# eMMC (4.41, 4.51 and 5.0) and SD (UHS-I) Electrical Validation and Protocol Decode Software



Detail View correlates Waveform, Protocol and electrical measurements

## **Features**

- eMMC and SD (UHS-I) electrical measurements and Protocol testing software conforms to eMMC version 4.51 and 5.0 and SD version 3.01 specification.
- eMMC/SD/SDIO Protocol Aware Trigger features
- Industry first Protocol decoding CMD and Data (1 bit/4 bit and 8 bit mode) using MSO capabilities of Oscilloscope
- Supports SDR and DDR and Boot mode for electrical measurement and protocol Decode
- Fastframe capability allows protocol analysis of CMD in 100s of second time
- Software automatically identifies the read and write operations using CMD and apply the electrical parameter limits accordingly.
- Detail View provides efficient debugging capability by correlating the analog waveform, protocol messages and electrical measurements for each protocol packet in single view
- Protocol View lists the protocol activities in sequential form to assist designers to know the host and card transactions

- Time stamp at the end of command token and time stamp at beginning of the response token in Protocol View enables designer to comply with specification and locate any anomaly in timing between host and card
- Software displays the details of command and response in Protocol View and list the errors messages in card status for quick analysis
- Ability to store the eMMC and SD protocol data in CSV and txt format
- Utility features like zoom, undo, and fit to screen for easy maneuvering the waveforms while debugging the cause to problem in Detail View makes it easy to use tool
- Software seamlessly integrates with Tektronix windows based oscilloscope and supports live signal analysis using live channels of oscilloscope
- Supports data analysis for long record length and more acquisition memory of oscilloscope enables analysis of protocol events for longer duration
- Report generation in pdf format.



• Supports wfm and isf file formats of Tektronix oscilloscope for offline analysis



## Applications

- ✓ Protocol Analysis
- ✓ eMMC and SD (UHS-I) Electrical Compliance Test (Supports eMMC4.42, 4.51 and 5.0 & SD3.01)
- ✓ Correlation of Analog waveform, Protocol activities and Electrical Measurements

#### Seamless Integration with Oscilloscope

PGY- MMC and SD Electrical Validation and Protocol Decode Software runs inside the Tektronix high performance windows oscilloscopes. Automatically imports the data from oscilloscopes live channels. Also supports Tektronix .wfm and .isf file formats. This enable live and offline testing of eMMC and SD Signals.



Measurement selections

- Provides the flexibility to select type of Card interface to be tested and related Bus speed modes
- Flexibility select necessary or all electrical measurements
- Save and recall of application setup for repetitive testing at different times
- Supports single and continuous test mode using oscilloscope live data
- Ob-line help

#### eMMC/SD/SDIO Protocol Aware Triggering

For efficient test and debugging eMMC/SD/SDIO, it is important to capture signals at right condition. PGY-MMC-SD software provides protocol aware triggering along serial pattern trigger option of the oscilloscope to capture signals at specific event in CMD line.

🔯 PGY-MMC-SI	) Electrical Validation and Protocol Decode Software	Save Recall Recall Default	About	2 🔿 😣
	Trigger Event			Run
Select	Trigger Source: CH2 - Data Rate: 100 Mbps		Set Trigger	Single
			Set Higger	No Acq
Configure	Trigger On Index Content			Run / Stop
	Command  CMD7  SELECT/DESELECT_CARD	<b></b>		Run Options
Limit Setup				Analyse
Trigger	[47:44] [43:40] [39:36] [35:32] [31:28] [27:24]	[23:20] [19:16] [15:12] [11:8]	[7:4] [3:0]	Export
	<b>Edit</b> 1XXX _ XXX _ 0000 _ 0000 _ 0000	0000 0000 0000 0000	1110 0010	Report
Version :2.5.7	Oscilloscope: clock ch1, DATA ch2,CMD c	h3  bits/data 8   bit order msb   Ma	rk	
	Trigger setup menu			

- Flexibility to trigger on command or response
- Offers all the standard triggers patterns with command and Response
- Flexibility to edit trigger pattern



### Automated Electrical Validation and Protocol Decode Software

As per the specification of eMMC and SD, the measurement limits are different for read and write operation. The PGY-MMC-SD measurement algorithms automatically find the read and write operations and validates with the respective limits. This enables you to save time in identifying the read and write operation and isolating any compliance issues.

