Keysight Technologies
Electrical and Optical Clock Data Recovery Solutions

N1076A Electrical Clock Recovery

N1077A Optical/Electrical Clock Recovery

Data Sheet

Electrical and optical clock recovery solutions up to 32 GBaud:

- 50 MBaud to 32 GBaud (continuous)
- Supports NRZ and PAM4 signals
- Integrated O/E and clock recovery design
- Optical splitter: Integrated (Option SMS) or External - user supplied (Option SXT)
- Ultra-low residual random jitter < 100 fs RMS
- Jitter spectrum analysis (JSA) capability
- Golden phase-locked loop (PLL) for compliant operation

KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

Electrical and Optical Clock Recovery Solutions

Keysight clock recovery solutions offer a wide data rate range from 50 MBaud to 32 GBaud, and are ideal for many transmitter and receiver test setups for computers, datacom, and communication standards.

The Keysight Technologies, Inc. N1076A electrical clock recovery provides clock recovery capabilities for electrical non-return-to-zero (NRZ) and pulse amplitude modulation 4-level (PAM4) signals.

The Keysight Technologies, Inc. N1077A optical/electrical clock recovery integrates electrical clock recovery with an amplified optical-to-electrical (O/E) converter, enabling it to work for both electrical and optical applications. The N1077A optionally provides internal single-mode (SM) and multimode (MM) splitters, which simplifies setup and improves ease-of-use.

N1076A and N1077A models include adjustable loop bandwidth and selectable peaking, and provide high sensitivity and low intrinsic jitter performance that ensures optimal measurement accuracy. The optional jitter spectrum analysis (JSA) capability provides insight into the magnitude and distribution of low-frequency jitter, which is helpful in troubleshooting root cause for excessive jitter.

PLL and Jitter Spectrum Analysis

Use Keysight Technologies, Inc. 86100DU-400 PLL analysis software to make fast, accurate, and repeatable measurements of phase-locked loop (PLL) bandwidth/jitter transfer. The N1076A/77A can be configured as a jitter receiver, which can be combined with a precision jitter source, such as the Keysight Technologies M8000 Series of BER test solutions, to create a PLL stimulus-response test system. PCI Express®-approved PLL bandwidth compliance tests are pre-configured, with automatic report generation.

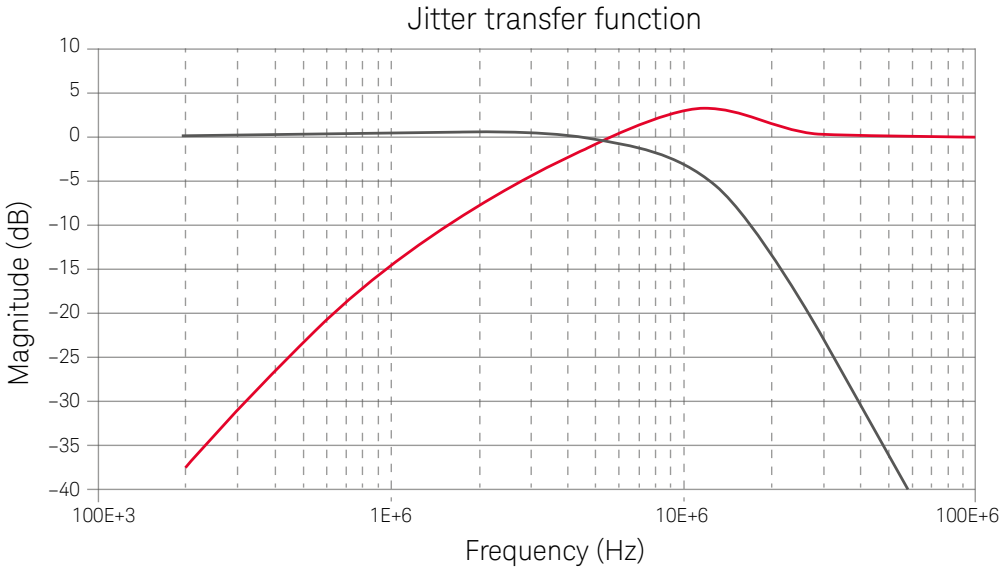

Figure 1. The N1076A/77A clock recovery may be configured as a jitter receiver when characterizing phase-locked loop (PLL) designs using 86100DU-400 PLL analysis software.

