SpaceWire InterFace Tester

SWIFT: First Glance

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SpWire Components to be tested:

- **FPGA / ASIC**
  - *Digital simulation*
    - Standard design procedure
- **Transmitter**
  - *No testing required, except perhaps maximum drive current*
    - Fixed and specified by manufacturer
- **Receiver**
  - *Most likely to fail (received errors) due to various operational conditions*
    - Marginal operation conditions needs to be established
- **Cables**
  - *Cable's length and wire gauge can greatly degrade SpW performance*
    - Maximum performance speed needs to be established

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Simulated parameters:

- **Communication speed (Mbps):**
  - *Same, or slightly higher than maximum required rate*
- **Skew/Jitter:**
  - *Between Data and Strobe*
- **Received signal Span:**
  - *Guaranteed minimum Peak-to-Peak (P2P) voltage span at receiver end*
- **Common mode voltage or Bias:**
  - *Offset from ground*

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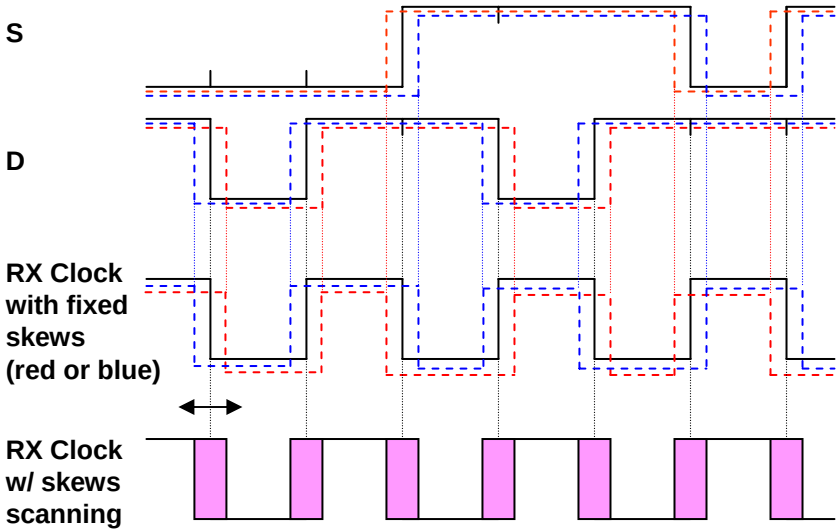
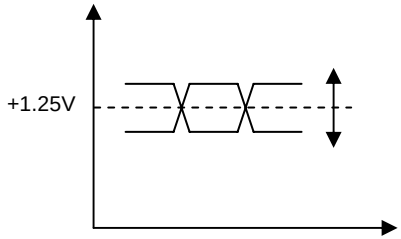
Parameter simulation diagrams:

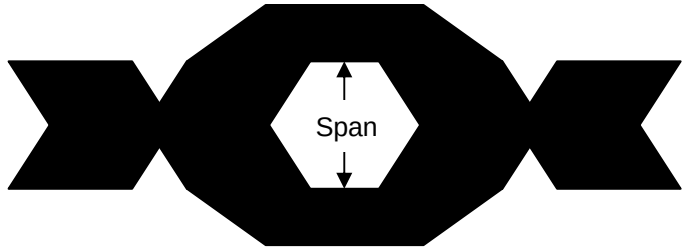
D/S Skew



LVDS Bias



"Eye" Span



Red: fixed positive D / negative S skew

Blue: fixed negative D / positive S skew

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SWIFT Evolution

Concept:

- Was first presented during ISC in Nara, Japan

Prototype:

- Currently being tested at NASA GSFC
- 95% complete

Production:

- Q1/Q2-2010
- Price is TBD

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Modes of Operation:

- **PASS**
  - *Signal is generated by an any independent SpW Auxiliary (Aux.) source, e.g., Star Dundee, 4Links, SWTS, etc., and is passed to SpW Test Port (TP) through SWIFT where it is degraded*
  - *From TP back to Aux.; signal is unaltered: SWIFT works as 1:1 transceiver*
- **LOOP**
  - *Signal is generated by TP source and is looped back to TP through SWIFT where it is degraded*
  - *From TP to SWIFT signal is unaltered*
- **BERT (Bit Error Rate Test)**
  - *Signal is generated by SWIFT itself (PRN-16 sequence) where it can be degraded and goes to TP*
  - *At TP LVDS received signal (in its digital form) loops back to LVDS transmitter and then back to SWIFT*
  - *SWIFT will sync to received PRN sequence and define TP's front end RX performance*
- **WIRE**
  - *Signal is generated by SWIFT itself (PRN-16 sequence) and loops back to SWIFT Aux Port by Cable to be tested*
  - *No simulation parameters are available except communication speed (Mbps)*
  - *SWIFT will sync to received PRN sequence and display any bit mismatches*

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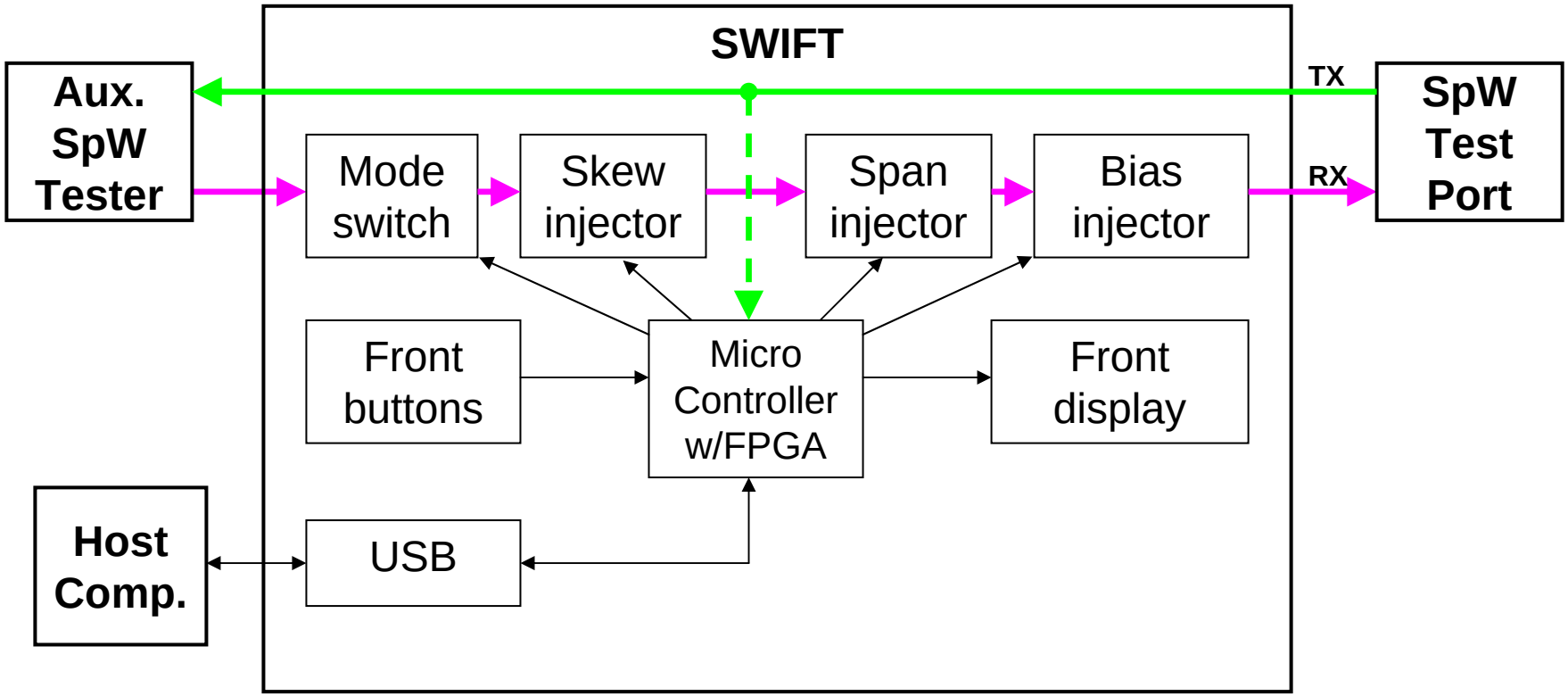
PASS Mode



