# FC-16G DPOJET Option

## FC-PI-5 Fibre Channel Transmitter Compliance and Debug Datasheet



## Features & Benefits

- Simplified Scope Setup, Limits, and Standard Specific Measurements
  The Tektronix FC-16G DPOJET Option Simplifies test setup which reduces human error and results in faster and more accurate compliance testing of FC-PI-5 designs
- Flexible Limits FC-16G allows engineers to seamless transition to debug environment in event of observing a compliance failure
- Detailed Test Reports Tektronix FC-16G solution provides Printable reports results, margin and statistical data enhances analysis capabilities and allows for results sharing
- Integrated Method of Implementation Document MOI Document which is bundled as part of the FC-16G solution ensures that proper steps are taken to execute Compliance tests
- FC-PI-5 Clause 9 Electrical Physical Layer Test Suite Version 1.1 Specification – FC-16G solution Ensures that your results are recognized and accurate to industry standards
- FC-16G Fixturing Tektronix provides the complete solution to compliance verification and debug; including Oscilloscopes, Software, and Fixtures all from a single Test and Manufacturing vendor
- Reduces Testing Time FC-16G solution takes roughly 10 minutes to perform all Compliance measurements, reducing testing time up to 80% as compared to manual testing method
- Scope Support FC-16G software can be installed and run on Tektronix DPO/DSA/MSO Oscilloscopes with bandwidth ≥20 GHz. Design Engineers using Tektronix Oscilloscopes can always install FC-16G on their existing oscilloscopes
- Offline Waveform Support FC-16G provides Validation and Design Engineers the Ability to Run Tests on Stored Waveforms reducing the dependency on availability of DUT
- Floating License Option Provides Engineers with Tektronix Floating License Installation Option ensuring multiple use of one software license across instruments

## Applications

#### Ethernet FC-16G Transmitter Testing for:

- Device silicon validation
- System compliance and debug
- Manufacturing test



# About Option FC-16G Compliance and Debug Solution

Option FC-16G provides a standard user interface for FC-PI-5 testing within the DPOJET environment. The software automatically configures all limit and measurement parameters, reducing the learning curve to create and run compliance tests. FC-16G contains all standard-specific measurements including Deterministic Jitter, Uncorrelated Jitter, DDPWS, and Transmitter Output Waveform Requirements. This approach helps engineers reduce their testing time by up to 80% as compared to manually configured testing. Option FC-16G includes setup files for different signal types such as N1N0, PRBS7, PRBS9, PRBS11, PRBS15, PRBS20, PRBS23 and PRBS31. This feature lets users test their device using different supported signal patterns while in debug mode.

Additionally, FC-16G is fully integrated into DPOJET. On seeing a failure, users have the flexibility to add a new measurement which could help them further debug and root cause their device failure.

## About FC-PI-5 Technology

Fibre Channel, or FC, is a gigabit-speed, bidirectional point-to-point serial data channel network technology, primarily used for high-performance information transport (such as storage networking). Fibre Channel is standardized by the T11 Technical Committee of the InterNational Committee for Information Technology Standards (INCITS), an American National Standards Institute (ANSI)-accredited standards committee.

Despite its name, Fibre Channel signaling can run on twisted pair copper wire in addition to fiber-optic cables.

While 16GFC doubles the throughput of 8GFC, the line rate of the signal only increases to 14.025 Gbps because of a more-efficient encoding scheme. 16GFC uses 64b/66b encoding.

The physical interface (FC-0) is specified in FC-PI-5[5]. FC-0 consists of transmission media, transmitter devices, receiver devices and their interfaces.

Clause 9 of FC-PI-5 describes the electrical interface specification for 1600-DF-EL-S and 1600-DF-EA-S:



## Method Of Implementation (MOI) Document

The FC-16G MOI document (included with the software) provides a list of supported measurements, connection diagrams, and in-depth details of the measurement and oscilloscope settings. Use the MOI to make sure that the measurements and results comply with industry standards.

DPOJET Status INITIALIZING DPOJET For details on using Fibre Channel-16G please see C.\Program Files\TekApplications\DPOJET\FC-16G\_Tx\_DPOJET\_MOI.pdf

Message box providing information about MOI document

#### **Detailed Results and Reporting Feature**

The FC-16G application generates detailed HTML reports that include the performance, status, and test results of your device. Report generation tools also provide features such as auto-incremented report file names, adding user comments to a report, and listing complete instrument and measurement configuration details.