	Measurement	Minimum	Mean	Maximum	Low Limit	High Limit	Result ^		Ru
Select	Clock Frequency	389.84	1.0558	25.456	0.0000Hz	26.000 MHz	Pass	Detail View	Sing
	Clock Rise Time	1.3305 nS	1.8930 nS	3.5875 nS	NA	10.000 nS	Pass		No A
onfigure	Clock Fall Time	1.3063 nS	1.9395 nS	3.9166 nS	NA	10.000 nS	Pass E		Run /
Anigure	Clock High Time	19.742 nS	473.92 nS	1.2842 µS	10.000 nS	NA	Pass	Protocol View	Run Op
	Clock Low Time	18.460 nS	473.25 nS	1.2838 µS	10.000 nS	NA	Pass		<u>Run Or</u>
nit Setup	Clock Duty C	49.533 %	50.523 %	53.489 %	NA	NA	NA		Analy
	🔇 Clock Cycle	39.285 nS	947.16 nS	2.5652 µS	1.0000 nS	5.0000 nS	Fail	- Acg Count -	
	😑 Output Setup	NA	NA	NA	11.701 nS	20.000 nS	NA	1	Expo
	Output Hold	19.239 nS	493.09 nS	1.2836 µS	8.3000 nS	NA	Pass		Repo

Analyze lists all electrical measurements with pass/fail report

- Lists electrical measurements with mean, minimum and maximum values measured for the entire acquired waveform
- Indicates if measurement exceeds the min or max limits by orange color
- Lower and Upper limits of the electrical measurements are compared against measured values
- Supports Electrical Measurements as per eMMC 4.41 and 4.51 and UHS3.1 Specification.
- Automated identification read and write operation and apply electrical limits as per eMMC and UHS-I specification

#### Timing Parameters between CMD, Response and Data

EMMC specifies the minimum and maximum cycles to present between the host and device to ensure interoperability. PGY-MMC-SD analyzes the data for these specifications and offers results.

Description	Symbol	Primary Coverage	Minimum	Maximum	Unit	Minimum Measured	Maximum Measured	<u>Results</u>	ſ
Data Read Timing	NAC	System		10*(TAAC*FOP+100+	Clock Cycles		2260	Pass	
Last Host Command to Next Host Co	NCC	System	8	NA	Clock Cycles	NA	NA	NA	
Boot Operation Command - Command	NCD	System	56	NA	Clock Cycles	92	92	Pass	-
Boot Operation Command - Data Timi	NCP	System	74	NA	Clock Cycles	2959	2959	Pass	:
Assign a Device Relative Address Ti	NCR	System	2	64	Clock Cycles	5	9	Pass	
Device Identification and Device Op	NID	System	5	5	Clock Cycles	5	5	Pass	
Last Device Response to Next Host	NRC	System	8	NA	Clock Cycles	131	14003	Pass	
R1b Response Timing	NST	System	2	2	Clock Cycles	2	2	Pass	
Data Write Timing	NWR	System	2	NA	Clock Cycles	275	18251	Pass	
Boot Operaion tBA Timing	tBA	System	NA	50	mS	21.096	21.096	Pass	

#### **Protocol View**

PGY-MMC-SD software lists all the protocol activity between the host and card. Engineers can now quickly view the command and its corresponding response from card. Selected protocol activity details are listed on right side of the list table. Now Engineers can know the errors reported by card or any other message to host without struggling to know the content of each message.