Full duplex communication between Aux. Port and TP

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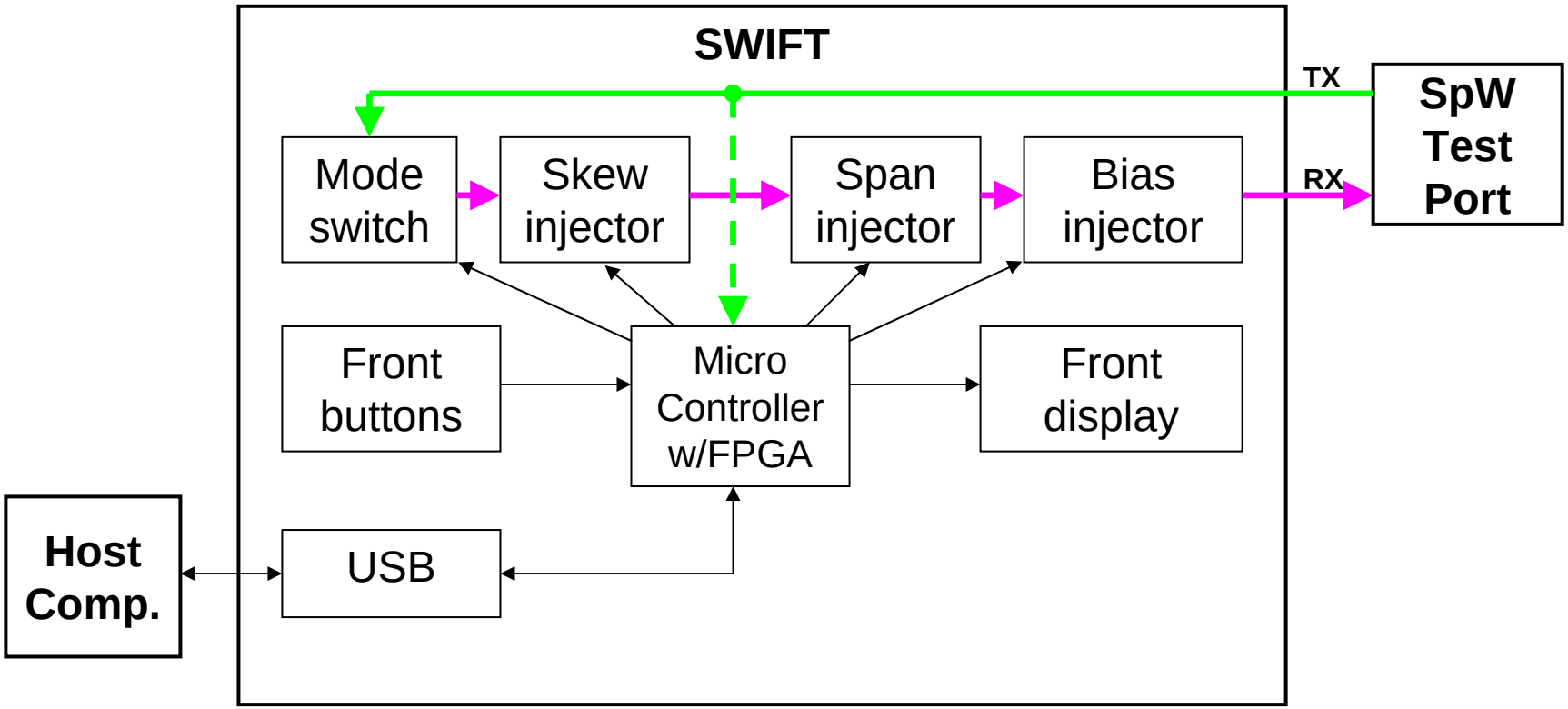
LOOP Mode



