LTC4556EUH
Smart Card Interface
Evaluation Board Manual
(DC564)

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DESCRIPTION

Demonstration board DC564 is configured to easily interface the LTC4556 smart card interface to a personal computer via an RS-232 serial port. The demonstration package includes a compact disk containing a user-friendly graphical interface program. RS232 commands are interpreted by the MC68HC711E9CFN2 micro-controller and sent on to the LTC4556. A simple interface language (ICCICL56) is permanently programmed into the micro-controller and is summarized in Appendix A. The demonstration board operates on a 3V to 5.5V input supply. To begin evaluating the LTC4556 using demo board DC564 see **GETTING STARTED** below.

SYSTEM REQUIREMENTS

- PC with a 486 processor or higher and serial port mapped to COM1
- Microsoft Windows 95 or higher
- CD-ROM drive
- PC keyboard
- 9 pin male-female serial cable (straight through connection)
- A bench power supply or battery pack capable of producing 3V to 5.5V at up to 125mA of current.

GETTING STARTED

The software must be installed on a personal computer before the demonstration board can be evaluated. Follow the software installation instructions below.

Software Installation

- Insert the compact disk labeled *DC564 Demonstration Software* into an appropriate CD-ROM drive on the PC.

- Access the CD-ROM drive, double click the link **SETUPRT.BAT** and follow the instructions until the HP VEE RUNTIME libraries are installed.

- Access the CD-ROM drive, double click the link **SETUPIO.BAT** and follow the instructions until the HP VEE IO libraries are installed.

- From the Start Menu of the personal computer select “**Run…**”.
  At the “**Open:**” prompt type: “**veerun –ioconfig**” and click the **[OK]** button.

When the dialog box appears click the **[Add Instrument…]** button.

Ensure that the settings are:

Name:	*SERIAL1955*
Interface:	*Serial*
Address (eg 9)	*1*

Click on “**Advanced IO Config…**”

On the **General** tab change the settings to:

Timeout (sec)	*0.1*
Live Mode:	*ON*
Byte Ordering	*MSB*

On the **Serial** tab ensure that the settings are:

Baud Rate:	*9600*
Character Size:	*8*
Stop Bits:	*1*
Parity:	*None*
Handshake:	*None*
Receive Buffer Size:	*4096*

Click **[OK]**.
Click **[OK]**.
Click **[SAVE CONFIG]**

Hardware Connections

- Connect the 9 pin male-female serial cable from the PC serial port (COM1) to the demonstration board.

- Ensure that Jumper JP1 is in its VBATT=DVCC position (connecting terminals E1 and E3).

- Apply +3.2V to +5.5V from “VBATT” to “GND”.

Running the Program

- Access the CD-ROM drive and double click the program icon **LTC4556.vxe**. The demonstration program will appear on the screen (see figure below).