-	Jitter an	d Eye Diagran	n Analy	sis Tools : Measurement Report Te	ktronix					
	Configu ▶ Setup	ration Configuratior		December 04, 21	012 18:36:21					
Oscilloscope Version DPOJET Version Status			on	6.4.5 Build 2 6.0.0 Build 180 Pass						
Measurement Configurati			Source	1 Others						
	1	FC-16G Diff O/P Voltage1	(s) Math1	Edges => Signal Type: Data   Clock Recovery => Method: PLL - Custom BW, PLL Model: Type I, Damping: 700 8 413MHz, Nominal Data Rate: Off, Bit Rate: 2.5Gb/s, Known Data Pattern: Off, Pattern Filename: C:\TickApplicationsUPOUPTPatternsUPRBS1271 xt1   Filters => F1: Spec: No Filter / 2: Spec: No Filter   Genera Measurement Range Limts: Off, Max: Tms, Min: 05, subort Soutom Source Name	m, Loop BW:					
	2	FC-16G Fall Time1	Math1	Edges ⇒ Signal Type: Data   Clock Recovery ⇒ Method PLL – Custom BW, PLL Model Type  , Damping: 700 8 413MHz, Monima Data Rate ⊂ OR B Rate 2: 560k, Knorn Data Patterno: (M, Patterne Filearane C: TletApplicationsDPD/DETPattemsPH85127.bt   Files ⇒ F1: Spec: No Filer, F2: Spec: No Filer, F3: Spec: No Filer,	Im, Loop BW:					
	3	FC-16G TX Jitter EL	Math 1	$ \begin{array}{l} \label{eq:constraints} \begin{array}{l} \label{eq:constraints} \end{tabular} = Signal Type: Data (Cock Recovey => Method: PLL - Custom BW, PLL Model: Type  , Damping: 700 B 413MHz, Nominal Data Rate: On, Bit Rate: 1A 0256b/s, Known Data Pattern: Off, Pattern Friedmanne: Citte&Applications DPOLETIPatterns/FRBS127. tot (RD) => Pattern Type: Arbitrary, Window Length: SUI, Popular 1E-121 (Filters => F1: Spec: No Filter, F2: Spec: No Filter, F2: Spec: No Filter, General => Measurement Range Limits: Off, Max: Custom Source Hame \\ \end{array}$	m, Loop BW: lation: 100, BER 1ns, Min: 0s,					
	4	FC-16G Rise Time1	Math1	Edges ⇒ Signal Type: Data   Clock Recovery ⇒ Method FUL – Custom BW, PLL Model' Type  , Damping' 700 8 413MHz, Monima Data Rate ⊂ OR, BR Rate 2:505K, Knorm Data Patterno: (P, Pattern Filearane: C\TieKApplicationsDPD/DETPAttemsPRB5127.bt   Filess ⇒ FI: Spec: No Filer, F2: Spec: No Filer   Genera Measurement Range Limits. Of, Max: Tins, Min: O, Custom Source Name. –	Im, Loop BW:					
	5	<u>FC-16G Tx</u> <u>RMS CM 0/P1</u>	Math2	Edges ⇒ Signal Type: Data   Clock Recovery ⇒ Method: PLL – Custom BW, PLL Model: Type  , Damping: 700 8 413MHz, Monima Data Rate. < Or, BR Rate. 2560; Known Data Pattern: Of, Pattern Filearane: C\TieKApplicationsDPD/UETPatternsPRB5127.txt   Fiters ⇒ F1: Spec: No Fitter   Genera Measurement Range Limits: Of, Max: Tris, Min: Sp. Custom Source Name: –	im, Loop BW: I =>					
	6	<u>FC-16G Tx Eye</u> <u>Mask</u>	Math1	Bit Config => Bit Type: AI Bits, Mask: C:Users/Public/Tektronic/TekApplications/FiberChannel- InGOMasks/FCFE, Puk Ask, E. mark J. Clock Recovery > Method 'PL - Conston RW, PL Model: Type I, Dat Loop BW: 8.413MHz, Nominal Data Rate: On, Bit Rate: 14.025Gb/s, Known Data Pattern: Off, Pattern Filename C:TtekApplications/DPOLEPatterns/PRBS12/1xd   General => Measurement Range Limits: Off, Max: 50HHs, Custom Source Name: –	nping: 700m, : Min: OHits,					
	7	<u>FC-16G UJ1</u>	Math1	Edges ⇒ Signal Type: Data   Clock Recovery ⇒ Method PLL – Custom BW, PLL Model Type  , Damping: 700 8 413MHz, Monima Data Rate < OF, BR Rate 2:560k, Known Data Patteriori, OF, Patterner Filesame. C\TekApplicationsUPD/UETPatterns/PR851271xt   Fitters ⇒ F1: Spec: No Fitter   Center Measurement Range Limits. Of, Max: Tran, Min: Sp. Custom Source Name: –	im, Loop BW: I =>					
	8	FC-16G DJ	Math1	Edges => Signal Type. Data   Clock Recovery => Method ! PLL - Custom BW. PLL Model : Type  . Damping: 700        8413MHz, Normal Data Rate: 001 Bit Rate: 2560%, Known Data Pattern: 001 Pattern Filename        C:TekApplications/DPCUETPatterns/PRBS127.tot. [R0] => Pattern Type: Arbitrary, Window Length: 5UI, Populary	Im, Loop BW:					

