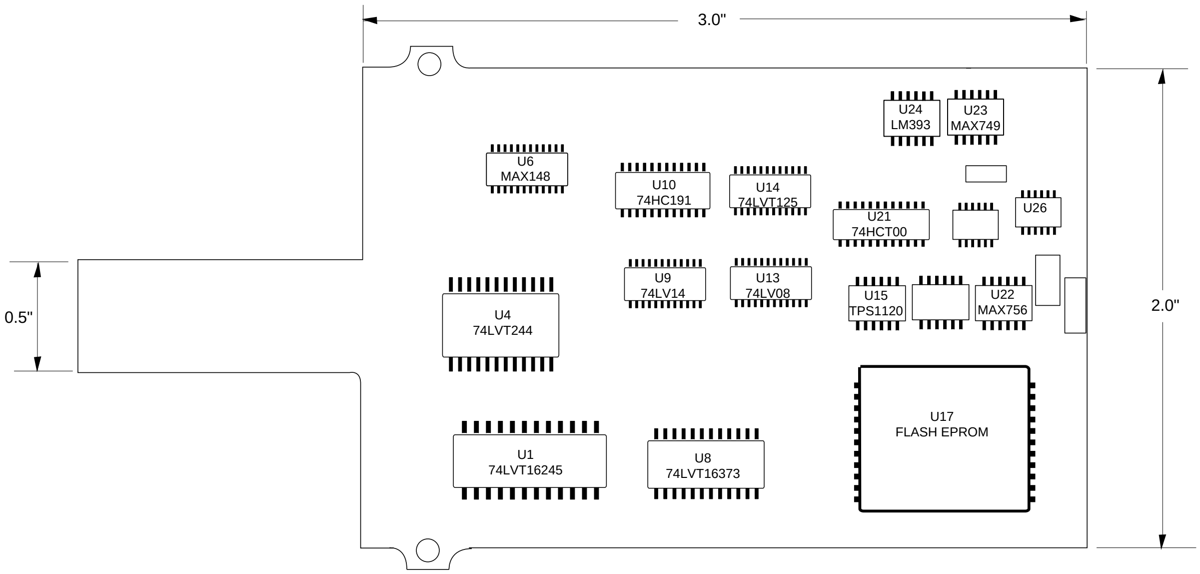
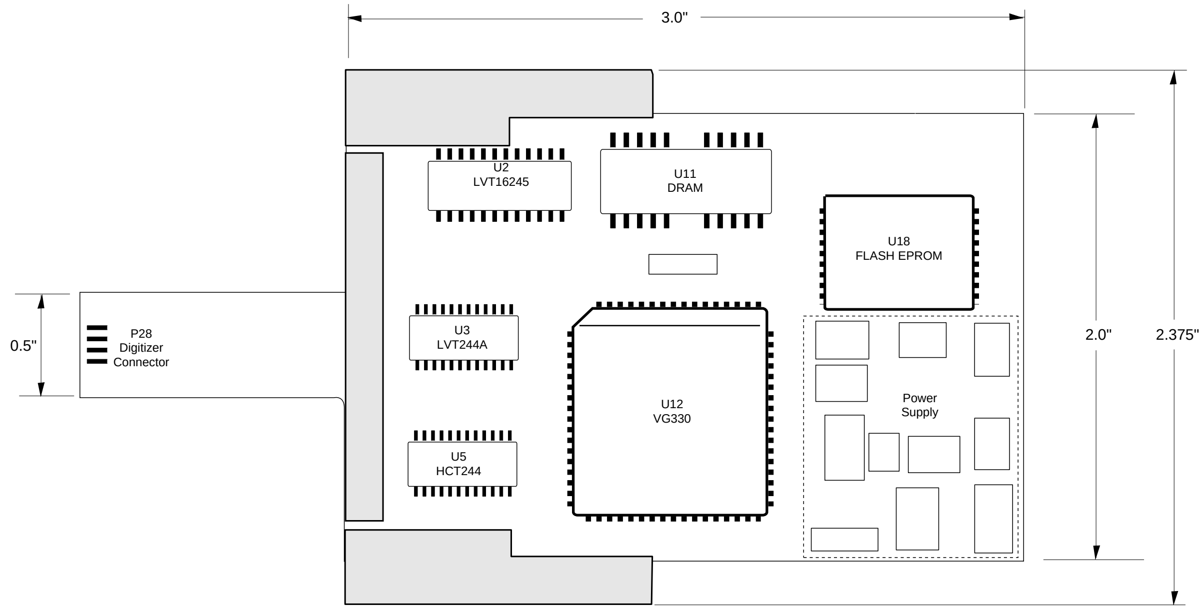


Figure 1.4
Cobra PCB (bottom).