What Does Clock Recovery Do?

The N1076A/77A clock recovery takes an incoming data (or clock) signal, locks onto it using a phase-locked loop (PLL) circuit, and outputs a recovered clock. The recovered clock can be used as a timing reference for oscilloscopes or BERTs.

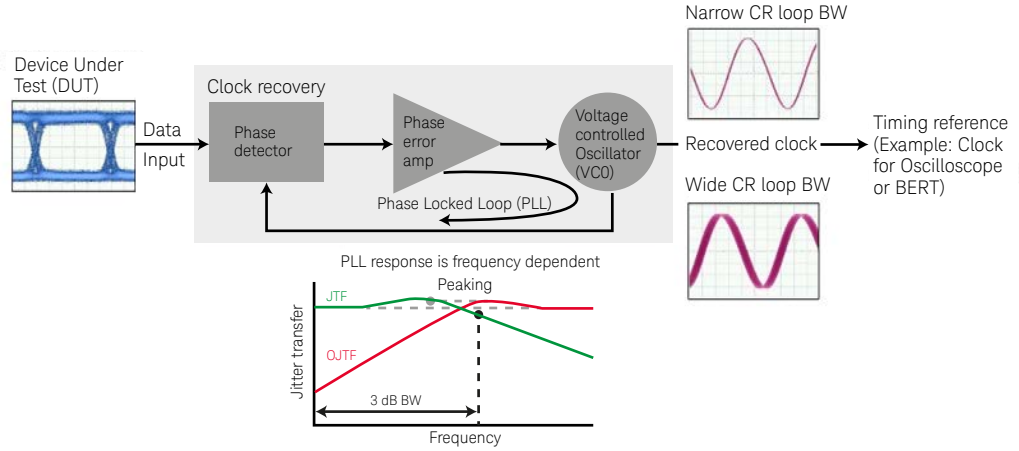

Figure 2. Clock recovery can be used to extract a timing reference signal from an incoming data signal. The amount of jitter on the recovered clock is determined by the loop bandwidth of the PLL.

Standards typically specify loop order, bandwidth, and peaking, all of which determines how much jitter on the incoming signal will appear on the recovered clock (also known as the jitter transfer function, or JTF). Users can configure the FlexDCA graphical user interface (GUI) to adjust these parameters and ensure standards-compliant clock recovery (often referred to as a "golden PLL").

Why Use Clock Recovery?

Standards compliance

To comply with standards such as IEEE 802.3 Ethernet, Fibre Channel, or the Optical Interworking Forum – Common Electrical Interface (OIF-CEI), clock recovery must be used when performing measurements such as jitter, eye width, and/or eye height.

Clock-less devices

Another reason to use clock recovery is when a clock or trigger signal is not provided by the device under test (DUT), but a clock is required to trigger an oscilloscope, or the error detector in a BERT.

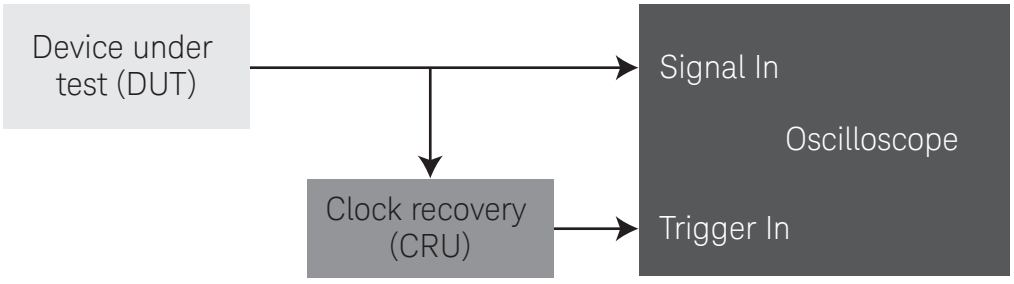

Figure 3. Clock recovery provides a compliant trigger signal for use by an oscilloscope or BERT.