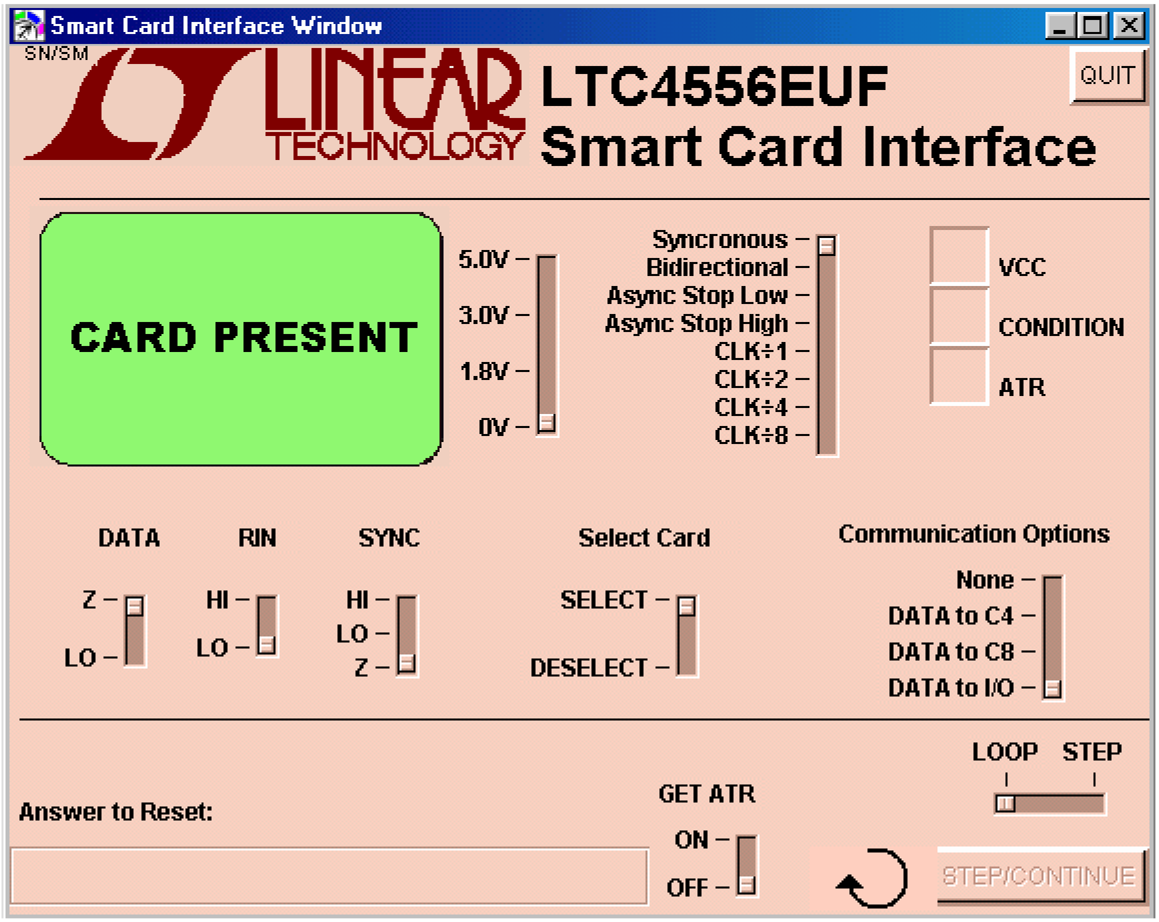
- Insert a credit card or smart card into the smart card socket. On the computer screen, the icon for smart card socket should indicate the presence of a card.

- Using the software program, move the voltage slider to the 3V position. Measure VCC with respect to GND on the demonstration board and observe that it is at approximately 3V.

OPERATION

The graphical interface program **LTC4556.vxe** can be used to perform extensive evaluation of the LTC4556. It can be used to set the voltage on the card to 1.8V, 3V or 5V as well as the clock divider modes. By using the **SELECT**, **DATA** and **RIN** controls, it can manipulate the I/O and RST pins of the smart card socket. If an EMV compliant asynchronous smart card is inserted into the socket, its answer to reset can be retrieved. Finally, it provides status indicators showing the state of the smart card. There are indicator icons for card detection, VCC status, electrical fault status and ATR fault status. The program can be iterated in an infinite loop or it can be switched to single step mode.

When the software is installed and working properly the following screen should appear after running **LTC4556.vxe**:



Looping vs. Single-Stepping the Program

As mentioned above, the graphical interface program can be looped continuously or operated in single step mode. *For the following sections, the program should be left in **LOOP** mode unless otherwise noted (it will automatically start in this mode).* The **LOOP-STEP** slider in the lower right corner of the program window controls the mode of the program. If the slider is switched to **STEP** mode, then only a single read/write cycle to the LTC4556 is performed with each press of **STEP/CONTINUE**.

LOOP mode is indicated by the clockwise arrow to the left of the **LOOP-STEP** control slider. When in **STEP** mode, a pulse icon appears in this location.

Smart Card Detection

The smart card detection channel will indicate the presence of a card by changing the smart card icon in the program window. When no card is present, the icon will show “NO CARD”. When a card is present it will show “CARD PRESENT”.

