Fluke 8840A: IEEE-488- / GPIB-Interface (Option -05)

decoded protocol-specification	EN	Page **1**/17
asynchronous interface between U901 (Option -05) and U202 (Main-PCB)	Alex B.	July 26, 2022
electrical interfaces, mechanisms and data-format		

Contents:

1 Requirements

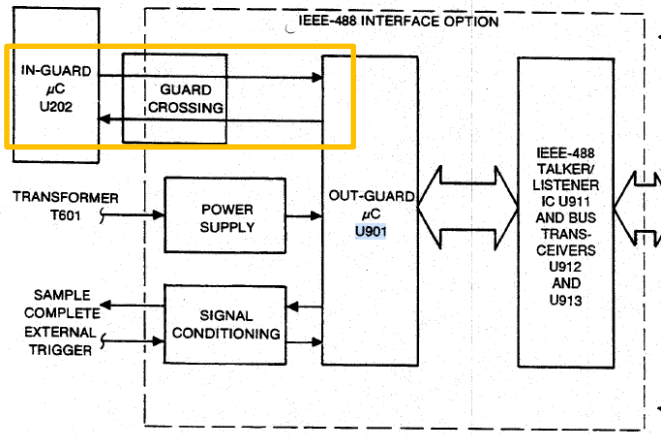
1.1 System-requirements of the interface

1.1.1 UART-interface

A asynchronous half-duplex interface is used for transmission. The single-ended signals of the UART-interface are converted to differential signals to make the transmission more robust. They are transmitted galvanically isolated.

The physical layer of the transmission-path looks almost like being similar to the TIA/EIA RS-485 specification.

TX and RX of the UART are differentially transmitted across the galvanically isolation barrier:



Galvanically isolated Guard-Crossing:
(example: communication direction U202 (Main-PCB) => U901 (GPIB-PCB))