N1076A Electrical Clock Recovery

The N1076A provides instrument-grade clock recovery on electrical signals from 50 MBaud up to 32 GBaud (32.8 GBaud characteristic). Adjustable loop bandwidth (to 20 MHz) and peaking ensures standards-compliant clock recovery capability. The N1076A is controlled via a USB connection to an 86100D DCA-X mainframe, or to a standalone PC running N1010A FlexDCA software.

Figure 4. The N1076A recovers a clock from data signals operating from 50 MBaud to 32 GBaud.

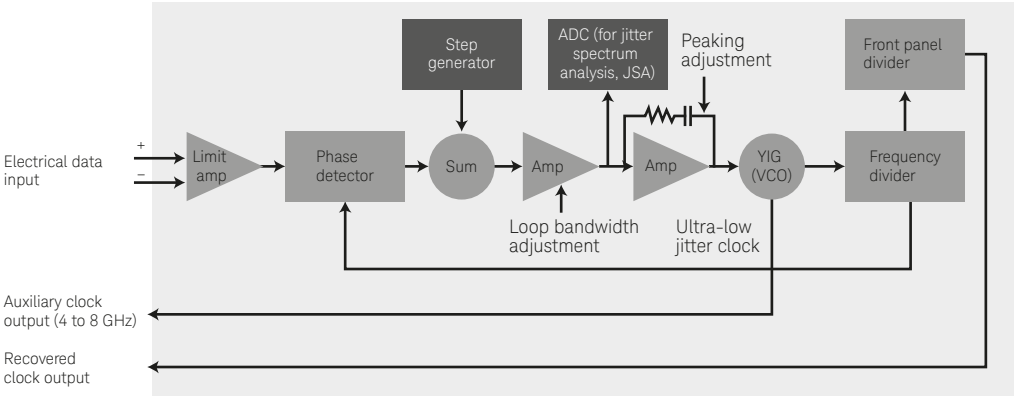

Figure 5. As shown in this block diagram of the electrical clock recovery, the N1076A recovers clock signals from NRZ and PAM4 input signals, and provides jitter analysis capability (Option JSA) for additional insight and measurement accuracy.

Accurate clock recovery for high-speed applications

- Recovers clock from data streams up to 32 GBaud (Option 232) and 16 GBaud (Option 216)
- Supports both NRZ and PAM4 signal types
- Tolerates small input signals with input sensitivity as low as 25 mVpp
- Provides an auxiliary clock output signal with intrinsic random jitter as low as 100 fs RMS for accurate measurements. Use to connect to 86100D DCA-X precision timebase (PTB) input
- Optional jitter spectrum analysis (Option JSA) feature provides additional insight into jitter and allows users to perform jitter measurements using an “ideal” clock recovery model
- Connects to an 86100D DCA-X or PC via a USB 2.0 interface

N1077A Optical/Electrical Clock Recovery - Option SMS

The N1077A provides instrument-grade clock recovery on electrical and optical signals from 50 MBaud up to 32 GBaud (32.8 GBaud characteristic). Option SMS integrates an optical splitter, hybrid coupler, and amplified O/E to minimize external cabling and losses, while maximizing flexibility and ease-of-use. Just like the N1076A, the N1077A is controlled via a USB connection to an 86100D DCA-X mainframe, or to a standalone PC running N1010A FlexDCA software.

