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FLUKE Biomedical
ESA614 Communications Interface

Revision 1 4/4/2018

INTRODUCTION

This document specifies the communications interface for the ESA614.

The ESA614 can be controlled remotely by sending it commands receiving responses, including test data.

The ESA614 has a USB Device Port (peripheral) that can be connected to a computer (PC). This port can be configured to look like a COM port to the PC or to look like a regular USB Device.

USB INTERFACE

USB CABLE CONNECTION
The ESA614 USB Device Port (peripheral) has a Mini Type B connector. It connects to a PC USB Controller Port that has a Type A rectangular connector.

Connect the ESA614 to your PC with the USB Type A to Micro Type B cable supplied.

OPERATING SYSTEM REQUIREMENT
Fluke supports connecting the ESA614 to a PC running Windows 7, or later.

WINDOWS SOFTWARE DRIVER
The ESA614 USB port is built from an integrated circuit (IC) device that is commonly used inside adapter cables that convert USB to RS232. When this device is connected to a PC, it looks like a COM port to the PC. When Windows enumerates the device, it assigns a COM port number to it. It is called a virtual COM port (VCP).

The IC is an FT232R from the FTDI company. It is compatible with the USB Version 2.0 Full Speed specification.

Versions of Windows 7 and later include a software driver for FTDI USB Serial Converters, including the FT232R. The USB ID numbers are VID 0403 and PID 6001.

When you connect the Impulse to your PC for the first time, Windows should recognize and register your ESA614 as a USB Serial Converter and USB Serial Port (COMx).

The ESA614 can be controlled as a virtual COM port or from the FTDI D2XX Direct Interface API. Typically, single users typing commands in a terminal emulation program would use the COM interface. Users writing their own programs might prefer D2XX.

VIRTUAL COM PORT
When using the virtual COM port, the USB port resides inside the ESA614, but the PC acts like it now has an additional COM port and that COM port is connected to an RS232 serially controlled instrument.

DEVICE MANAGER
The ESA614 is configured to enable COM port enumeration unless turned off in device manager.

Run Device Manager to check the status of the ESA614 COM port. When viewing by Type, your ESA614 shows up in two places:
- Universal Serial Bus controllers / USB Serial Converter.
- Ports (COM & LPT) / USB Serial Port (COMx).

If you view by Connection, the ESA614 will be under one of the USB Root Hubs as:
- USB Serial Converter / USB Serial Port (COMx).

If Device Manager only lists the USB Serial Converter but not the COM port it could be that the Virtual COM Port driver is not enabled. Open USB Serial Converter Properties and go to Advanced. Check the Load VCP box if it is not already checked and press OK. Then the COM port should show up.

You can change the COM port number assigned by Windows in Device Manager. Open the Properties for the USB Serial Port (COMx), go to Port Settings and press Advanced. Select the desired COM Port Number from the drop down list box and press OK. To get the device list to show the new COM port number perform a Scan for hardware changes.

If Device Manager says that a COM port number is in use, it may be from another USB device that is no longer being used. You can click through the error message and force it to the number you want.

If you unplug your ESA614, you can still see it in Device Manager by selecting View / Show hidden devices. It will be shown grayed out.

ADVANCED USERS
Advanced users can get more information about the FT232R from the FTDI web site: www.ftdichip.com. You can get new software drivers, application notes, and USB utilities. You can learn how to view your USB connections and load and/or delete all FTDI drivers from your PC. You can get drivers for other operating systems. You can learn how to use the D2XX direct interface API to include in your own custom interface programs if you don't want to use a COM port.

COM PORT SETTINGS
Settings for the COM port should be made by the program that opens and uses the COM port such as a terminal emulation program (HyperTerminal, Tera Term or other). The settings in Device Manager are usually irrelevant because they are overridden by the controlling program.

The COM port should be set to:
- 115,200 baud
- No parity
- 8 data bits
- 1 stop bit
- Hardware handshaking should be turned on.