*HINT: It is important to have a card in the socket for the following sections. Setting a card voltage (other than **0V**) with an empty card socket will result in an <u>automatic card removal fault</u>. Any standard credit card or even a reversed smart card can be used to activate the card detection switches.*

Setting VCC

The VCC setting can be adjusted quickly by using the voltage slider to the right of the smart card icon. Simply manipulate the slider from **0V** to **1.8V**, **3.0V** or **5.0V**. Use a voltmeter to confirm that the V_{CC} voltage at the smart card socket is correct.

*NOTE: It is possible to change the slider from any setting to any other setting using the software. However, if the slider is moved from a lower voltage setting, (other than **0V**) to a higher voltage setting, a fault on that channel will likely result. This is due to both an undervoltage and overcurrent condition on that channel. All settings should start from the **0V** position. <u>If a fault does occur, it can only be cleared by returning the slider to the **0V** position</u>. Changing from a higher voltage setting to a lower voltage setting will generally not result in a fault.*

Setting the LTC4556 Clock Modes

Once the smart card socket is activated at one of the three VCC levels, its clock speed can be easily changed. Using an oscilloscope, observe the CLK pin. With the clock setting slider set to **CLK÷1** mode, observe that the CLK pin is switching at precisely 2Mhz. By moving the slider to **CLK÷2**, **CLK÷4** and **CLK÷8** the clock frequency can be changed to 1MHz, 500Khz and 250Khz respectively. By moving the clock control slider to **Stop Low** or **Stop High**, the CLK pin can be stopped in either state.

The LTC4556 supports synchronous cards in one of two ways. If the clock control switch is set to **Synchronous**, the CLK pin can be manipulated high and low by moving the **SYNC** switch to **HI** and **LO** respectively. If the clock control switch is set to **Bidirectional**, the CLK pin can be set to low or high Z by setting the **SYNC** pin to **LO** or **Z** respectively.

Setting RST

The RST pin can be manipulated by setting or clearing **RIN**. On the **Select Card** control, set the slider switch to **SELECT**. Manipulate the **RIN** slide control to **HI**. Observe with a voltmeter that the RST pin has gone to its VCC level. Sliding the **RIN** control back to **LO** will force the RST pin back to 0V.

The RST latch on the LTC4556 can be demonstrated using these controls. Once the card is selected, its RST pin follows the **RIN** slide control. If the card is deselected, the RST pin will ignore changes on this control and will remain in its current state.

Asserting I/O

The I/O pin can also be easily manipulated. First, the card must be selected using the **Select Card** control. Once the card is selected, its I/O pin will follow the state of the **DATA** slider control. Note that the I/O pin for an unselected card will automatically return to the Z state (high).

Detecting Card Removal Faults

Once the card has been powered to **1.8V**, **3V** or **5V** it will indicate a card removal fault upon extraction of the card. This can be demonstrated by powering up a card and simply removing the card. The fault will be cleared when the voltage slider is moved back to **0V**. Note that a card removal fault is considered an electrical fault. It can be distinguished from other faults such as short circuits by observing both the fault status bit and the card detection bit in the LTC4556's status word.

Detecting ATR Faults

The LTC4556 has an answer to reset counter to detect ATR faults. An ATR fault can be detected by selecting the card and setting the **RIN** slider to **HI**. Notice that without a real smart card in the socket, the **ATR STATUS** indicator switches to red. The fault will be cleared in the LTC4556 by switching **RIN** back to **LO**. The clock control slider should be set to **CLK÷1** for this demonstration.

Detecting Electrical Faults

Electrical faults can be demonstrated in a number of ways. Once the card's VCC is brought to **1.8V**, **3V** or **5V**, it can be shorted to GND. Furthermore, short circuits on the CLK and RST pins will result in an electrical fault. They can be induced by shorting the CLK or RST pins to the supply representing its opposite state (VCC or GND) or by shorting to the same potential and changing the state of the pin using the software.