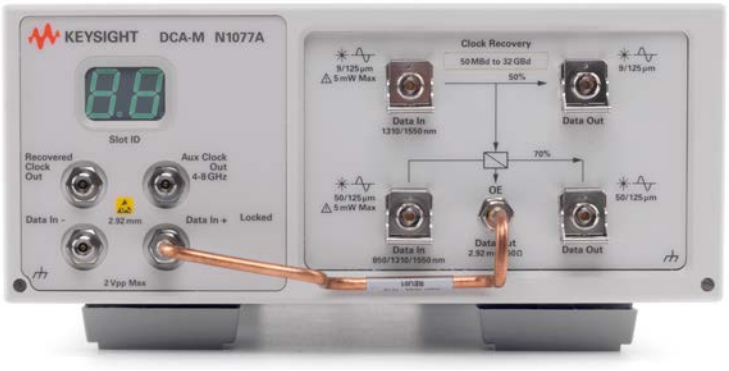

Figure 6. The N1077A recovers clock from both electrical and 850 to 1550 nm optical signals operating from 50 MBaud to 32 GBaud.

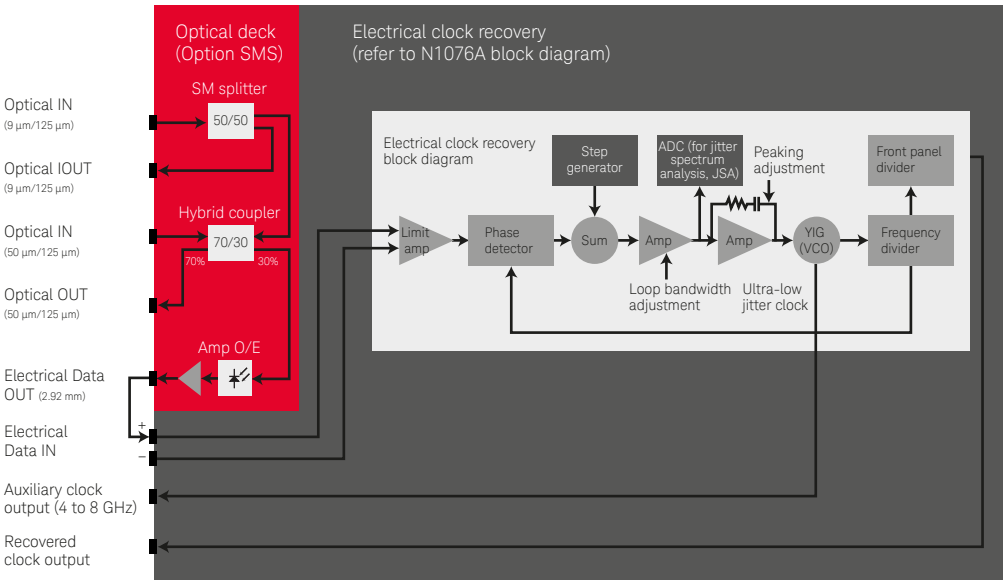

Figure 7. The N1077A with Option SMS combines an integrated optical deck (a splitter, bulk-optics coupler, and an amplified O/E) with an instrument-grade electrical clock recovery circuit.

Accurate, convenient solution for recovering clock signals from high-speed optical communication signals

- Recovers clock from data streams up to 32 GBaud (Option 232) and 16 GBaud (Option 216)
- Supports both NRZ and PAM4 signal types
- Provides an easy method for using the electrical clock recovery solution with optical signals
- Integrated splitter/coupler extracts a portion of the optical test signal using a built-in coupler. Main optical signal returned to the front panel
- Converts the tapped optical signal to an electrical signal using an amplified O/E for greater sensitivity
- Operates with both multimode and single-mode optical signals

N1077A Optical/Electrical Clock Recovery - Option SXT

The N1077A provides instrument-grade clock recovery on electrical and optical signals from 50 MBaud up to 32 GBaud (32.8 GBaud characteristic). Option SXT provides a direct optical connection from the instrument front panel to the amplified O/E, allowing users to provide an external optical splitter that is optimized for their particular setup. For example, users can supply an optical splitter with a 50/50, 20/80, or 10/90 split ratio depending on their setup.