HANDSHAKING
ESA614 uses hardware handshaking.
ESA614 does not use XON/XOFF software handshaking.

COMMAND PROTOCOL

COMMANDS
Commands are made up of alphanumeric characters. The first character must be alphabetic. Alphabetic characters may be sent in upper or lower case.

Special characters are:

Name	Abbreviation	Hex Value
Carriage Return	**CR**	**0D**
Line Feed	**LF**	**0A**
Space	**SP**	**20**
Backspace	**BS**	**08**
Escape	**ESC**	**1B**

- Commands must be terminated by **CR**, **LF**, or both.
- **BS** erases the last character from the command.
- **ESC** erases all characters from the command.
- Some commands require one or more parameters to be sent with them. Where a command needs parameters, the command is followed by an equal sign and the parameters. Multiple parameters are separated by commas.
- In the command specification, parameters are given names in *lower case italics* that are placeholders for the actual parameter to be sent with the command.
- Boolean parameters are **TRUE** or **FALSE**.

COMMAND RESPONSES
After receiving a command, the ESA614 will not store or respond to additional received characters until it has executed the command and responded to it.

The ESA614 always responds to a command after it has executed it, by returning a response, terminated by **CR** and **LF**.

The standard command response is "*****", unless other data is to be returned. "*****" indicates that the command was understood and executed.

Sticky commands turn on something then stay active until turned off: On initiation, sticky commands return "*" immediately. Some sticky commands return data responses, either:
- Once, after which the command turns itself off, or
- Periodically, staying active.

An active sticky command shall turn off if the slave receives the Escape character. Then the slave returns "*" indicating the command is turned off.

Incorrect commands return the following error coded messages.

Error Coded Message	Description
!	Command empty, no characters
!00 No commands allowed now	Commands not allowed at this time
!01 Unknown command	Command not recognized
!02 Illegal command	Command not legal for current mode or state
!03 Illegal parameter	Parameter not legal for command
!04 Buffer overflow	Command too long for buffer
!05 General failure	A non-specific failure has occurred
!21 ADC out of range	The measurement limits have been exceeded
!30 Test pass	Test Pass indicator
!31 Test fail	Test Fail indicator
!32 No current	No current measured
!33 Cannot null	Unable to null measurement
!37 Readings not available	Readings not available at this time
!38 Load discharge timeout	Load took too long to discharge
!40 Over temperature	Functionality temporarily locked due to unit being over temperature
!42 Initialization error	Unit was unable to initialize successfully
!50 GFI	GFI fault occurred
!51 Over voltage	Over voltage fault occurred
!52 Out of calibration	Problem detected with unit calibration
!53 Mains out of range	Mains voltage measured beyond expected range
!54 Open ground	No ground or IT network was detected
!55 Reverse voltage	Input mains voltage reversed
!56 Polarity timer wait	Too soon for polarity command, wait for polarity timeout to expire
!57 ZigBee error	Error occurred with ZigBee communication
!58 External memory error	External memory corruption was detected
!70 SD card operation failed	Operation to read or write from the SD card failed
!80 SD card failure	The SD card has experienced a failure
!81 File does not exist	The file requested does not exist
!82 Cannot open file	Unable to open the file requested
!83 Cannot read from file	Cannot read data from the file, it may be corrupt
!84 Cannot write to file	Cannot write data to the file
!85 SD card write protected	SD card is write protected. Eject the card and flip the switch on the side
!86 SD card not present	SD card is not installed
!87 SD card full	SD card is full, delete some files before adding more

CONTROL STATES AND MODES

LOCAL CONTROL MODE
ESA614 powers up initially under Local control by user keys.