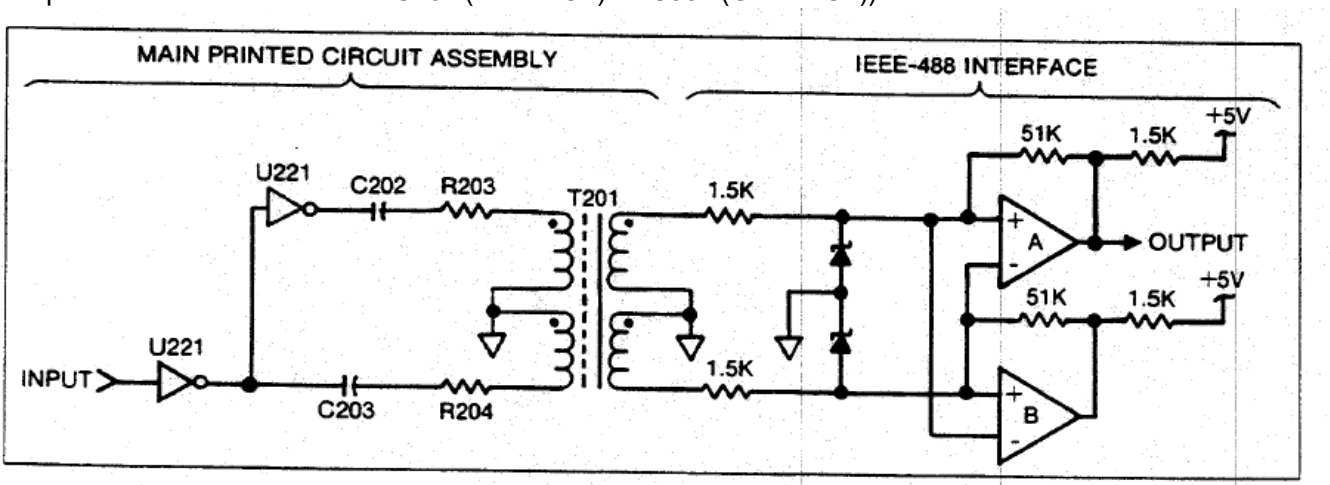


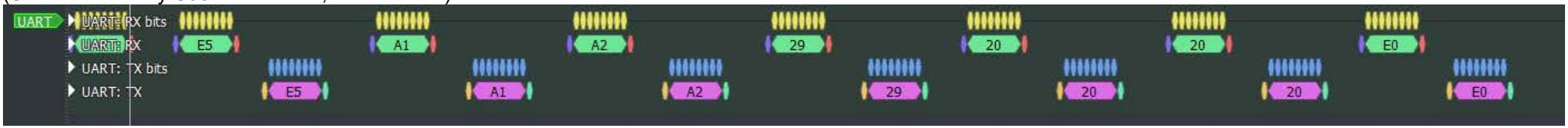
Figure 5-15. Guard Crossing Circuit

1.1.2 Transmission-Error handling

To be able to detect transmission-errors and busy/locked-up processors, every participant in the communication mirrors the each UART-Byte received on RX back to the Sender via the TX line. This is done in a Byte-wise manner:

Example 1:
U901 sends a Status-Request to U202:
(UART as seen by U901: send = TX, receive = RX)

Example 2:
U202 sends the answer tot he Status-Request of U901:
(UART as seen by U901: send = TX, receive = RX)



What happens, if the Byte is mirrored back FASLE or NOT-AT-ALL???

1.1.3 Stop-Byte behaviour

When a Stop-Byte (0x40) sent from „A“ is received and mirrored back by „B“, „B“ can start the transmission of its own data (0xE5).
If the Byte sent by „B“ (0xE5) is not mirrored back by „A“, because the transmission from „A“ was not finished yet, due to the fact, that the Stop-Byte is also part of the transmission’s payload, „B“ stops sending its data and keeps on mirroring back the data from “A” until the next Stop-Byte appears.

After the nex (now really meant as) Stop-Byte „B“ can try again to transmit ist data. In this case it’s the answer to a Status-Change-Command.
Now “A” mirrors back the Bytes as expected:

1.2 Data format

Pause	Start	0 (LSB)	1	2	3	4	5	6	7 (MSB)	Stop	Stop	Pause

1 Start-Bit
8 Data-Bits (LSB first)
No Parity
2 Stop-Bits

Baud rate: 62500 Baud

2 Transmission protocol

2.1 Frame structure

Pause	Start-Byte	Data-Byte(s) (from 0 to 8 Bytes possible)	Stop-Byte	Pause

2.2 Byte structure

The general structure of a Data-Byte is as follows:

ODD Parity	Data-Bits 0 - 6						
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

The parity is calculated over the 7 Data-Bits.
If the number of ones (“1”) in the seven Data-Bits is even, the Parity-Bit is “1” to get a odd total number of ones (“1”) in the Data-Byte.
If the number of ones (“1”) in the seven Data-Bits is odd, the Parity-Bit is “0” to get a odd total number of ones (“1”) in the Data-Byte.

2.3 Start-Byte structure

ODD Parity	1	DIR	0	0/1	0/1	0/1	0/1
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Bit	Parameter	Value	Meaning
1		0	
1		1	
2		0	
2		1	
3		0	
3		1	
4		0	
4		1	

5	DIR	0	U901 is sender of the frame
5	DIR	1	U202 is sender of the frame

2.4 Stop-Byte structure

ODD Parity	1	DIR	0	0	0	0	0
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Bit	Parameter	Value	Meaning
1		0	
1		1	
2		0	
2		1	
3		0	
3		1	
4		0	
4		1	
5	DIR	0	U901 was sender of the frame
5	DIR	1	U202 was sender of the frame

2.5 Commands

2.5.1 Board handshake on Start-Up

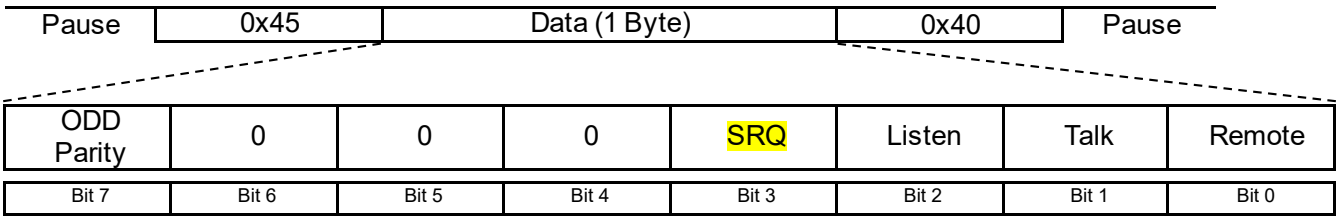
How does the handshake between main controller and GPIB-Board on system start-up work?