### 1.8.2 Hardware Component Descriptions

This section describes the main hardware components in more detail.

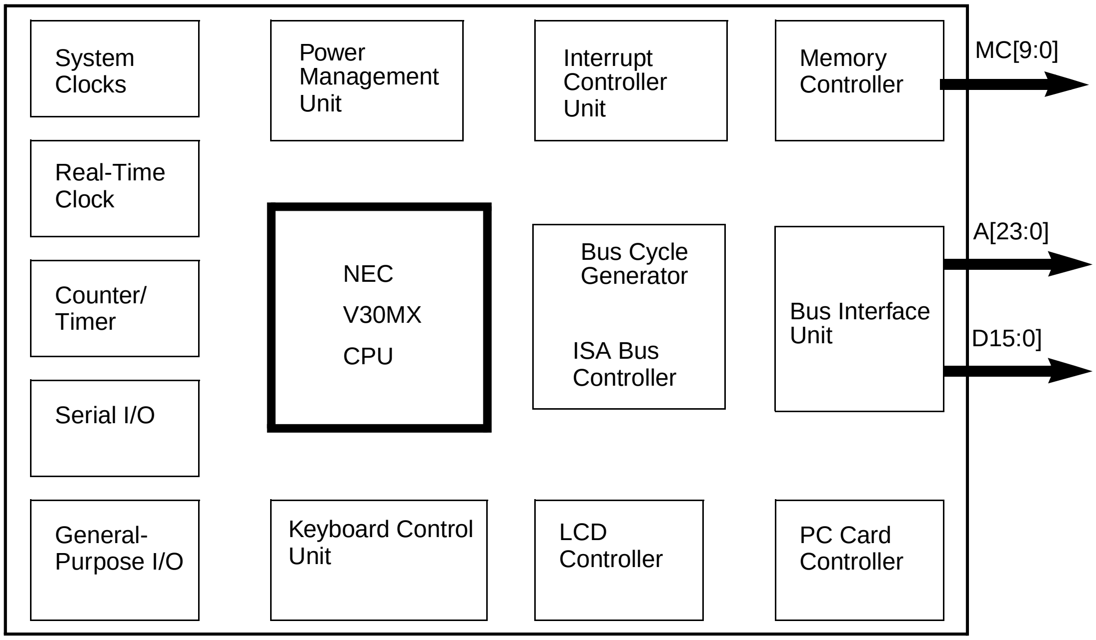
#### 1.8.2.1 Vadem VG330

The Vadem VG330 is a single 160-pin CMOS chip. Vadem's custom design makes it easy for OEMs to develop low-power, yet cost-sensitive, DOS-based personal electronic products. The VG330 integrates the following, as illustrated in Figure 1.5.

- 32-MHz NEC V30MX processor (16-bit, 80186-compatible CPU)
- PC Card 2.10/ExCA/JEIDA 4.2 controller
- 8254-compatible Counter/Timer
- 16450-compatible serial port with HP infra-red interface option
- RTC (Real-Time Clock)
- LCD controller, supporting CGA 640x200, AT&T 640x400, and VGA 640x480 monochrome graphics modes
- Interrupt Controller
- XT-compatible keyboard interface (scanning up to 101 keys) and a matrix keypad scanner
- LIM 4.0-compatible EMS memory subsystem, supporting DRAM, SRAM, or PSRAM
- Vadem Power Management Unit (PMU)

- 24 GPIO (General-Purpose I/O) pins, for flexible configuration of inputs and outputs
- ISA Bus controller, capable of 8- and 16-bit memory and I/O cycles, similar to PC-AT bus cycles
- Bus Cycle Generator, which controls all timing
- Bus Interface Unit, controlling external ISA bus and internal address and data path handling

Figure 1.5
VG330 Block Diagram




### 1.8.2.2 Memory

The Cobra demonstration unit contains 2 Mbytes of DRAM, shown on sheet 4 of the schematic. The DRAM addressing conforms to the Memory Controller Pin Functions table in Chapter 6, “Memory Controller Unit,” of the VG330 Data Manual.