Full duplex communication from TP Tx and TP Rx

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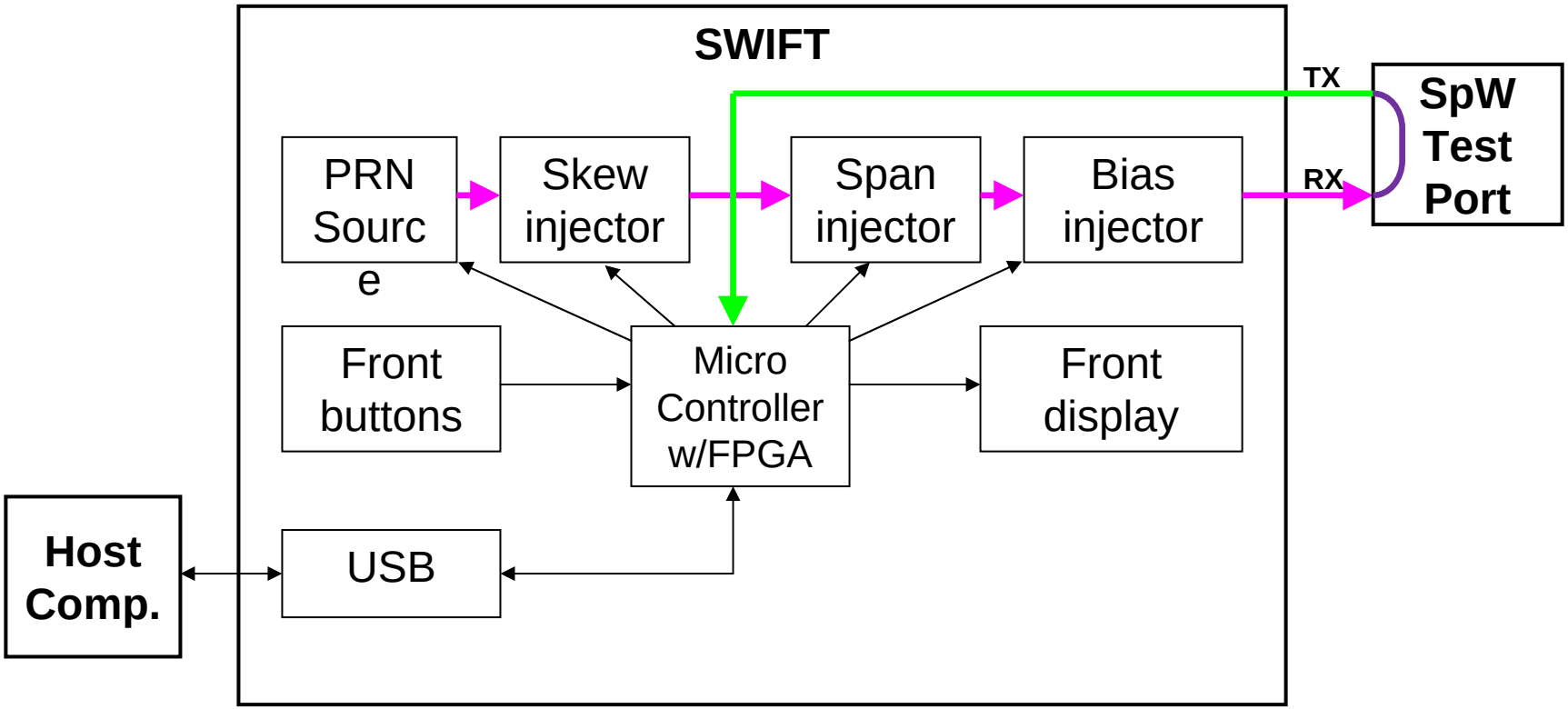
BERT Mode



BERT Mode will work with LVDS PHY01 I/F chips from Aeroflex

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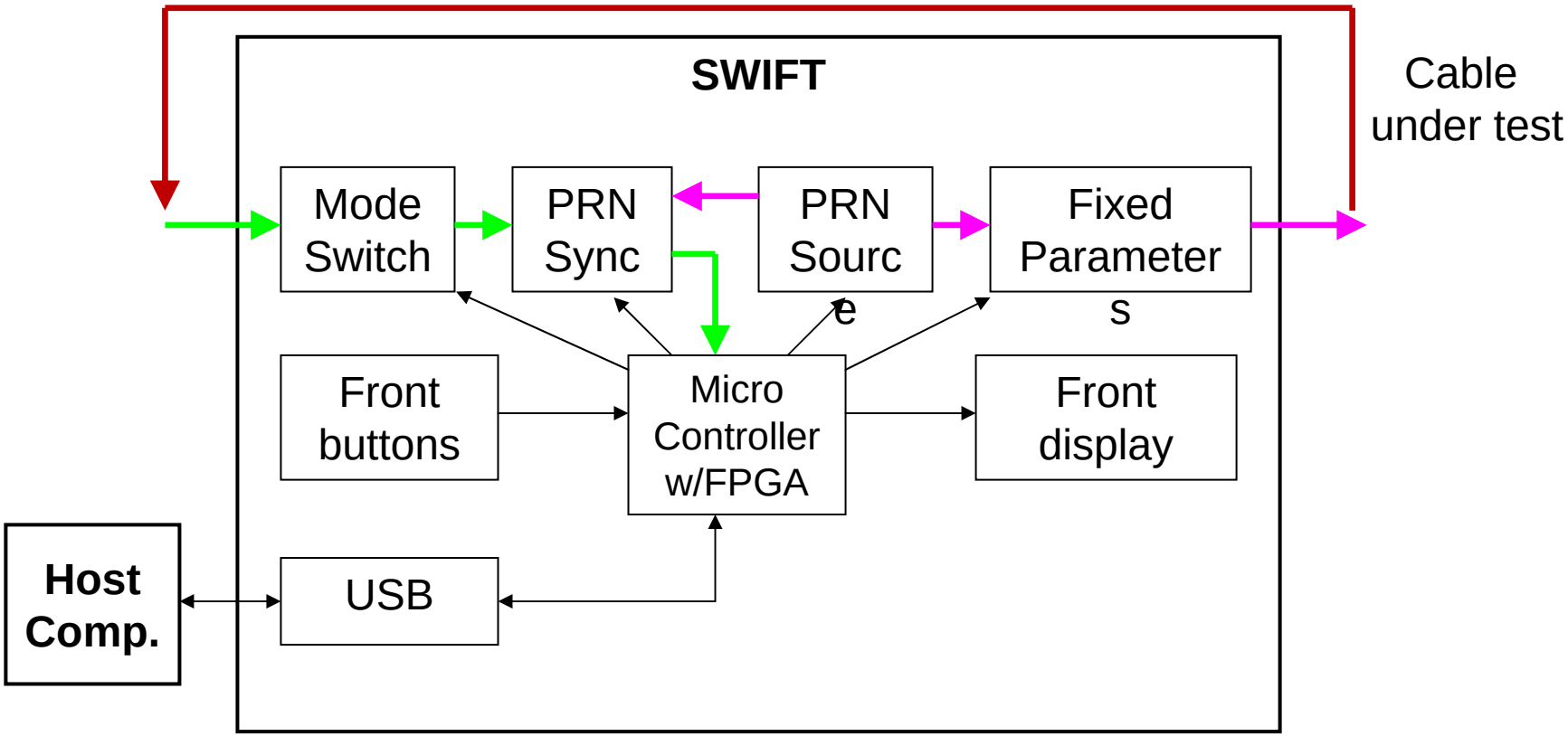
WIRE Mode



WIRE Mode will work with all SpW cables, 1 direction at a time
(to test cable for both directions, cable must be flipped)

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Displayed Errors:

- **PASS and LOOP Modes**
  - SWIFT detects TP TX signal dropout (called **Drops**)
- **BERT and WIRE Modes**
  - SWIFT detects mismatched received bits (called **ErBit**)
- **Maximum number of detected errors**
  - Up to 10^5 errors over 10^5 seconds (27+ hours)
  - Each error is time tagged with 1 ms resolution