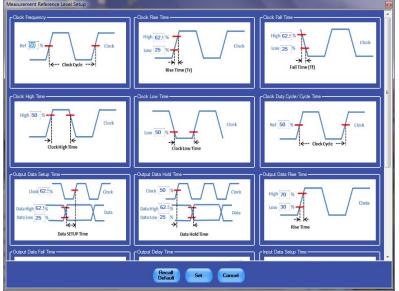
Proto	col Comn	nand Response A	Activity													
SI#	CMD Index	CMD_Argument	CMD_End Time (TC)	Response Type	Response CheckBits / Index	Response Status	Respose Start Time (TR)	Delta (TR-TC)	Cmd Ir		CM	ID1 ND OP COND		Type Response	bor R3	
	CMD0	0x00000000							Abbre	viation	100	ND_OF_COND		Expected		ls
1	CMD1	0x40000080	480.70 µS	R3	b000001	0x40000080	357.62 µS	0.0000S	Cmd In	idex (45:4	10) 000	0001		CRC (7:1)	1110100	
3	CMD1	0x40000080	2.4669 mS	R3	b000001	0x40000080	2.3439 mS	12.821 µS								
5	CMD1	0x40000080	5.3722 mS	R3	b000001	0x40000080	5.2491 mS	12.821 µS	Argur	ment (39	9:8) 010		00001 拿	End bit 0	1	Hex
7	CMD1	0x40000080	8.2446 mS	R3	b000001	0x40000080	8.1216 mS	12.821 µS								
9	CMD1	0x40000080	11.134 mS	R3	b000001	0x40000080	11.011 mS	12.821 µS	R3	Response	e 11	1111	111111	1	1	-
11	CMD2	0x00000000	14.168 mS	R2	b111111	0x00000000	14.045 mS	12.821 µS			Ch	eck bits 45:40	Check	bits 7:1	End bit	0
13	CMD3	0x00010000	14.888 mS	R1	6000011	0x00010000	14.765 mS	12.820 µS			00	000000111111111000	00001000000	)		HEX
15	CMD9	0x00010000	15.486 mS	R2	b111111	0x00010000	15.363 mS	15.385 µS	8		00	R Register 39:8				
17	CMD10	0x00010000	16.206 mS	R2	b111111	0x00010000	16.083 mS	15.385 µS	6							
19	CMD7	0x00010000	17.096 mS	R1	b000111	0x00010000	16.973 mS	15.385 µS					-	Detecti	on	-
21	CMD6	0x03B90000	21.092 mS	R1b	b000110	0x03B90000	20.969 mS	15.385 µS	Bits	Ide	entifier		Туре	Mode		Error
23	CMD6	0x03B70000	22.827 mS	R1b	b000110	0x03B70000	22.825 mS	20.513 µS	24	Loc	k_Unloc	ked_Failed	E	X		1
25	CMD16	0x00000200	24.188 mS	R1	b010000	0x00000200	24.186 mS	320.08 nS	16	CID	/CSD_0	verwrite	E	X		1
27	CMD23	0x00000004	27.653 mS	R1	b010111	0x00000004	27.651 mS	280.09 nS	15	WP	_Erase_	Skip	E	X		1
29	CMD25	0x00000001	28.210 mS	R1	b011001	0x00000001	28.208 mS	280.01 nS	13	Eras	se_Rese	t	E	R		1
31	CMD16	0x00000200	37.313 mS	R1	b010000	0x00000200	37.311 mS	320.17 nS	8	Rea	ady_For_	Data	S	R		1
33	CMD23	0x00000004	40.785 mS	R1	Ь010111	0x00000004	40.783 mS	280.09 nS								
35	CMD18	0x00000001	41.347 mS	R1	ь010010	0x00000001	41.345 mS	279.96 nS								
37	CMD6	0x03B90000	60.593 mS	R1b	b000110	0x03B90000	60.591 mS	360.44 nS								
39	CMD6	0x03B70100	61.797 mS	R1b	b000110	0x03B70100	61.795 mS	320.28 nS								
41	CMD16	0~00000200	62 274 mS	D1	L010000	0-00000200	\$2 272 ms	220 72								