**DRAM Memory –** Memory control lines MC6 and MC7 control /LCAS and /UCAS, while MC8 and MC9 control /OE and /WE. The bank selection is done by MC0, which is connected to the /RAS pin of the DRAM.

**FLASH ROM Memory –** The ROM memory in the demo unit consists of two 1Mx16 FLASH ROMs, for a total of 4 Mbytes. /SMRD is used to control /OE for both ROMs. The two are addressed by setting either /ROMEN active or /ROMCE1 active. Designers may choose to use other ROM sizes. A design may use only one ROM bank accessed by /ROMEN, if required, in which case /ROMCE1 would go unused.

### 1.8.2.3 PCMCIA

Cobra has one card slot that complies with PC Card 2.10 (JEIDA 4.1) standards. This is shown on sheet 5 of the schematic.

### 1.8.2.4 Infrared Communication (IrDA)

For purposes of illustration, Cobra includes components to show how infrared communication can be easily included in a design, but software drivers are not included at this time with the hardware.

Cobra uses Temic's TFDS3000 Infrared IrDA Integrated Transceiver Circuit, which is connected to the VG330's serial port IR_RXD and IR_TXD signals. The IR_RXD and IR_TXD signals are two of the VG330's GPIO (General Purpose Input/Output) pins.

Temic's TFDS3000 IrDA Integrated Transceiver connects to the VG330 and contains an integrated photo-diode and LED. The transceiver RXD output is inverted before being sent to the VG330 as IR_RXD, and the VG330 IR_TXD signal is fed through a tri-state buffer before being sent to the transceiver as TXD. The TFDS3000 transmits and receives the pulse shaped bit stream and can be shut down for power management under control of the VG330 /IRDA_EN signal.

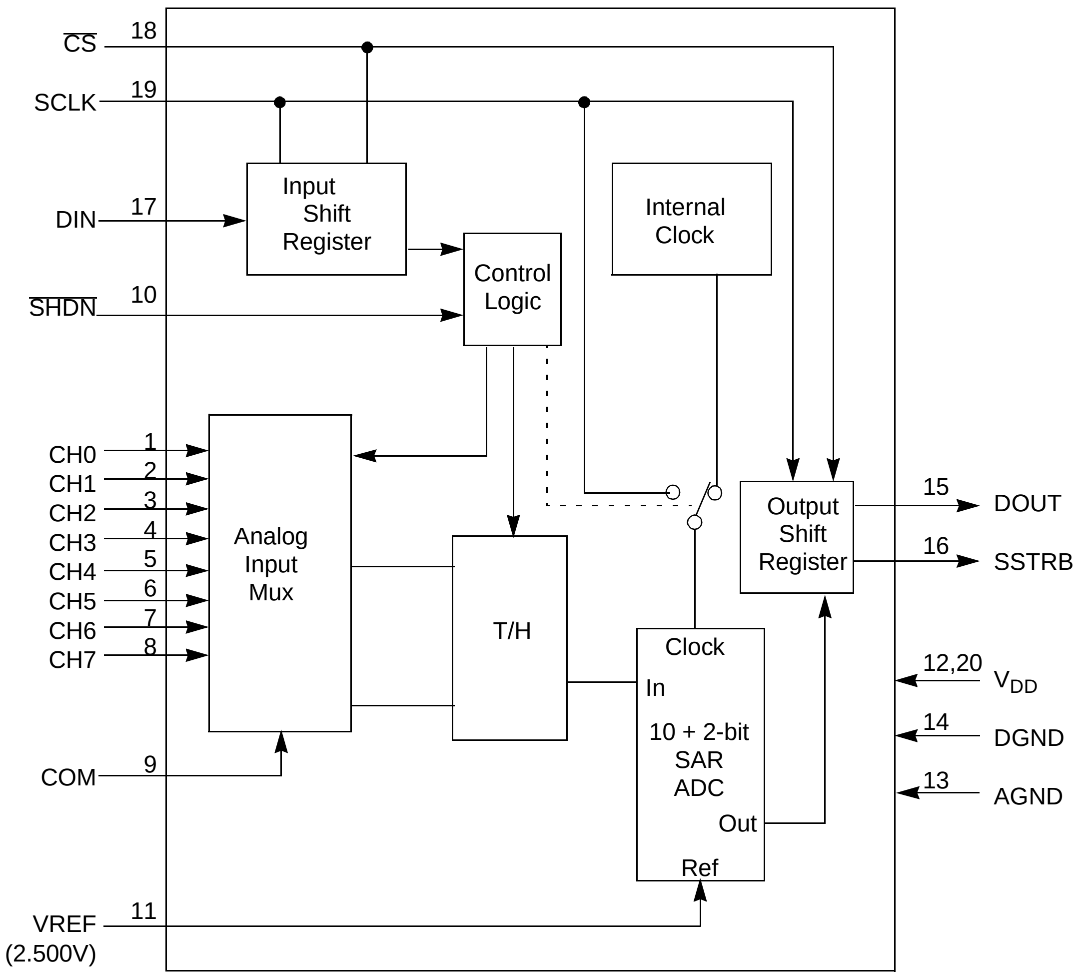
The IrDA standard allows data rates from 2.4kBaud up to 115kBaud.