2.5.2 Front-Panel configuration

Configures the (GPIB) status display in the front panel, as well as the key lock in remote/local-lockout mode.
The following LEDs can be switched on and off:
- „Remote“
- „Listen“
- „Talk“
- „SRQ“

When the “Remote” LED is on, the key-pad is locked.

U901 ➔ U202



Bit	LED	On	Off
SRQ	„SRQ“	1	0
Listen	„Listen“	1	0
Talk	„Talk“	1	0
Remote	„Remote“	1	0

Not sure, if SRQ LED can be set/cleared this way. Maybe the Main-Controller (U202) manages this.
Was not able to test this by now.

2.5.3 Status request

When the device status gets queried with the GPIB-commands “G0” or “G5”, this Frame is sent.
Anfrage des Geräte-Status mit „G0“ oder „G5“.
The queried data for „G0“ (F, R, S, T), as well as the queried data for „G5“ (I, A, B), are both returned via the status-response (see 2.5.3)

Side Note:
Status information, which is queried with „G6“, is only stored locally in U901. Therefore, a data-request to U202 is not needed.

U901 ➔ U202

Pause	0x49	0x40	Pause

2.5.4 Status response

Transfer of the current device status from the Main-Controller (U202) to the GPIB-Controller (U901).

Is transmitted when the device status is requested (see 2.5.2) and when configuration or status changes occur.

Side note:
Status information, which is queried with „G6“, is only stored locally in U901. Therefore, a transmission from U202 to U901 is not needed.

U202 ➔ U901

Pause	0xE5	Data (5 Bytes)	0xE0	Pause

Data-Byte 1:

ODD Parity	0	1	0	Function			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 2:

ODD Parity	0	1	0	Range			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 3:

ODD Parity	0	1	0	SD	Speed		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 4:

ODD Parity	0	1	0	OS	MR	RI	ET
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 5: Function unknown!

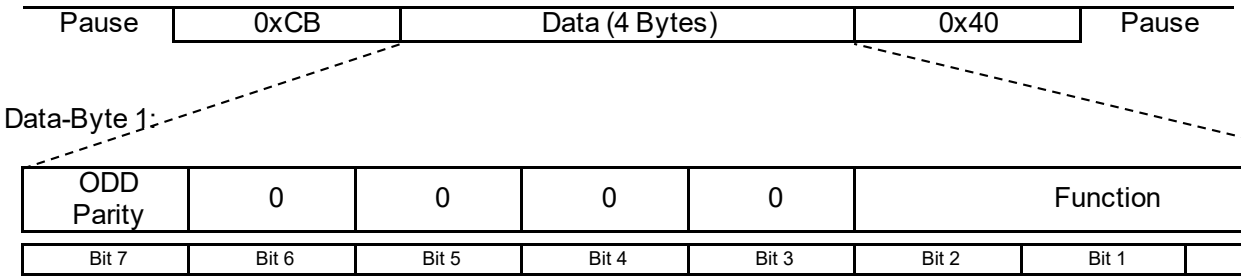
ODD Parity	0	1	0	0	0	0	0
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Byte	Bit	Parameter	Value	Meaning
1	Function	Function	1	Volt (DC)
1	Function	Function	2	Volt (AC)
1	Function	Function	3	Ohm (2-Wire)
1	Function	Function	4	Ohm (4-Wire)
1	Function	Function	5	Ampere (DC)
1	Function	Function	6	Ampere (AC)
2	Range	Range	1	200 mV, 200 Ohm
2	Range	Range	2	2 V, 2 kOhm
2	Range	Range	3	20 V, 20 kOhm
2	Range	Range	4	200 V, 200 kOhm
2	Range	Range	5	1000 V (DC), 700 V (AC), 2 MOhm, 2000 mA
2	Range	Range	6	20 MOhm
3	SD	Settling-Delay	0	ON
3	SD	Settling-Delay	1	OFF
3	Speed	Speed	1	Slow
3	Speed	Speed	2	Medium
3	Speed	Speed	3	Fast
4	OS	Off-Set	0	OFF
4	OS	Off-Set	1	ON
4	MR	Manual-Range	0	OFF (➔ Auto-Range ON respectively)
4	MR	Manual-Range	1	ON (➔ Auto-Range OFF respectively)
4	RI	Rear-Inputs	0	OFF (➔ Front-Inputs ON respectively)
4	RI	Rear-Inputs	1	ON (➔ Front-Inputs OFF respectively)
4	ET	External Trigg	0	OFF (➔ Internal-/Auto-Trigger ON respectively)
4	ET	External Trigg	1	ON (➔ Internal-/Auto-Trigger OFF respectively)