Retrieving an Answer to Reset

The demonstration board DC564 has the capability of retrieving the answer to reset from an asynchronous card. This is accomplished by the following steps:

1. *Insert an asynchronous EMV or ISO7816 compliant smart card into the socket*
2. *Set the voltage slider to the appropriate level for the card*
3. *Select the smart card using the **Select Card** slider*
4. *Ensure that the clock slider is set to **CLK÷1***
5. *Move the **LOOP – STEP** slider to the **STEP** position*
6. *Move the **GET ATR** slider to the **ON** position*
7. *Push the **STEP/CONTINUE** button*

The answer to reset will appear in the output box at the bottom left of the program window.

Separating VBATT and DVCC

For maximum flexibility, the LTC4556 has two separate supply levels. VBATT provides the main power to the chip and DVCC is used as a reference level for the digital control inputs and outputs. On demonstration board DC564, DVCC provides power to the micro-controller as well as the LTC1348 RS-232 chip. While the LTC4556 will work with DVCC levels as low as 1.6V, these two chips need at least 3V to operate correctly.

Jumper JP1 connects DVCC and VBATT. To experiment with various VBATT levels, simply remove the shorting bar from JP1 and apply a separate supply to VBATT. VBATT is specified down to 2.7V but will typically work below that level if the LTC4556 is not asked to deliver significant power. The under-voltage detection set point has been set to approximately 2.93V and is detecting the DVCC line.

Advanced Evaluation Using ICCICL56

The on-board micro-controller contains a very simple LTC4556 control language known as ICCICL56 that can be used to access the LTC4556 directly. ICCICL56 (*Interface Chip Card Interface Command Language for LTC4556*) can be accessed by a simple dumb terminal or with a personal computer. With a personal computer, either a terminal emulation program could be used or a dedicated program could be written in a high level language such as BASIC to send commands to the LTC4556. The demonstration disk contains a shareware terminal emulation program known as Zebra103.

The RS232 port of the demonstration board is configured for 9600 8-N-1.

The ICCICL56 command structure is documented in Appendix A. The commands consist of a single character. Some commands will be followed by an argument of either 2 or 4 hexadecimal characters.

The simplest command is the question mark: **?**. This command doesn't affect the LTC4556 but can be used to determine if the demonstration board is working properly and connected to the correct port of the personal computer. If all connections and settings are correct, the demonstration board will return the string "ICCICL56" in response to the **?** command. No carriage or line feed will be returned and the **?** will not be returned. The cursor will simply remain at the end of the ICCICL56 string.

The most commonly used command will be the serial port command (minus sign) **-**. The serial port command always needs to be followed by 2 hexadecimal characters. These characters are translated into binary and sent directly to the LTC4556's command register. For example, to configure the LTC4556 for VCC=3V, card selected, I/O connected to DATA and CLK set to ASYNC÷1, the ICCICL56 command would be:

```
-9E
```

To clear the LTC4556, the command would be:

```
-00
```

NOTE: The command will not be echoed to the screen.

Upon entry of a serial port command, the LTC4556 status word will be immediately sent to the screen. For example, if there is a card inserted into the socket and the command –00 is given, the screen will show the following:

```
-0080
```

80 shows that bit D7 is 1. This bit indicates the presence of the smart card. Recall that the –00 will not appear as it will not be echoed. Furthermore, as serial port commands are entered, the resulting status data will appear on the screen without a carriage return or linefeed.

As mentioned above, more sophisticated programs can be used to write command data and receive status data from the demonstration board using ICCICL56. The program will need to be able to communicate with the correct serial port on the personal computer.

Using a Different Micro-controller

To experiment with different micro-controllers, a separate board containing the micro-controller will be needed. It can be connected to DC564 by a ribbon cable or individual fly wires. The on-board micro-controller can be disconnected from the LTC4556 by removing resistor networks RN1 and RN2 from the demonstration board. This can be accomplished by either carefully clipping their pins or by melting their solder and carefully lifting them up. Their solder can be melted by locally heating the board with a temperature controlled heat gun set to approximately 600°F (351°C).

Troubleshooting

The most likely problem with DC564 will be getting proper communications with a host personal computer. Problems can arise from selecting the wrong port or having the wrong protocol settings for the correct port. Note that on most Windows based systems the physical serial port is mapped to a logical port. For the LTC4556 graphical user interface, the port is COM1.