### 1.8.2.5 A/D Converter

Cobra uses Maxim's MAX148, a 10-bit serial Analog-to-Digital Converter with an internal Track/Hold and a sampling rate of 133KHz. The converter is shown on sheet 7 of the schematic, and shown in Figure 1.6.

The device can be used in 8-channel single-ended mode, or 4-channel differential mode. The present Cobra design uses single-ended mode. An auto-calibration cycle eliminates need for offset or gain adjustment. Conversion results are available through a serial output.

Figure 1.6
MAX148 A/D Converter Block Diagram



### 1.8.2.6
### Touch Panel

The demonstration unit uses a GUNZE G-20 (resistive touch panel) digitizer. It works in conjunction with custom pen driver software to display digital ink on the LCD display. The performance specifications are listed in Table 1.1.

Table 1.1
Touch Panel
Specifications

**Electrical**

| **Parameter** | **Value** |
|---|---|
| Maximum voltage | 5 VDC. |
| Maximum current | Less than 1 mA at contact point of top layer with bottom layer |
| Operating temperature | 0 °C to 50 °C |
| Operating Humidity | 20% to 85% (non-condensing) |
| Non-Operating temperature | -10 °C to 60 °C |
| Non-Operating humidity | 20% to 90% (non-condensing) |
| Terminal resistance | between XL and XR: 250 to 760 ohms<br>between YU and YL: 250 to 760 ohms |
| Linearity | +/- 1% |
| Insulation resistance | 10 megohm or more at 26 VDC |

**Mechanical**

| | |
|---|---|
| Input | ±0.8 stylus or finger |
| Actuation force | 10 - 80 grams |
| Transparency | Typical 78% |
| Surface hardness | Pencil hardness 3H or more according to IIS-K6400 |