Info:
Rear-Panel-Trigger ON/OFF is only sored in U901 (GPIB-Controller), no transmission via UART!
=>"Ext Trig." Button in "Local" --> T2.
=> "Ext Trig." Button in "Remote" --> T1.
(verify/check with set/clear of Remote-LED)
Suffix (Y0, Y1) for G6 is only sored in U901 (GPIB-Controller), no transmission via UART!
Terminator (W0-W7) for G6 is only sored in U901 (GPIB-Controller), no transmission via UART!

2.5.5 Status configure (F, R, S, T)

U901 ➔ U202



Data-Byte 1:

ODD Parity	0	0	0	0	Function		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 2:

ODD Parity	0	0	0	Range			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 3:

ODD Parity	0	0	0	0	0	Speed	
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 4:

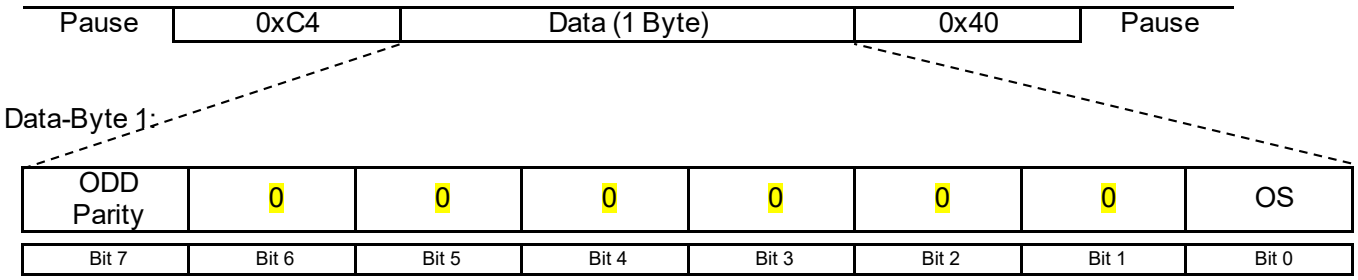
ODD Parity	0	0	0	0	0	Trigger	
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Byte	Bit	Parameter	Value	Meaning
1	Function	Function	0	No change ➔ keep current setting
1	Function	Function	1	Volt (DC)
1	Function	Function	2	Volt (AC)
1	Function	Function	3	Ohm (2-Wire)
1	Function	Function	4	Ohm (4-Wire)
1	Function	Function	5	Ampere (DC)
1	Function	Function	6	Ampere (AC)
2	Range	Range	0	No change ➔ keep current setting
2	Range	Range	1	Auto-Range ON
2	Range	Range	2	200 mV, 200 Ohm
2	Range	Range	3	2 V, 2 kOhm
2	Range	Range	4	20 V, 20 kOhm
2	Range	Range	5	200 V, 200 kOhm
2	Range	Range	6	1000 V (DC), 700 V (AC), 2 MOhm, 2000 mA
2	Range	Range	7	20 MOhm
2	Range	Range	8	Auto-Range OFF
3	Speed	Speed	0	No change ➔ keep current setting
3	Speed	Speed	1	Slow
3	Speed	Speed	2	Medium
3	Speed	Speed	3	Fast
4	Trigger	Trigger	0	No change ➔ keep current setting
4	Trigger	Trigger	1	T0
4	Trigger	Trigger	2	T1 oder T2
4	Trigger	Trigger	3	T3 oder T4

Info:
Rear-Panel-Trigger ON/OFF is only sored in U901 (GPIB-Controller), no transmission via UART!
=>"Ext Trig." Button in "Local" --> T2.
=> "Ext Trig." Button in "Remote" --> T1.
(verify/check with set/clear of Remote-LED)
Suffix (Y0, Y1) for G6 is only sored in U901 (GPIB-Controller), no transmission via UART!
Terminator (W0-W7) for G6 is only sored in U901 (GPIB-Controller), no transmission via UART!