**Protocol View** 

#### Characterization of PHY layer by custom limit setup

PGY-MMC-SD is not just for standard electrical compliance testing, you can also vary the limits and test your device with custom limits. The intuitive limits and reference level setup allows you to configure the limits and reference levels for your custom testing needs. This enables you to test your device beyond the specification and characterize it.



Config panel to custom set the reference setting for electrical measurement

#### Powerful Debug environment: Detail view

In Detail View, engineers can view the analog waveform, details of protocol and electrical measurements in single view. If there is any failure in electrical measurement or error in protocol messages, designers can quickly correlate the protocol data with analog waveforms. These protocol errors can be caused due to the failure in electrical measurements. User can select any row in the detail view; corresponding analog waveform will be zoomed and displayed. In the same row, engineers can view all the electrical measurements corresponding to the selected row. Utility features such as zoom, cursors, and markers make custom measurement while debugging.



Detail view

Detail view provides following capabilities:

- Plots the acquired waveform in waveform view window
- Lists all decoded command and response tokens in each row in decode table
- Indentifies of type of command and response for easy protocol interpretation
- Lists respective electrical measurements for command and response for each row



- Selected Protocol command or response's related analog waveform is plotted in a window.
- Bus Diagram view overlays protocol data for the selected row along with waveform
- Snap button enables storing selected waveform window for report generation purpose
  Zoom, fit to screen, pan, undo, vertical and horizontal cursors enables quick analysis and measurement of electrical signals

#### Industry First Decoding of CMD and data Signals:

PGY-MMC-SD leverages powerful capabilities of Digital Channels of MSO70000/5000 series oscilloscope to provide industry decoding of data signals in eMMC and UHS-I.

	Com	mand (Hoat)		Res	onse Card			And and a second second	DEAD MU	TIPLE BLOCK	- Fermion	11
Seriel No	index	Argument	Fesporas	Own Bits 7 Index	Status / CID / CID / OCR Register / //gumments	Total Data Bytes + CRC	Start Terr	Cour initian (20140)	010010		5	0000010
	CM018	0+00087080	R1	12	Dx00000900		12.00%S	Access	0x00087080		Brothes. Events	
	DATA					500	715.41µ5					0
1	DATA		4	1	4	\$13	736.53µ5	Computed CR	c	Expected CRC	Fee	A
£	DATA		1			520	757.90 <sub>6</sub> 5	1507		8507	Pass	
5	DATA		+	-	+	520	779.05µ5	4682		4682	Pass	
£	DATA		+			520	811.84µS	54068		54068	Pass	
ţ .	DATA		+		*	520	812.9645	58514		50514	Piere	
1	DATA	+	+.	e.)	+	520	354.08µS	Sec.				
3	DATA.	+	+	÷.	+	520	875.25,4					
10	DATA	÷	+	*	+	301	907.68µS			contract on Epiterical		
11	CM012	0x00000000	R1	52	Dx00000800	4	521.94u5			967, 9405, 9435, 9447 945, 9437, 9437, 9485		
								DiD1, Di30, Di Di27, Di47, Di Di25, Di47, Di Di47, Di47, Di Di47, Di47, Di75, Di Di49, Di47, Di75, Di Di49, Di47, Di75, Di Di46, Di41, Di25 Di46, Di41, Di25 Di41, Di47, Di7,	31, 0x90, 0x90 17, 0x46, 0x26 75, 0x1, 0x47, 0x 1, 0x15, 0x7, 0x 1, 0x15, 0x67, 0x 1, 0x15, 0x67, 0x 0, 0x40, 0x31, 7, 0x77, 0x25, 0x 0x1, 0x25, 0x 0x1, 0x25, 0x	26/05 0x75 0x1 0x7 0x31 0x1, 0x1, 0x1, 0x2 0x75 0x1, 0x17, 0x23 0x85 0x65 0x1, 0x7, 0x3 0x1 0x25 0x15 0x7, 0x7 0x75 0x05 0x15 0x7 0x76 0x75 0x15 0x10 0x65 0x05 0x1, 0x17 0x 0x65 0x05 0x1, 0x17, 0x 0x65 0x05 0x1, 0x17, 0x 0x65 0x17 0x1, 0x17, 0x 0x65 0x17 0x1, 0x17, 0x 0x65 0x17 0x1, 0x17, 0x0	<ul> <li>br1 br85 br</li> <li>br85 br85 br</li> <li>br85 br85 br</li> <li>br85 br85 br</li> <li>br85 br87 br</li> <li>br85 br87 br</li> <li>br85 br85 br</li> <li>br86 br87 br</li> <li>br85 br85 br</li> <li>br85 br</li></ul>	17. br1, 6x25, 6x1, ct, 5x47, 6x47, 6x47, 6x47, 6x47, 6x47, 6x47, 6x45, 6x45, 6x45, 6x4, 6x5, 6x47, 6x45, 6x4, 5, 6x55, 6x47, 6x4 5, 6x55, 6x45, 6x45, 6x45, 6x35, 6x45, 6x45, 6x35, 6x45, 6x45, 6x35, 6x45, 6x45, 6x35, 6x45,