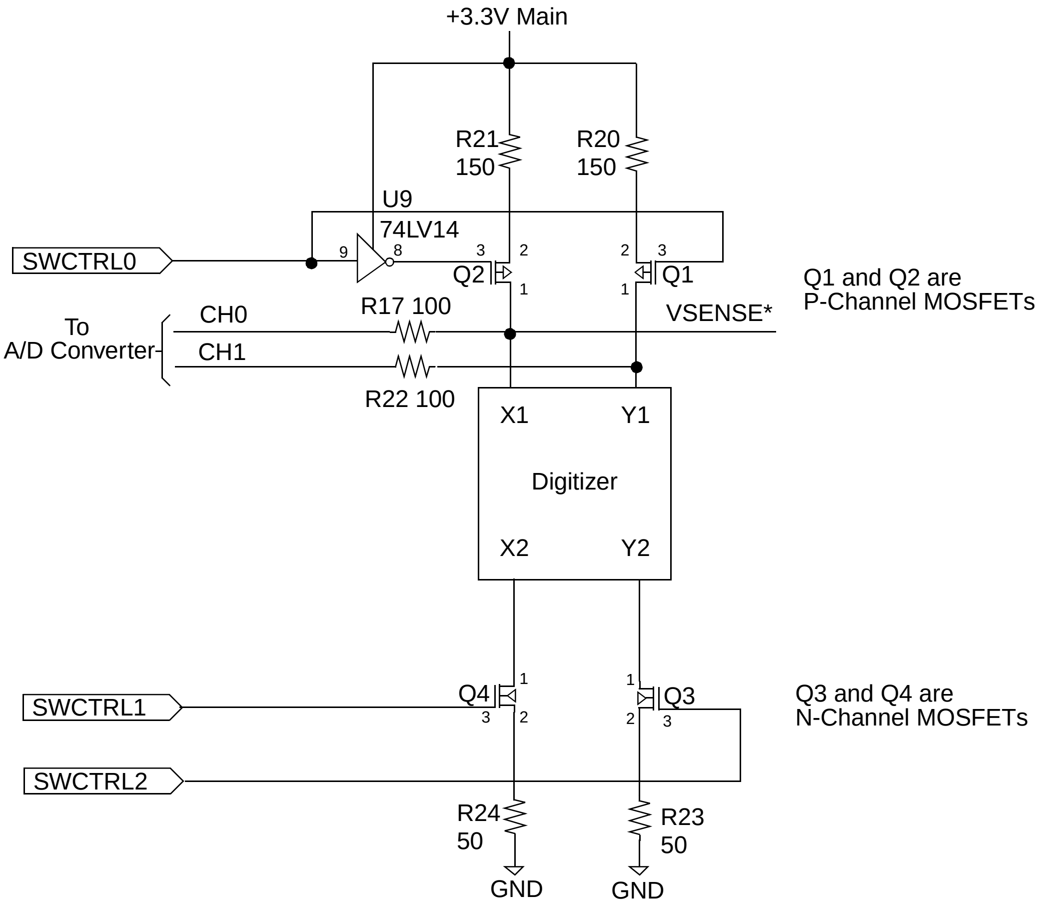
The touch panel operates by producing an X axis and a Y axis resistance value that corresponds to where the pen is pressed. These values are read by passing a voltage through the panel on each axis and measuring the output voltage for that axis. Refer to Figure 1.7.

Refer to sheet 7 of the schematic for details of the MOSFET switches used in this design. Switch Control signals SWCTRL[2:0] open and close the MOSFETs, Q1-Q4, shown on that sheet and in Table 1.2.

The digitizer output is read as follows: hardware detection of pen-down causes the firmware to control reading of one digitizer axis at a time. For example, the Y-axis value is read by turning Q1 and Q3 on to provide a voltage across the Y axis of the digitizer sheet. Analog voltage CH1 is buffered and sent to an input of the A to D converter, where it is converted to a digitized value.

Designers may use their own choice of vendor for the Digitizer Panel.

Figure 1.7
Digitizer Electronics




* The VSENSE signal is used for detecting pen-down (see schematic page 7)

Table 1.2
Switch States for Digitizer

| | Switch State | | | |
|---|---|---|---|---|
| **State** | **Q1** | **Q2** | **Q3** | **Q4** |
| Waiting for pen-down | Closed | Open | Open | Open |
| Pen-down, scan X<br>(A/D converter reads CH0) | Open | Closed | Open | Closed |
| Pen-down, Scan Y<br>(A/D converter reads CH1) | Closed | Open | Closed | Open |