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Main Simulated Parameters:

- **D and S Skew injection:**
  - ***Simulation range***
    - 0 to ±30 nS (speed dependent) from "0" nominal with D leading and S trailing, or vs. vs
  - ***Step resolution***
    - 1 nS with ± 0.5 nS accuracy, maximum of 61 steps (speed dependent)
- **Span injection:**
  - ***Simulation range***
    - ±100 mV to ±400 mV peak-to-peak at 100 Ohm termination
  - ***Step resolution***
    - 100 mV with ± 10 mV accuracy in 4 steps
- **Bias injection:**
  - ***Simulation range***
    - ± 1.0 V from +1.25 V LVDS nominal
  - ***Step resolution***
    - 200 mV with ± 10 mV accuracy in 11 steps

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Other Parameters:

- **Simulated parameters change:**
  - ***Manual (through front panel switches)***
    - Static with a fixed setup value (either negative or positive) for **Skew**, **Span**, **Bias**, **Mbps**
    - Dynamic random within positive and negative setup values for **Skew** and **Bias**
    - Dynamic random within maximum value (400mV) and setup value for **Span**
  - ***Remote (controlled by PC)***
    - Either static or dynamic as described above
    - Script defined
    - Uses USB port
- **Dynamic scan selection**
  - Independent for **Skew**, **Span**, **Bias**
- **Dynamic scan step**
  - Every 1 ms if this parameter is selected to be scanned
- **Operating speed:**
  - 10 Mbps to 200 Mbps in 20 steps of 10 Mbps each

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Other Parameters (continued):

- **Stored non-volatile working profiles:**
  - ***Stand-alone operations***
    - 4 (four)
  - ***PC controlled operations***
    - Infinite (all stored in PC)
  - ***Latest setup values are saved upon power-off***
- **Physical dimensions:**
  - 160mm (W) x 160mm (D) x 110mm (H)
- **Power consumption**
  - 3W

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Automatically Reported Telemetry:

- **Without any detected errors:**
  - Every 100 mS
- **In case of detected error:**
  - Every error on up to 1 mS interval

TXA byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Notes 1	
1	All 1's								Sync pattern = FFh	
2	**0**	Seconds MSB (**XX**xxxx) 00-99							Max Timer **99,999.999** mSec (1 mS resolution)	
3	Reserved	Seconds MidB (xx**XX**xx) 00-99								
4	Rejected RX	Seconds LSB and mSec MSB (xx**XX**xx) 00-99								
5	Run/Stop	mSec LSB (xxxx**XX**) 00-99								
6	Zero Phase	Mode		Communication speed in Mbps (**01**0-**20**0)					4+1 modes	20 Mbs sets
7	Profile number		Skew with sign						4 profiles	61 skews
8	Skew Scan	Span Scan	Bias Scan	TX @ Cnt Error	Reserved	Reserved	Span		4 spans	
9	Error Counter MSB (**X**xxxx) 0-9				Bias					11 biases
10	CLK TO TP	Error Counter MID (x**XX**xx) 00-99							Max Error Count: 99,999	
11	CLK FROM TP	Error Counter LSB (xxx**XX**) 00-99								

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List of Commands:

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Notes
Command 1	0	0	0	0	0	0	0	0	NOP: No Operations
Command 2	0	0	0	0	0	0	0	1	Request for TxB (setup parameters)
Command 3	0	0	0	0	0	0	1	0	Inject error in BERT/WIRE modes
Command 4	0	0	0	0	0	0	1	1	Reset Error Counter
Command 5	0	0	0	0	0	1	0	0	Stop (Halt) Error Counter
Command 6	0	0	0	0	0	1	0	1	Start (Resume) Error Counter
Command 7	0	0	0	0	0	1	1	0	Stop Skew scan
Command 8	0	0	0	0	0	1	1	1	Start Skew scan
Command 9	0	0	0	0	1	0	0	0	Stop Span scan
Command 10	0	0	0	0	1	0	0	1	Start Span scan
Command 11	0	0	0	0	1	0	1	0	Stop Bias scan
Command 12	0	0	0	0	1	0	1	1	Start Bias scan
Command 13	0	0	0	0	1	1	0	0	Stop all scan
Command 14	0	0	0	0	1	1	0	1	Start all scan
Command 15	0	0	0	0	1	1	1	0	Normal BERT mode
Command 16	0	0	0	0	1	1	1	1	Set BERT mode with Zero phase
Command 17	0	0	0	1	0	X	X	X	Profile Number Setup
Command 18	0	0	0	1	1	X	X	X	***Reserved (same as NOP)***
Command 19	0	0	1	0	0	X	X	X	Mode Setup
Command 20	0	0	1	0	1	X	X	X	Span Setup
Command 21	0	0	1	1	X	X	X	X	Bias Setup
Command 22	0	1	0	X	X	X	X	X	Frequency Setup
Command 23	0	1	1	X	X	X	X	X	***Reserved (same as NOP)***
Command 24	1	0	X	X	X	X	X	X	Skew Setup
Command 25	1	1	X	X	X	X	X	X	***Reserved (same as NOP)***

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SWIFT prototype (Pic.1)