Figure 8. The N1077A with Option SXT recovers a clock from both electrical and optical (850 to 1550 nm) signals operating from 50 MBaud to 32 GBaud. Instead of an integrated optical splitter, Option SXT units allow users to provide their own external optical splitters having a split ratio optimized for their particular setup.

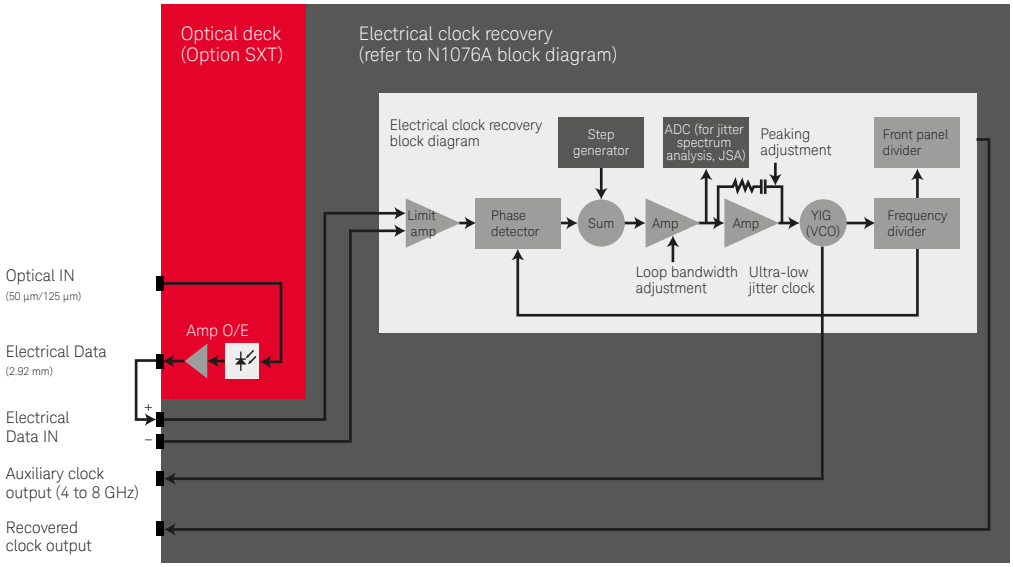

Figure 9. The N1077A with Option SXT combines an integrated amplified O/E with an instrument-grade electrical clock recovery circuit (user supplies an external optical splitter as necessary).

Accurate and flexible solution for recovering clock signals from high-speed electrical and optical communication signals

- Recovers clock from data streams up to 32 GBaud (Option 232) and 16 GBaud (Option 216)
- Supports both NRZ and PAM4 signal types
- Allows users to provide their own external optical single-mode or multimode splitter/coupler
- Converts the optical signal to an electrical signal using an amplified O/E for greater sensitivity
- Operates with both multimode and single-mode optical signals

Characterize Next-generation Receivers and Transmitters

The N1076A/77A clock recovery operates from 50 MBaud to 32 GBaud, on both NRZ and PAM4 signal types. The wide data-rate range allows testing of standards like 100/400G Ethernet and 32GFC, while covering existing lower speed standards. A lower rate option operating up to 16.5 Gb/s is ideal for 16GFC as well as computer standards like USB 3.0, SATA, SAS, and PCIe®.