Digital Decode View

#### Protocol test:

PGY-MMC-SD software automatically checks for Protocol Integrity. This allows very easy method ensuring protocol packets are as per protocol specifications of eMMC, UHS-I Specifications.

Description	Result
Packet Integrity	Pass
Integrity Between Command and Response	Pass
Reserve Command Presence	No
Error Flag Set in Response	Pass
CRC Error Check For Command	Pass
CRC Error Check For Response	Pass
CRC Error Check For Data(Digital)	Fail



#### **Tektronix Oscilloscopes Supported**

- DPO/MSO5000 series
- DPO7000 series
- DPO/MSO/DSA 70000 series

#### **Ordering Information**

**PGY-MMC-SD** (shipment includes CD with PGY-MMC-SD Electrical Validation and Protocol Decode Software)

#### Contact:

Prodigy Technovations Pvt. Ltd. 2145, 2<sup>nd</sup> Cross, 17<sup>th</sup> Main, HAL II Stage, Indiranagar, Bangalore, India 560008 Phone: +91 80 42076546 Email: contact@prodigytechno.com www.prodigytechno.com

#### About Prodigy Technovations Pvt Ltd

Prodigy Technovations Pvt Ltd (www.prodigytechno.com) is a leading global technology provider of Protocol Decode, and Physical layer testing solutions on test and measurement equipment. The company's ongoing efforts include successful implementation of innovative and comprehensive protocol decode and physical Layer testing solutions that span the serial data, telecommunications, automotive, and defense electronics sectors worldwide.

#### **Other products**

- HDMI and MHL Protocol Compliance Test Software
- UniPRO and LLI Protocol Decode Software
- UFS Protocol Decode Software
- HSI Electrical Validation and Protocol Decode Software
- I2C Electrical validation and Protocol Decode Software
- SPI Electrical Validation and Protocol Decode Software
- I2S Electrical, Audio, and Protocol Testing Software
- UART/RS232 Protocol Decode Solution
- FlexRay Protocol and SI Analysis Software
- USB2.0 Protocol Decode Software
- HSIC Protocol Decode Software
- RFFE Protocol Analysis Software
- KX/KR Ethernet DME and Line Training Analysis Software
- SSIC Protocol Analysis Software
- SPMI Protocol Analysis Software
- DigRF V4 Protocol Analysis Software