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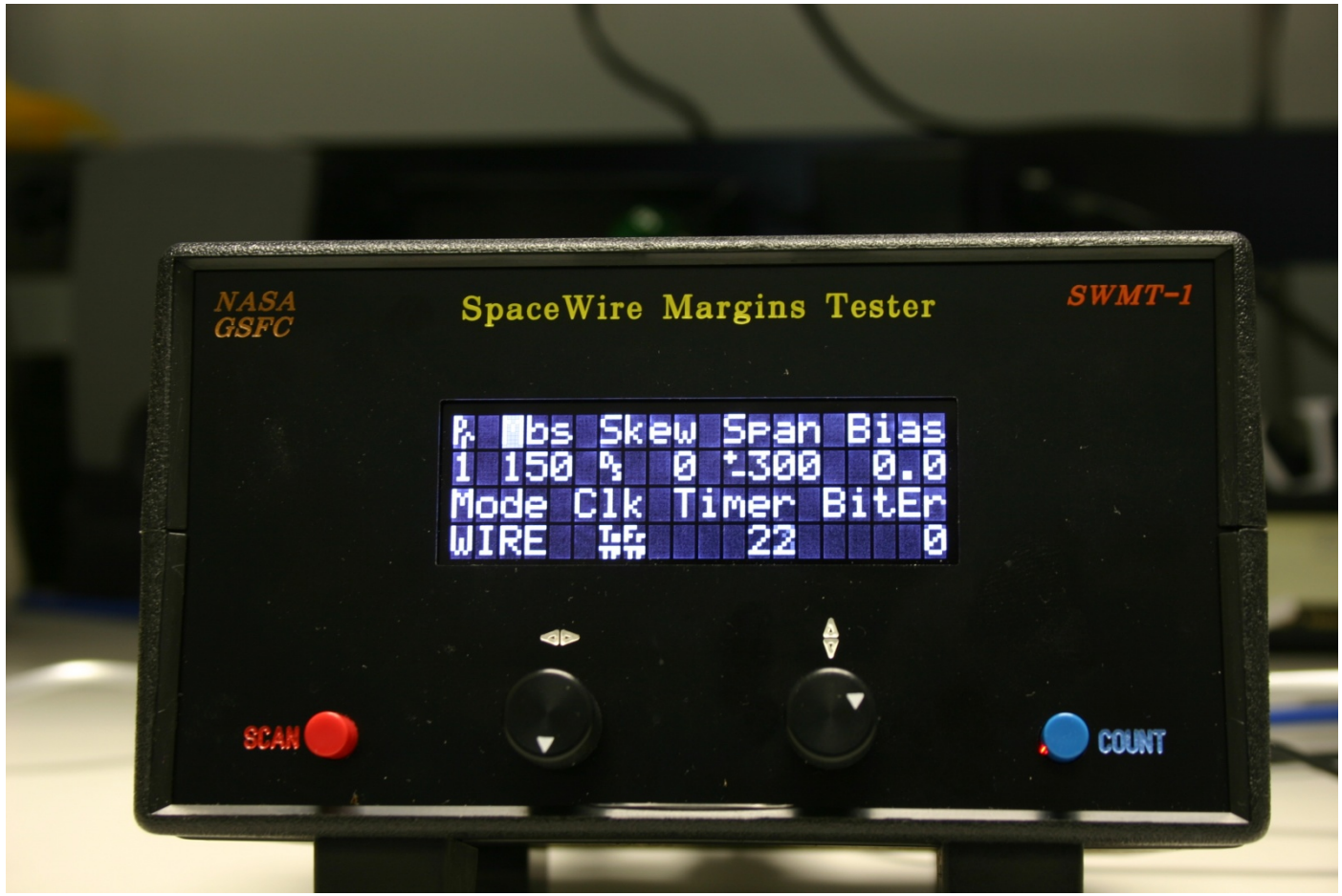
SWIFT prototype (Pic.2)



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SWIFT prototype (Pic.3)

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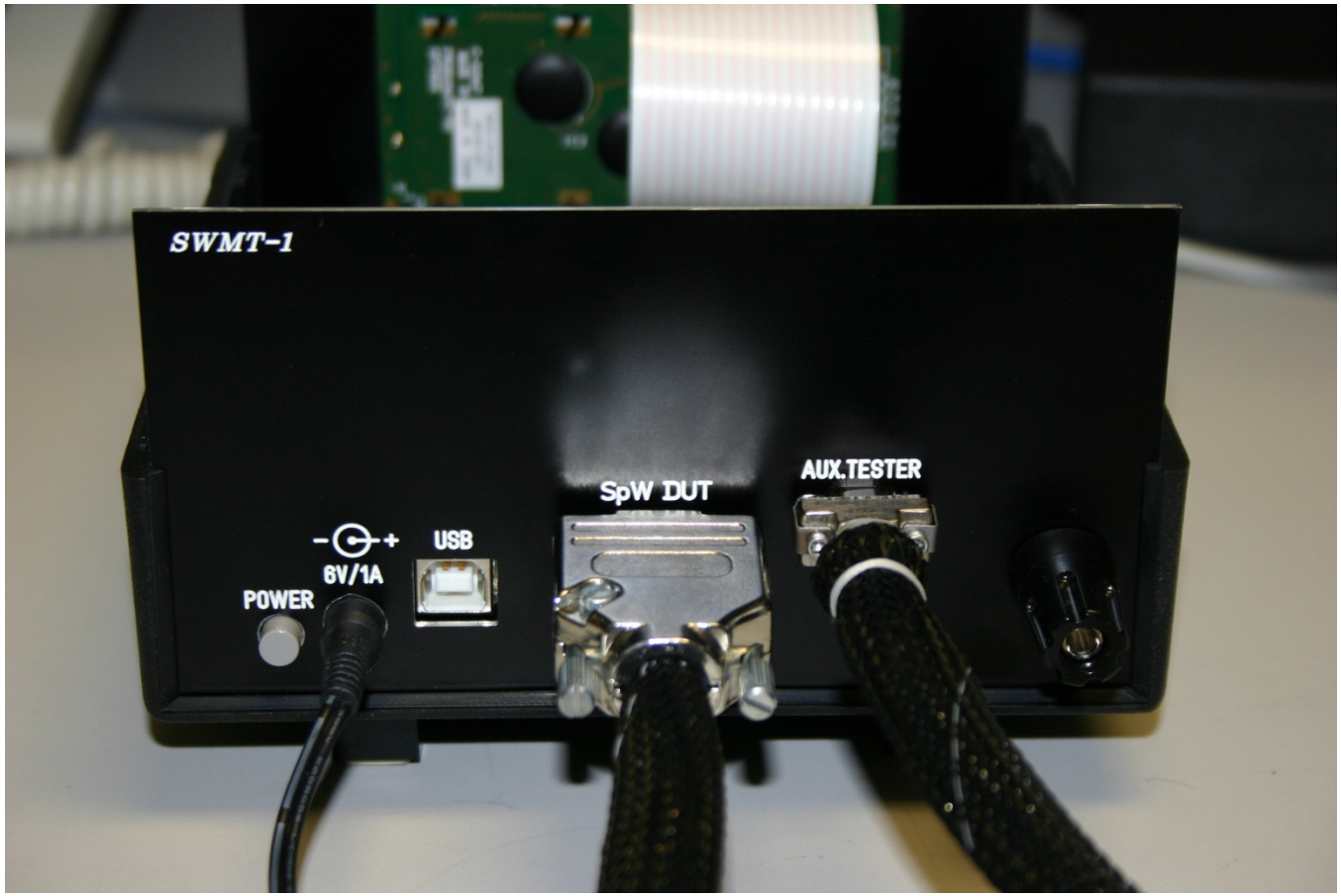
SWIFT prototype (Pic.4)