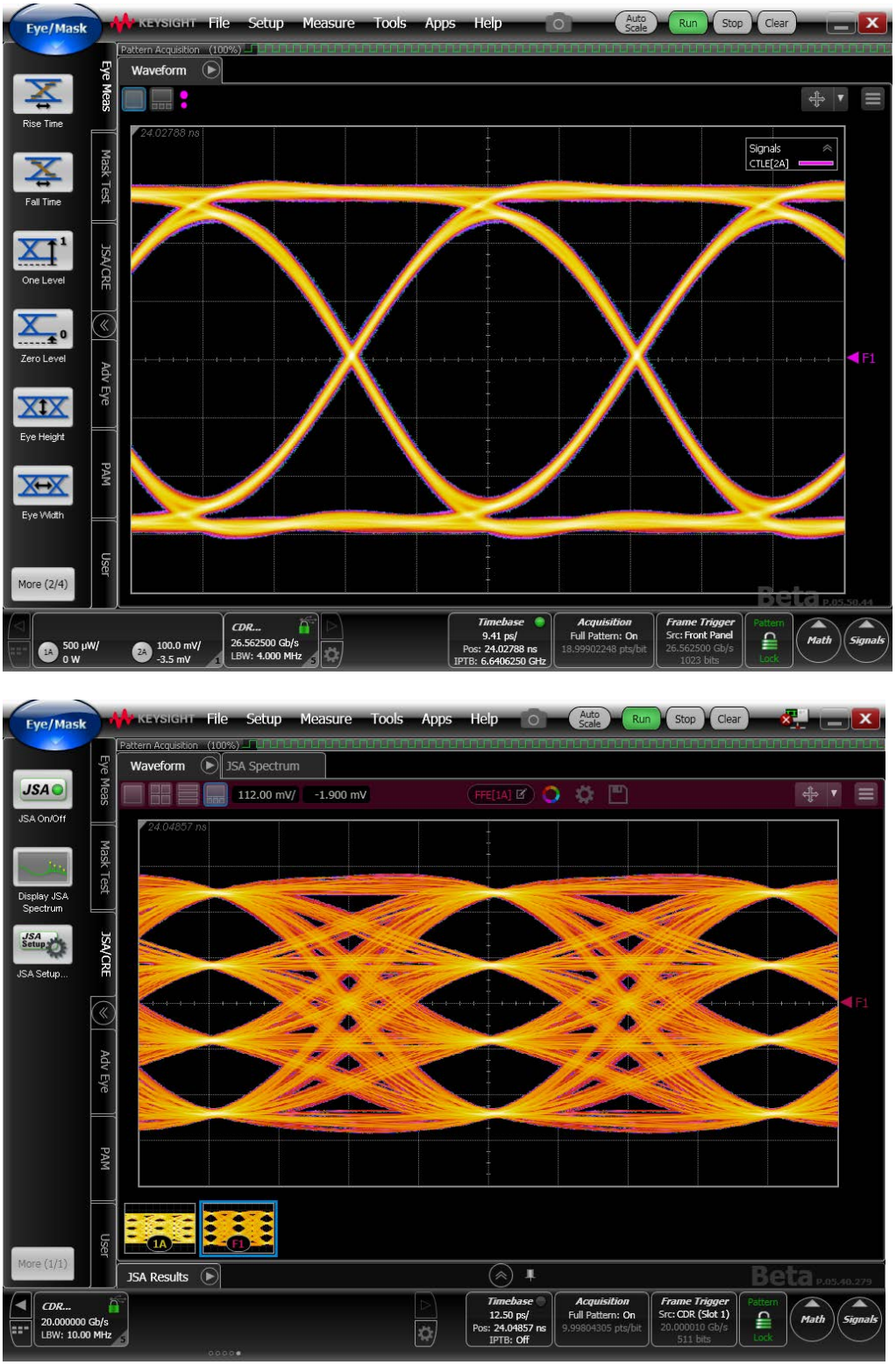

Figure 10. The N1076A/77A provides clock recovery capabilities for NRZ (top) and PAM4 (bottom) signals.

Characterize Next-generation Receivers and Transmitters (Continued)

Recover clocks or clean-up clocks

The N1076A/77A provides clock signals for BERTs or oscilloscopes when access to appropriate clock signals from the DUT is not possible. It can also act as a clean-up PLL for existing clocks with excessive intrinsic jitter to allow accurate measurements.

Measure the real performance of clock-less devices

Accurate transmitter measurements are possible because of low intrinsic jitter, paired with tunable loop bandwidth, selectable peaking, and good sensitivity. The N1076A/77A's auxiliary clock output provides ultra-low intrinsic random jitter of less than 100 fs RMS, making it the ideal companion for sampling scopes equipped with a precision time base.