It is possible that the RS232 port of the computer is connected for *null modem*. In this configuration the output of the LTC1348 RS232 chip may be connected to the output of the serial port and likewise the inputs may be connected together. No damage will occur if the board is connected but of course it will not function properly. The simplest solution to this problem is to insert a null modem adapter in series with the serial cable. These adapters simply switch the TD and RD signals from the computer. Alternatively, DC564 is configured with series resistors R10 and R11 that can be removed. Once they are carefully removed, two small jumper wires can be tack soldered to their pads to convert the board to the null modem configuration.

Appendix A The ICCICL56 interface language

Integrated Circuit Card Interface Chip Language For LTC4556 (I.C.C.I.C.L.56)

Name	Syntax	Arguments	Comments
IDENTIFICATION	?		Returns the string “`ICCICL56`” for identification and functional testing. There are no CR or LF characters transmitted.
SERIAL PORT COMMAND	-	ab	Sends 2 hex characters to the LTC4556 serial port. “a” is the most significant byte. Returns 2 hex characters from LTC4556 serial port. No termination character is returned.
GET ATR	\		Calls “SET RIN” Calls “RECEIVE BLOCK”
RECEIVE BLOCK	<		Polls smart card I/O pin for up to ~9600 ETU per character. After the last character is received the entire block is returned followed by a LF. Up to 32 characters may be received per block.
SET RIN	!		Sets the RIN pin of the LTC4556 high.
CLR RIN	@		Sets the RIN pin of the LTC4556 low.
SET SYNC HIGH (HIGH Z)	/		Sets the SYNC pin of the LTC4556 high Z. For use with synchronous memory cards.
SET SYNC HIGH (LOW Z)	#		Sets the SYNC pin of the LTC4556 high. For use with synchronous memory cards.
CLR SYNC	$		Sets the SYNC pin of the LTC4556 low. For use with synchronous memory cards.
READ SYNC	(		Reads the SYNC pin of the LTC4556. For use with synchronous memory cards.
WRITE PORT B	^	ab	Provides direct access to all of PORT B on the 68HC711e9. May be used as general purpose output. “a” is the most significant byte.
CHANGE ETU	+	abcd	Changes the ETU (Elementary Time Unit) used by the RECEIVE BLOCK command. “a” is the most significant byte. The value is assumed to be hexadecimal.
READ DATA	=		Returns “1” if DATA is high and “0” if DATA is low
SET DATA TO 0	*		Forces the DATA pin of the LTC4556 low. For use with synchronous memory cards.
SET DATA TO 1	%		Forces the DATA pin of the LTC4556 to high impedance. For use with synchronous memory cards.

Appendix B The LTC4556 Serial Port Commands

	Status Output	Bit	Command Input
CARD B	0	D0	V_{CC} Options (See Table 2)
	0	D1	
	0	D2	Card Select/Deselect
	0	D3	Card Communication Options (See Table 4)
	Card B Electrical Fault	D4	
	Card B ATR Fault	D5	Card Clock Options (See Table 3)
	Card B VCC Ready	D6	
	Card B Present	D7	

Table 1 Serial Port Bits

D1	D0	Status
0	0	V_{CC} = 0V (Shutdown)
0	1	V_{CC} = 1.8V
1	0	V_{CC} = 3V
1	1	V_{CC} = 5V

Table 2. V_{CC} and Shutdown Options

D7	D6	D5	Clock Mode
0	0	0	Synchronous Mode
0	0	1	Bidirectional Mode
0	1	0	Asynchronous Stop Low
0	1	1	Asynchronous Stop High
1	0	0	Asynchronous ÷1
1	0	1	Asynchronous ÷2
1	1	0	Asynchronous ÷4
1	1	1	Asynchronous ÷8

Table 3 Clock Options

D4	D3	Communication Mode
0	0	Nothing Selected
0	1	$C4_A$ Connected to DATA Pin
1	0	$C8_A$ Connected to DATA Pin
1	1	I/O_A Connected to DATA Pin

Table 4 Card A Communication Options