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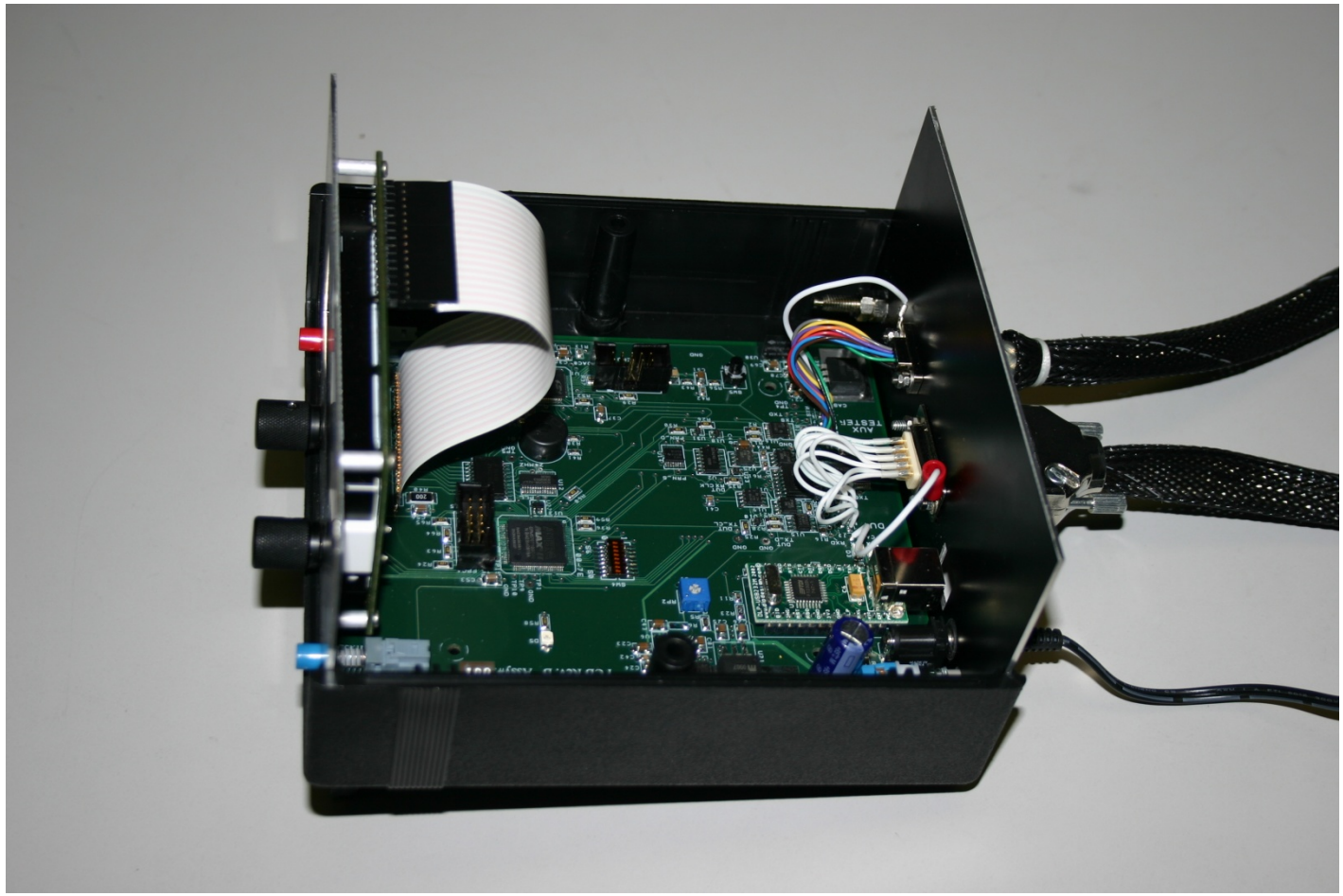
SWIFT prototype (Pic.5)



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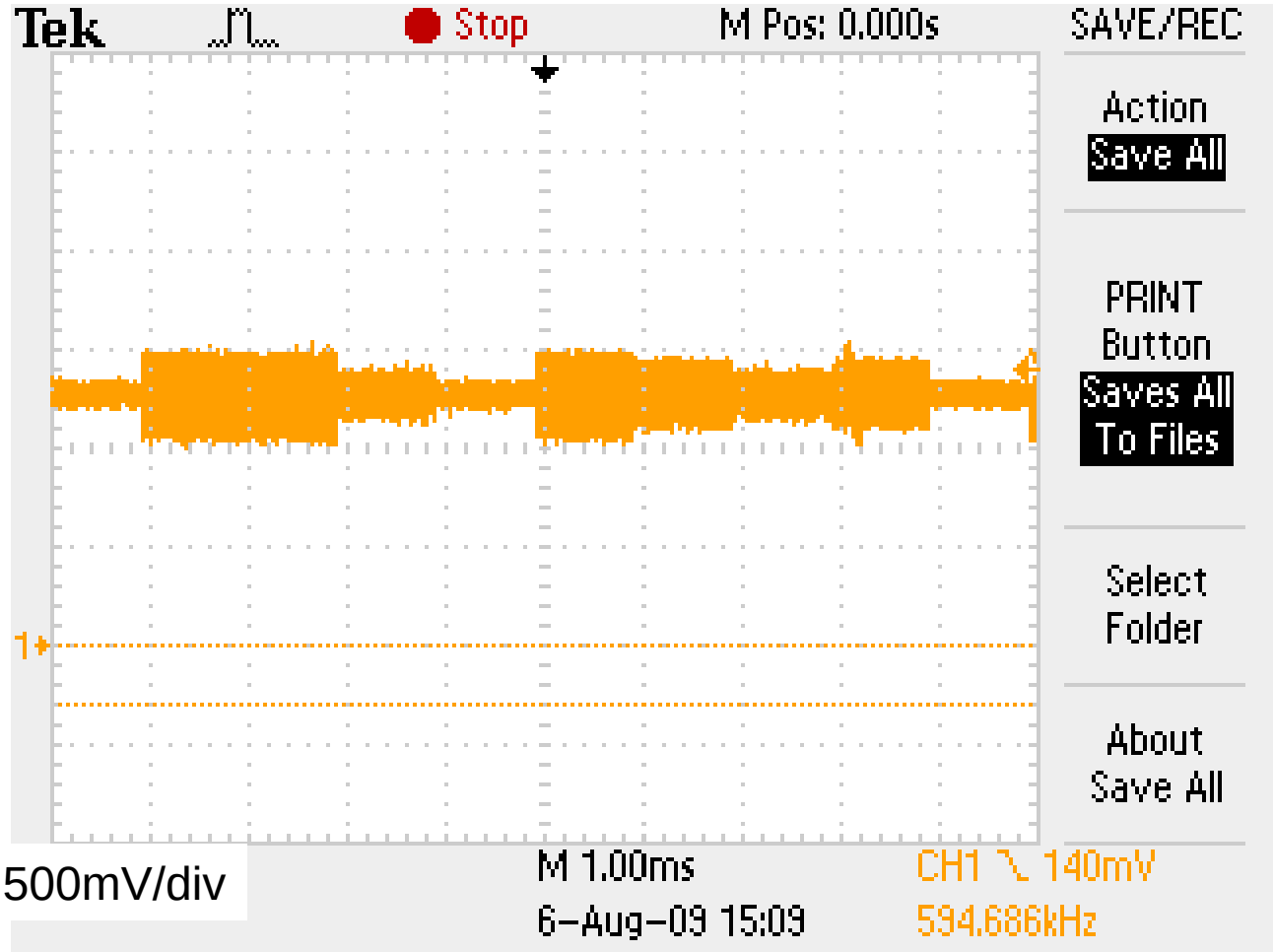
SWIFT Dynamic Span (single ended view)