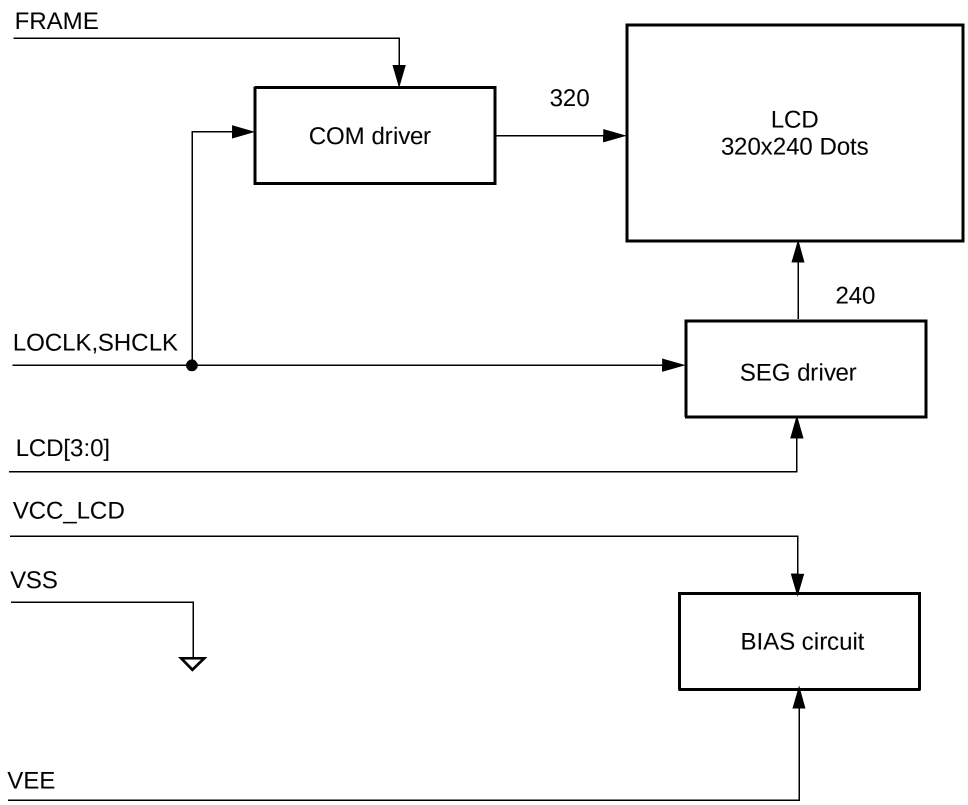
### 1.8.2.7
### Liquid Crystal Display

The LCD used is a Sharp LM320081 passive matrix LCD. It has an integrated decoder for the external 4-bit parallel data bus and has the following basic specifications:

Table 1.3
LCD
Specifications

| Parameter | Value |
|---|---|
| Dot size | .28 mm |
| Dot pitch | .30 mm |
| Pixel Resolution | 320 dots W x 240 dots H |
| Active viewing area | 100W x 76H (mm) |

Figure 1.8
LCD Block Diagram



Note: Vadem chose the Sharp LCD used in the demonstration unit for size, quality and availability. Designers may of course select their own choice of vendor for the LCD Panel. Samsung's UG32F07FNBRX-A panel is a low cost alternative

#### 1.8.2.8 Power Supply

Main power to Cobra comes from two AA batteries. A Maxim MAX756 device steps up the battery voltage to 3.3V, which powers most of Cobra's electronics. A Maxim MAX777 device provides +5V to run the LCD panel and PCMCIA card. A MAX858 device provides 3.3V from the lithium backup battery to maintain the system configuration information while the AA batteries are being changed.

The Power Management Unit (PMU) of the VG330 supplies signals for controlling power to the ROM, LCD and PCMCIA card. These switches are implemented using a TPS1120D MOSFET switch.

## 1.9 Bill of Materials

The bill of materials for Cobra is shown in Table 1.4

Table 1.4
Bill of Materials

| Item | Quantity | Reference | Part Description |
|---|---|---|---|
| 1 | 1 | D6 | 1N4148 |
| 2 | 39 | C1, C2, C3, C5, C6, C7, C9, C10, Cl1, C12, C13, C14, C15, C17, C18, C20, C21, C22, C23, C24, C25, C26, C27, C28, C31, C32, C35, C36, C38, C44, C45, C46, C47, C48, C50, C53, C56, C57, C58 | 0.l uF |
| 3 | 3 | C4, C8, C43 | l00 pF |
| 4 | 1 | C16 | 0.00l uF |
| 5 | 1 | Cl9 | 470 pF |
| 6 | 2 | C29, C30 | 15 pF |
| 7 | 4 | C33, C34, C51, C54 | l00 uF |
| 8 | 2 | C40, C37 | 22 pF |
| 9 | 1 | C39 | 0.0033 uF |
| 10 | 1 | C41 | 150 uF |
| 11 | 2 | C42, C49 | 22 uF |
| 12 | 1 | C52 | 0.0l uF |
| 13 | 1 | C55 | 6.8 uF |
| 14 | 1 | D1 | 12V |
| 15 | 1 | D2 | lN5818 |
| 16 | 1 | D3 | IN5817 |
| 17 | 3 | D4, D5, U20 | lN914 |
| 18 | 2 | JP5, JP1,JP9 | HEADER 12 |
| 19 | 2 | JP3, JP2 | 2-W |
| 20 | 2 | JP4, JP10 | HEADER 2 |
| 21 | 1 | JP7 | HEADER 5 |
| 22 | 1 | JP8 | 3-W |
| 23 | 1 | L1 | 4.7 uH |
| 24 | 1 | L2 | l0 uH |