REMOTE CONTROL MODE(S)
In Remote control, ESA614 accepts commands and executes them. The user interface is disabled except for a single touch that can return to Local Control Mode. Some commands are legal in other modes. The modes are listed in the table:

Mode Mnemonic	Type	Description
LOCAL	Local	Local control
REMOTE	Remote	Remote control mode

The **LOCAL** command brings the ESA614 back to local control.

COMMAND SPECIFICATIONS

Unless specified otherwise:
- Commands return *****.

Commands are legal only in **REMOTE** mode.

GENERAL COMMANDS

IDENT	Get the instrument identification and firmware version.
Legal modes:	All modes
Returns:	Model number: **ESA614**, followed by comma, followed by firmware version number, including build: ex. "**ESA614, v2.00**"

SN	Get the serial number.
Returns:	The serial number: up to 10 characters possible, normal production Fluke serial numbers are 7 decimal digits.

LOCAL	Go to Local control mode.
Legal modes:	All modes

REMOTE	Go to Remote control **REMOTE** mode.
Legal modes:	All modes

RSTUI	Resets the product as it was turned off and back on.
Legal modes:	All modes

STATUS COMMANDS

STAT	Get the UI status word.
Legal modes:	All modes
Returns:	4 digit hexadecimal result which can be decoded: POWER_UP 0x0001 device is in Power Up mode LOCAL 0x0002 device is in Local mode REMOTE 0x0004 device is in Remote mode

STAT1		Get status word 1	
	Returns:	4 digit hexadecimal result which can be decoded:	
		REMOTE	0x0001	device is in Remote mode
		ECG	0x0008	device is in ECG mode
		SPARE	0x0010	Spare
		SVOLTS	0x0020	measure from 0 to 300 volts
		SLEAK	0x0040	measure from 0 to 10,000 µA
		SOHMS	0x0080	measure from 0 to 2 ohms @ 200 ma
		SPARE	0x0100	Spare
		SMEG	0x0200	measure from 0 to 100 MΩ
		SEQUIP	0x0400	measure from 0 to 20 Amps AC
		SDIFF	0x0800	measure from 0 to 10 mA AC
		AC_ONLY	0x1000	measure AC only
		DC_ONLY	0x2000	measure DC only
		ACDC	0x4000	measure AC + DC
		SPARE	0x8000	Spare

STAT2		Get status word 2		
	Returns:	4 digit hexadecimal result which can be decoded:		
		LDAAMI	0x0001	AAMI load selected	
		SPARE	0x0002	Spare	
		LD601	0x0004	601 Load selected	
		EO	0x0008	Equipment Outlet ON	
		SPARE	0x0010	Spare	
		MAPR	0x0020	MAP Reverse selected	
		MAPON	0x0040	MAP Voltage ON	
		L2OPEN	0x0080	Neutral Open	
		EOPEN	0x0100	Earth Open	
		POLR	0x0200	EO Polarity reversed	
		GFIL	0x0400	GFI Low selected	
		GFIH	0x0800	GFI High selected	
		INS_ON	0x1000	INSULATION VOLTAGE On	
		RCURON	0x2000	Resistance Current ON	
		MAINS0 selection	0x4000	MAINS0-MAINS1 = mains parameter	
		MAINS1	0x8000	MAINS0-MAINS1:	00 = unused
					01 = L2-GND
					10 = L1-GND
					11 = L1-L2#

MEASUREMENT COMMANDS

AP=*meter+*/*meter-*/*remaining*	Select applied part connections. Valid part nouns are: RL, RA, LL, LL, V1 or ALL
meter+	Parts to connect to meter +
meter-	Parts to connect to meter -
remaining	Sets remaining parts to **OPEN** or **GND**

`AP2=`*meter+*`/`*meter-*`/`*gnd*	Select applied part connections. Valid part nouns are: RL, RA, LL, LL, V1 or ALL
meter+	Parts to connect to meter +
meter-	Parts to connect to meter -
gnd	Parts to set to GND (remaining parts are set to OPEN)

`APINS`	Select Applied Part to PE insulation test.