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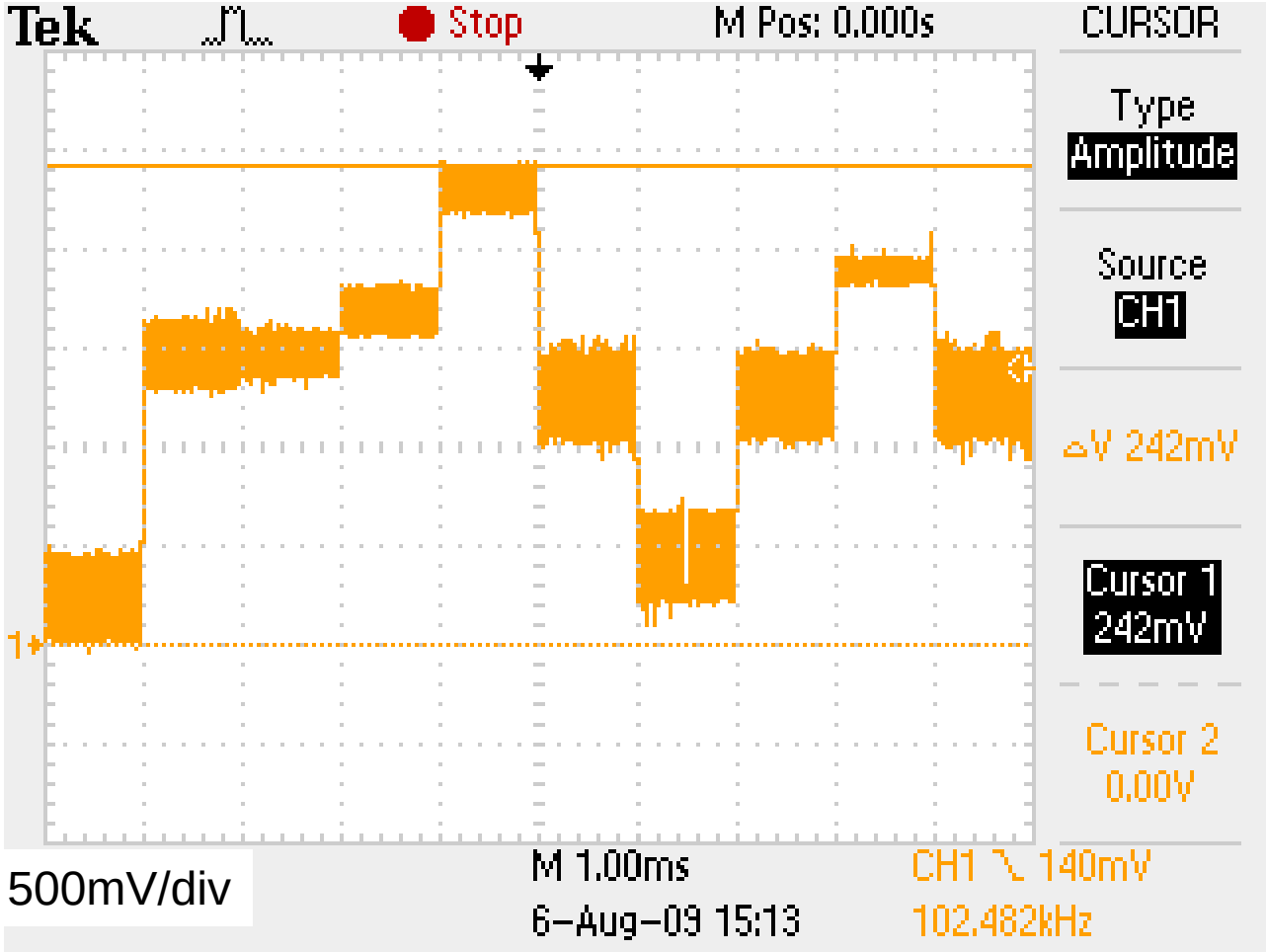
SWIFT Dynamic Span/Bias (SE view)



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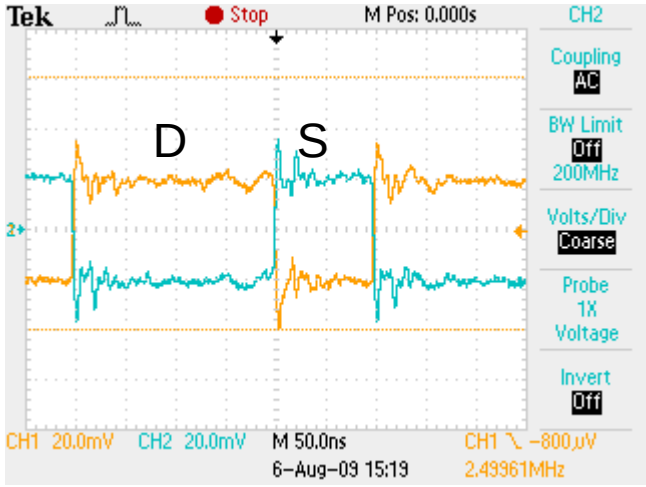
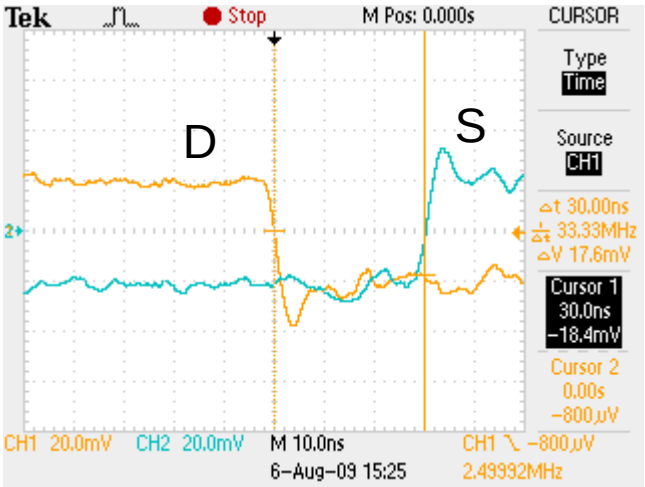
SWIFT Static Skew Change