Reports list available in HTML format

#### Measurement Results

Description	Mean	Std Dev	Max	Min	р-р	Population	Max-cc	Min-cc
FC-16G Diff O/P Voltage1, Math1	507.42m	9.8513m	514.28m	501.69m	12.586m	2745	8.3748m	-8.4930m
Current Acquisition	507.42m	9.8513m	514.28m	501.69m	12.586m	2745	8.3748m	-8.4930m
FC-16G Fall Time1, Math1	41.378pS	1.9883pS	49.586pS	36.105pS	13.482pS	41985	11.466pS	-10.649pS
Current Acquisition	41.378pS	1.9883pS	49.586pS	36.105pS	13.482pS	41985	11.466pS	-10.649pS
FC-16G TX Jitter EL, Math1	18.327ps	0.0000s	18.327ps	18.327ps	0.0000s	1	0.0000s	0.0000s
Current Acquisition	18.327ps	0.0000s	18.327ps	18.327ps	0.0000s	1	0.0000s	0.0000s
FC-16G Rise Time1, Math1	40.540pS	1.8599pS	47.748pS	35.187pS	12.560pS	26137	9.4743pS	-10.113pS
Current Acquisition	40.540pS	1.8599pS	47.748pS	35.187pS	12.560pS	26137	9.4743pS	-10.113pS
FC-16G Tx RMS CM O/P1, Math2	8.2899m	0.0000	8.2899m	8.2899m	0.0000	1	0.0000	0.0000
Current Acquisition	8.2899m	0.0000	8.2899m	8.2899m	0.0000	1	0.0000	0.0000
FC-16G Tx Eye Mask, Math1	0.0000		0.0000	0.0000		1.3959M		
Hits In Segment 3	0.0000		0.0000	0.0000		1.3959M		
FC-16G UJ1, Math1	946.47fS	0.0000S	946.47fS	946.47fS	0.0000S	1	0.0000S	0.0000S
Current Acquisition	946.47fS	0.0000S	946.47fS	946.47fS	0.0000S	1	0.0000S	0.0000S
FC-16G DJ, Math1	11.703ps	0.0000s	11.703ps	11.703ps	0.0000s	1	0.0000s	0.0000s
Current Acquisition	11.703ps	0.0000s	11.703ps	11.703ps	0.0000s	1	0.0000s	0.0000s
FC-16G DDPWS1, Math1	6.5966pS	0.0000S	6.5966pS	6.5966pS	0.0000S	1	0.0000S	0.0000S
Current Acquisition	6.5966pS	0.0000S	6.5966pS	6.5966pS	0.0000S	1	0.0000S	0.0000S
FC-16G Nominal UI, Math1	71.299ps	1.5540ps	81.657ps	62.769ps	18.888ps	1.4025M	17.956ps	-16.786ps
Current Acquisition	71.299ps	1.5540ps	81.657ps	62.769ps	18.888ps	1.4025M	17.956ps	-16.786ps

Detailed report information

The application also captures and saves measurement screen shots in reports for future reference.