2.5.6 Status configure (B,???)

U901 ➔ U202



Byte	Bit	Parameter	Value	Meaning
1	OS	Off-Set	0	OFF
1	OS	Off-Set	1	ON

Info:
Rear-Panel-Trigger ON/OFF is only sored in U901 (GPIB-Controller), no transmission via UART!
=>"Ext Trig." Button in "Local" --> T2.
=> "Ext Trig." Button in "Remote" --> T1.
(verify/check with set/clear of Remote-LED)
Suffix (Y0, Y1) for G6 is only sored in U901 (GPIB-Controller), no transmission via UART!
Terminator (W0-W7) for G6 is only sored in U901 (GPIB-Controller), no transmission via UART!

2.5.7 Status configure (D,???)

U901 ➔ U202

Pause	0x43	Data (4 Bytes)	0x40	Pause

Data-Byte 1:

ODD Parity	0	0	0	1	0	0	0
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 2:

ODD Parity	0	0	0	0	0	0	DISP
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 3:

ODD Parity	0	0	0	0/1	0	0	1
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 4:

ODD Parity	0	0	0	0	0/1	0	0/1
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Byte	Bit	Parameter	Value	Meaning
1				
1				
2	DISP	Display	0	ON
2	DISP	Display	1	OFF
3				
3				
4				
4				

2.5.8 Trigger signal from GPIB-Interface to Main-Controller

When a trigger-command (“?”) is received over the GPIB-Bus, or the external trigger input receives a signal, this command tells the Main-Controller that it has to trigger a measurement.
Main-Controller responses with commands described in 2.5.8 and 2.5.9.

U901➔ U202

Pause	0x41	0x40	Pause

2.5.9 Measurement triggered

Signals the GPIB-Controller, that the Main-Controller has triggered/started a measurement.
This becomes visible at the Trig-Out port.

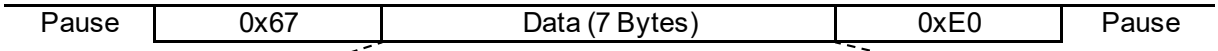
U202 ➔ U901

Pause	0x61	0xE0	Pause

2.5.10 Transmit measured value

Transmission of the last measured value to the GPIB-Controller

U202 ➔ U901



Data-Byte 1:

ODD Parity	0	1	0	VZ	0	0	Digit 1
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 2:

ODD Parity	0	1	0	Digit 2			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 3:

ODD Parity	0	1	0	Digit 3			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 4:

ODD Parity	0	1	0	Digit 4			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 5:

ODD Parity	0	1	0	Digit 5			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 6:

ODD Parity	0	1	0	Digit 6			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Data-Byte 7:

ODD Parity	0	1	0	0	Range		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Byte	Bit	Parameter	Value	Meaning
1	VZ	Vorzeichen	0	„+“
1	VZ	Vorzeichen	1	„-“
1	Digit 1	Digit 1	0	„0“
1	Digit 1	Digit 1	1	„1“
2	Digit 2	Digit 2	0 - 9	„0“ – „9“
3	Digit 3	Digit 3	0 - 9	„0“ – „9“
4	Digit 4	Digit 4	0 - 9	„0“ – „9“
5	Digit 5	Digit 5	0 - 9	„0“ – „9“
6	Digit 6	Digit 6	0 - 9	„0“ – „9“
7	Range	Range	1 - 6	see “Range-Notation” below

Range-Notation:

Range	Type	GPIB	Comma (Full-Scale)	Exponent
1	200 mV, 200 Ohm	-103.187E-3	200 => xxx.yyy	mV => E-3 Ohm => E+0
2	2 V, 2 kOhm	-0.10319E+0	2 => x.yyyyy	V => E+0
3	20 V, 20 kOhm	-00.1031E+0	20 => xx.yyyy	V => E+0
4	200 V, 200 kOhm	-000.102E+0	200 => xxx.yyy	V => E+0
5	1000 V (DC), 700 V (AC) 2 MOhm 2000 mA	-0000.09E+0	2000 => xxxx.yy	V => E+0 MOhm => E+6 mA => E-3
6	20 MOhm	-00.2061E+6	20 => xx.yyyy	MOhm => E+6