`AUX`	Select Patient Auxiliary Leakage test.

`EARTH=`*param*	Select state for ground line to the equipment outlet.
param	`C` tests with closed earth, `O` tests with open earth.

Note: Valid for the following tests. Command will return illegal command error (!02) unless a valid test has been selected.

Enclosure leakage
Patient leakage
Patient auxiliary leakage
Direct equipment leakage
Alternative equipment leakage
Differential leakage

`EARTHL`	Select Earth Leakage test (aka Ground Wire Leakage).

`ENCL`	Select Enclosure Leakage test (aka Chassis Leakage or Touch Current).

`EQCURR`	Select Equipment Current test.

`ERES`	Select Protective Earth Resistance test (aka Ground Wire Resistance).

`ERES=`*current*	Select Protective Earth Resistance test current.
current	`LOW` tests with 200mA current

FN	Ask for current function number.
Returns:	0: No function selected
	1: Mains voltage
	2: Equipment current
	3: Earth resistance
	4: Mains to earth insulation
	5: Applied parts to earth insulation
	6: Earth leakage
	7: Enclosure leakage
	8: Patient leakage
	9: Patient auxiliary leakage
	10: Direct equipment leakage
	11: Direct applied parts leakage
	12: MAP leakage
	13: Alternative applied parts leakage
	14: Alternative equipment leakage
	15: Differential leakage
	16: Not used
	17: Point to point leakage
	18: Not used
	19: Point to point voltage
	20: Point to point resistance
	21: Mains to non-earthed insulation (red jack)
	22: Applied parts to non-earthed insulation (red jack)
	23: Mains to applied parts insulation
	24: Lead isolation leakage

GFI=*current*	Select Ground Fault Interrupt trip level.
current	**5MA** sets trip level to 5mA
	10MA sets trip level to 10mA
	25MA sets trip level to 25mA.

GFIR	Resets Ground Fault Interrupt ATTENTION

HIGH_RES=*param*	Select reading resolution. (Set until unit is reset.)
param	**ON** increases number of digits returned in measurement readings.
	OFF displays standard number of digits (power-on default).

IDLE	Sets instrument to IDLE.
	Turns off all relays and clears any faults.

INS=*param*	Select Insulation Voltage level.
param	**LOW** sets insulation voltage to 250V.
	HIGH sets insulation voltage to 500V (default).

INSB	Select Insulation Mains to NE insulation test. (was INSB)

INSD	Select Applied Parts to NE insulation test. (was INSD)

INSE	Select Mains to Applied Parts insulation test. (was INSE)

LEAD_ISO	Sets up for Lead Isolation function. This is different from 60601 MAP because the red jack is not connected to protective earth.

LOAD=*param*	Select load for meter input.
param	**601** sets load for IEC 60601 **AAMI** sets load for AAMI ES-1 **NONE** removes load from meter input circuit.

MAINS=*param*	Select Mains Voltage test.
param	**L1-L2** measures between Hot to Neutral **L1-GND** measures between Hot to GND **L2-GND** measures between Neutral to GND

MAP	Selects MAP test.

MAP=*param*	Sets up MAP test. MAP test must be selected otherwise this returns **!02**.
param	**LOW** Sets MAP to 100% of mains voltage **NORM** Sets MAP polarity to normal **REV** Sets MAP polarity to reverse **1MA** Sets MAP current limit to 1 mA **3.5MA** Sets MAP current limit to 3.5 mA **7.5MA** Sets MAP current limit to 7.5 mA

MINS	Select Mains to PE insulation test. (was MINS)

MODE=*param*	Selects measurement mode for leakage tests.
param	**AC** Selects AC measurement mode **DC** Selects DC measurement mode **ACDC** Selects AC+DC measurement mode

MREAD	Returns meter readings continuously (within every 400ms) until an **ESC** character is received.
Returns:	Meter reading according to reading formats table, above. Note: **ESC** does not trigger a ***** response. It only sends an extra carriage return and line feed.