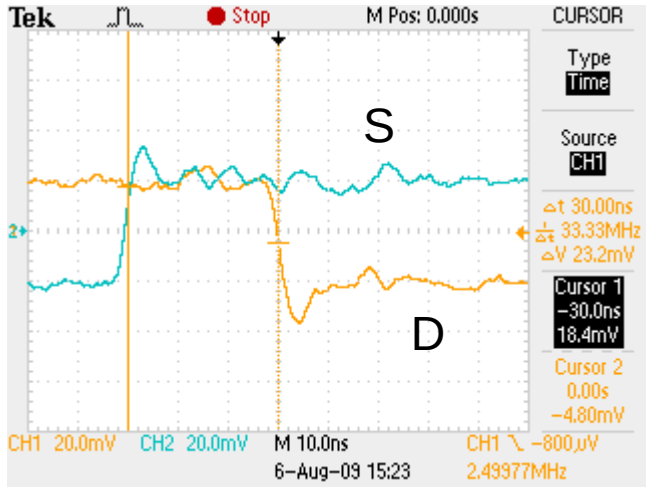


"0 skew"
(ZERO phase demo mode w/180º is used)

D leads S by 30 nS



D trails S by 30 nS



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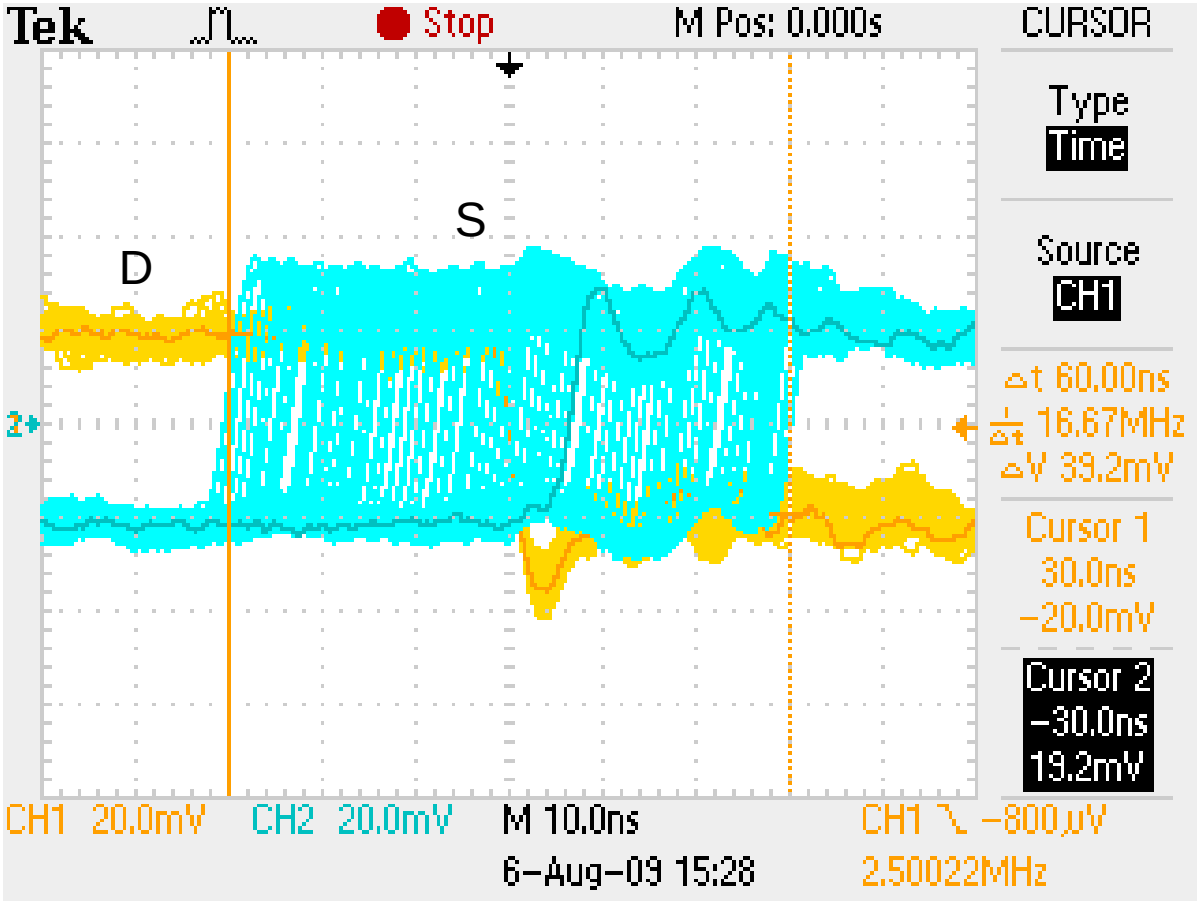
SWIFT Dynamic Skew Change



S is scanned around static D upto ±30 nS at 1 nS / step

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SWIFT Control:

- **Horizontal encoder wheel (left):**
  - ***Selects between Profile, Mbps, Skew, Span, Bias, Mode fields***
- **Vertical encoder wheel (right):**
  - ***Selects between available values assigned to the above fields***
- **Scan/Inject button (red):**
  - ***Momentary press:***
    - If cursor in Skew, Span, or Bias field – toggles Scan option for each current parameter
    - If cursor in Profile, Mbps, or Mode field – injects error to test **Drops/ErBit** counter
  - ***1 sec press:***
    - Toggle Scan option for all 3 parameters together: Skew, Span, Bias, if Clock to TP is active
- **Reset/Count button (blue):**
  - ***Momentary press:***
    - Start / Stop **Drops/ErBit** counter and **Timer**
  - ***1 sec press:***
    - Reset **Drops/ErBit** counter and **Timer**
- **USB port:**
  - ***Transmission (telemetry)***
    - Current SWIFT operational status with time tag resolution of up to 1ms (Telemetry A)
    - All 4 working profiles setup and SWIFT box unique identification data (Telemetry B)
  - ***Reception (commands)***
    - *New setup data, functions, and operational scripts*

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SWIFT Future Improvements

- Significantly decrease board's noise
- Finish GUI for PC applications
- Increase Span resolution from 100mV to 50mV per step
- Increase FPGA capacity to fit SpaceWire IP core
- Develop Remote only controlled unit