Eye Diagram available in HTML report

#### **Setup Diagrams**

FC-16G runs on Tektronix DPO/DSA/MSO Series Real Time Oscilloscopes with a bandwidth  $\geq$ 20 GHz.



Direct SMA cable connection diagram



SFP+ HCB fixture connection diagram

Use TCA-292D (TekConnect to 2.92 mm adapter with 33 GHz bandwidth) with DPO/DSA73304D oscilloscopes.

## Comprehensive Test Coverage

#### Available FC-16G measurements

Measurement	Low limit	High limit	Units	Reference to specification/electrical physical layer test suite	Supported patterns
1- Nominal UI	71.294	71.308	ps	FC-PI-5, Ver 6.1, Sect. 9.1, Table 21	PRBSn Where n= 7, 8, 9, 11, 15, 20, 23, or 31
2- Differential Output Voltage	180	700	mV	Electrical Physical Layer Test Suite (UNH-IOL), Test 9.1.2	N1N0 and PRBSn Where n= 7, 8, 9, 11, 15, 20, 23, or 31
3- Transmitter Jitter		0.24 (EA) 0.45 (EL)	UI	FC-PI-5, Ver 6.1, Sect. 9.4, Table 29	PRBSn Where n= 7, 8, 9, 11, 15, 20, 23, or 31
4- Rise Time and Fall Time	24		ps	FC-PI-5, Ver 6.1, Sect. 9.2.1, Table 22	N1N0 and PRBSn Where n= 7, 8, 9, 11, 15, 20, 23, or 31
5- Transmitter Eye Mask		0	Mask hits	FC-PI-5, Ver 6.1, Sect. 9.2.1, Table 22 FC-PI-5, Ver 6.1, Sect. 9.5.1	
6- Transmitter Common Mode Voltage (RMS)		30	mV	FC-PI-5, Ver 6.1, Sect. 9.2.1, Table 22	
7- Deterministic Jitter (1600-DF-EL-S Only)		0.31	UI	FC-PI-5, Ver 6.1, Sect. 9.4, Table 29	PRBSn Where n= 7, 8, 9, 11, 15, 20, 23, or 31
8- Uncorrelated Jitter (RMS) (1600-DF-EL-S Only)		0.03	UI	FC-PI-5, Ver 6.1, Sect. 9.4, Table 29	
9- Data Dependent Pulse Width Shrinkage (1600-DF-EL-S Only)		0.11	UI	FC-PI-5, Ver 6.1, Sect. 9.4, Table 29	
10- Transmitter Output Waveform Requirements				FC-PI-5, Ver 6.1, Sect. 9.7.1	PRBS9
Steady State Output Voltage (vf)	360	600	mV		
Linear Fit Pulse Peak	(0.73*vf)		mV		
RMS Error		(0.37*vf)	mV		
Normalized Coefficient Step Size	0.05	0.0083			
Maximum Post Cursor Equalization Ratio	4				
Maximum Pre Cursor Equalization Ratio	1.54				
Sum of Magnitudes of Normalized Coefficients	(0.6/vf)				
(C(0) + C(1) - C(-1)) / (C(0) + C(1) + C(-1))	1.161	1.419			
(C(0) - C(1) - C(-1)) / (C(0) + C(1) + C(-1))	2.313	2.827			

## **Ordering Information**

#### FC-16G

#### To Order Along with Oscilloscope

Oscilloscope	Option			
DPO/DSA/MSO70000	FC-16G* Fiber Channel – 16G DPOJET Essentials			

\* No free trials are available for Option FC-16G

#### To Upgrade an Existing Oscilloscope

Oscilloscope	Option
DPO/DSA/MSO70000	DPO-UP FC-16G DPOFL-FC-16G (Floating License) DPOFT-FC-16G (Floating Trial)

#### **Recommended Equipment**

Product Type	Models
Oscilloscopes	DPO/DSA/MSO72004C DPO/DSA72504D DPO/DSA72304D*1
Required software	FC-16G and DJA*2
Required accessories	Matched-pair SMA cables (TCA-SMA connector) Matched-pair SMA cables (TCA-292D*1 connector)
Test fixtures	TF-SFP-TPA-HCB-P TF-SFP-TPA-HCB-PK

\*1 Use TCA-292D (TekConnect to 2.92 mm adapter with 33 GHz bandwidth).

\*2 Prerequisite for FC-16G.

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