Table 1.4
Bill of Materials

| Item | Quantity | Reference | Part Description |
|---|---|---|---|
| 25 | 1 | L3 | 22 uH |
| 26 | 2 | L4, L5 | 47 uH |
| 27 | 1 | P1 | DIGITIZER |
| 28 | 1 | P2 | PCMCIA |
| 29 | 2 | Q2, Q1 | BSS84ZXCT-ND |
| 30 | 3 | Q3, Q4, Q6 | ZVN3310FCT-ND |
| 31 | 1 | Q5 | PMBT2222A |
| 32 | 1 | Q7 | ZTX750 |
| 33 | 20 | R1, R2, R3, R6, R9, R10, R12, R13, R14, R18, Rl9, R25, R37, R70, R71, R72, R75, R76,R777,R78 | 22K |
| 34 | 2 | R4, R39 | 100K |
| 35 | 15 | R5, R11, R16, R26, R27, R29, R35, R36, R38, R40, R44, R59, R61, R62, R63 | 47K |
| 36 | 3 | R7, R48, R74 | 1M |
| 37 | 1 | R15 | 220 |
| 38 | 2 | R17, R22 | 100 |
| 39 | 2 | R20, R21 | 150 |
| 40 | 2 | R23, R24 | 50 |
| 41 | 2 | R28, R54 | 10K |
| 42 | 1 | R32 | 10 ohm |
| 43 | 1 | R34 | 12K |
| 44 | 1 | R41 | 450K |
| 45 | 4 | R42, R43, R45, R50 | 100K 1% |
| 46 | 1 | R46 | 4.3K |
| 47 | 1 | R47 | 1.64M |
| 48 | 1 | R49 | 470 |
| 49 | 2 | R69, R51 | 100 OHM |
| 50 | 1 | R53 | 470K 1% |
| 51 | 2 | R65, R56 | 1M 1% |
| 52 | 1 | R57 | 0.5 |
| 53 | 1 | R58 | 43K 1% |
| 54 | 1 | R60 | 3K |
| 55 | 1 | R66 | 600K 1% |
| 56 | 1 | R67 | 4.7 OHM |
| 57 | 1 | R68 | 2K |
| 58 | 1 | R73 | lM 1% |
| 59 | 2 | TP2, TP1 | TP |
| 60 | 1 | TP3 | TP |
| 61 | 1 | U1 | 74LVT16245 |
| 62 | 1 | U2 | 74LVT16244 |
| 63 | 1 | U3 | 74HC244 |
| 64 | 1 | U4 | 74LVT244 |
| 65 | 1 | U5 | 74HCT244 |
| 66 | 1 | U6 | MAX148 |
| 67 | 2 | U25, U7 | MAX811 |
| 68 | 1 | U8 | 74LVT16373 |
| 69 | 1 | U9 | 74LV14 |
| 70 | 1 | U10 | 74HC191 |

Table 1.4
Bill of Materials

| Item | Quantity | Reference | Part Description |
|---|---|---|---|
| 71 | 1 | U11 | M5M4V18160BTP |
| 72 | 1 | U12 | VG-330 |
| 73 | 1 | U13 | 74LV08 |
| 74 | 1 | U14 | 74LVT125 |
| 75 | 1 | U15 | TPS1120D |
| 76 | 2 | U17, U18 | LH28F016SU |
| 77 | 1 | U19 | MAX777 |
| 78 | 1 | U21 | 74HCT00 |
| 79 | 1 | U22 | MAX756 |
| 80 | 1 | U23 | MAX749 |
| 81 | 1 | U24 | LM393 |
| 82 | 1 | U26 | MAX858 |
| 83 | 1 | U27 | TFDS3000 |
| 84 | 1 | U28 | TPS1120 |
| 85 | 1 | Y1 | 32.768 KHz |
| 86 | 1 | Y2 | 32 MHz |