NEUT=*param*	Select state for neutral line to the equipment outlet.
param	**C** tests with neutral closed, **O** tests with neutral open.

Note: Valid for the following tests. Command will return illegal command error (!02) unless a valid test has been selected.

Earth leakage
Enclosure leakage
Patient leakage
Patient auxiliary leakage

NOMINAL=*param*	Selects and sets up nominal mains voltage. This function, when turned ON, causes all leakage (except Differential) to be multiplied by the ratio of: $$\frac{\text{Nominal Mains}}{\text{Actual Mains}}$$
param	**ON** Turns nominal mains on **OFF** Turns nominal mains off **(value)** Sets nominal mains value

NOMINAL?	Ask for nominal mains voltage
Returns:	Nominal mains voltage, for example: "230" or "115"

NOSHOW	Return reading only during **MREAD** command (power-on default). In other words, it turns off **SHOWALL**.

OVR	Resets Over Voltage ATTENTION.

PAT	Select Patient Leakage test.

POL=*param*	Select state for equipment outlet power.
param	**OFF** tests with live and neutral disconnected from EO **N** tests with live and neutral connected in normal polarity to EO **R** tests with live and neutral connected in reverse polarity to EO

Note: Valid for the following tests. Command will return illegal command error (!02) unless a valid test has been selected.

Earth leakage
Enclosure leakage
Patient leakage
Patient auxiliary leakage
Direct equipment leakage
Direct applied parts leakage
MAP leakage
Differential leakage
Lead isolation leakage

PPL	Select Point to Point Leakage test.

PPR	Select Point to Point Resistance test.

PPR=*current*	Select Point to Point Resistance test current.
current	**LOW** tests with 200mA current

`PPV`	Select Point to Point Voltage test.

`READ`	Ask for single meter reading.
Returns:	Meter reading according to *reading formats* table, above, unless `HIGH_RES=ON`

`RESEND`	Resends the last response to the PC.

`RPTIME=`*param*	Sets EO polarity switch time
param	`(1-5, 15, 30, or 60)` sets value of polarity switch delay in seconds.

`RPTIMES=`*param*	Sets EO polarity switch time and saves in non-volatile memory
param	`(1-5, 15, 30, or 60)` sets value of polarity switch delay in seconds.

`SHOWALL`	Return readings with the following data for MREAD: Range, ADC count and Reading

`STD=`*param*	Selects the standard used during tests. Automatically sets load, GFCI trip level, MAP voltage and MAP current limit.
param	`353` sets standard to IEC62353 `601` sets standard to IEC60601 (factory default) `AAMI` sets standard to AAMI ES-1 `ASNZ` sets standard to AS/NZ 3551

`ZERO`	Zero the Resistance Meter.

ECG COMMANDS

`CPL30`	Runs ECG complex wave @ 30 bpm

`CPL60`	Runs ECG complex wave @ 60 bpm

`CPL120`	Runs ECG complex wave @ 120 bpm

`CPL180`	Runs ECG complex wave @ 180 bpm

`CPL240`	Runs ECG complex wave @ 240 bpm

`PLS30`	Runs ECG 63ms pulse @ 30 bpm

`PLS60`	Runs ECG 63ms pulse @ 60 bpm

`SN10`	Runs ECG sine wave @ 10 Hz

`SN40`	Runs ECG sine wave @ 40 Hz

`SN50`	Runs ECG sine wave @ 50 Hz

`SN60`	Runs ECG sine wave @ 60 Hz

`SN100`	Runs ECG sine wave @ 100 Hz

`SQ125`	Runs ECG square wave @ 0.125Hz

`SQ2`	Runs ECG square wave @ 2.0Hz

`TR2`	Runs ECG triangle wave @ 2 Hz

`VFIB`	Runs ECG Ventricular Fibrillation