Perform more accurate jitter measurements and gain greater insight into the root cause(s) of jitter

Jitter spectrum analysis (Option JSA) integrates a step generator and a low-noise, 14-bit ADC into the clock recovery design (see Figures 4, 6, and 8). The step generator and ADC characterize the clock recovery PLL in real-time, providing FlexDCA with the information that is necessary to calculate jitter at the input to the instrument. JSA uses this information to:

- Optimize the accuracy of random jitter measurements performed by 86100D-200 Jitter mode
- Emulate an "ideal" software clock recovery (CR) response; implement Golden PLL per standards
- Analyze the jitter spectrum of clock and data signals using jitter magnitude vs. frequency graphs
- View the spectral distribution of low-frequency jitter and isolate jitter components
- Perform band limited (integrated) TJ/DJ/RJ measurements; user-specified start/stop frequencies

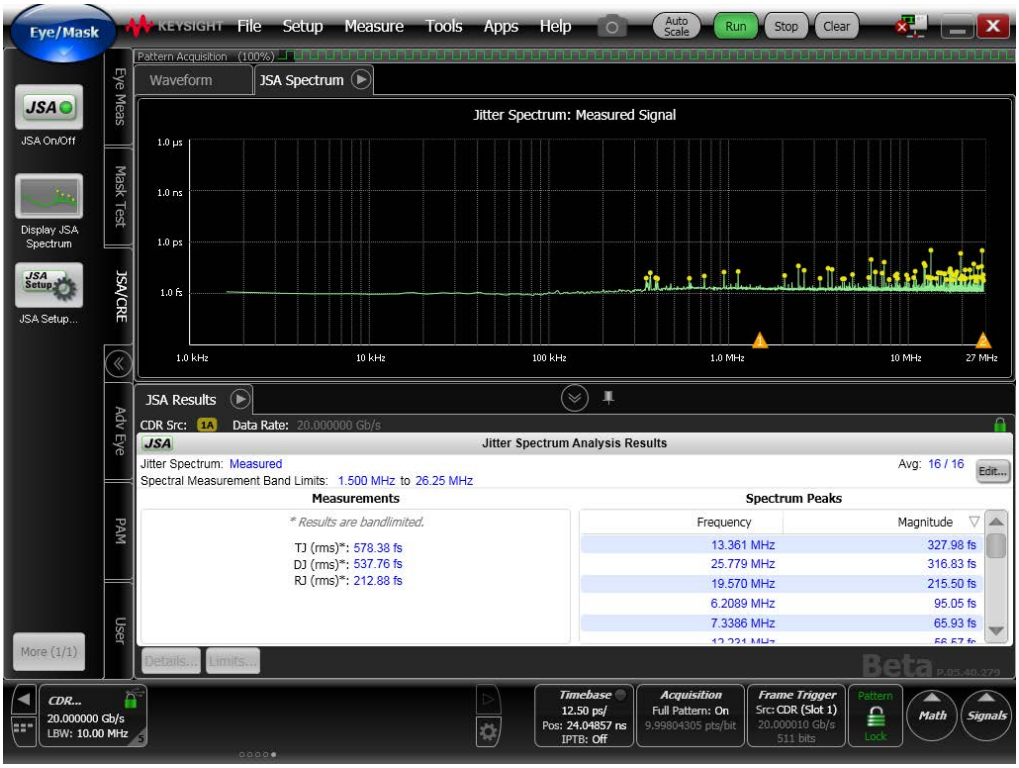

Figure 11. Jitter spectrum analysis (N107xA Option JSA) optimizes Jitter Mode (86100D Option 200) accuracy, measures low-frequency jitter (phase noise), and provides insight into the root cause(s) of jitter.

Characterize Next-generation Receivers and Transmitters (Continued)

Easily control all settings

The N1076A/77A clock recovery instrument is controlled via a rear-panel USB connection to an 86100D DCA-X mainframe, or to a standalone PC (Win7) running Keysight Technologies N1010A FlexDCA software (no license required for CR control).

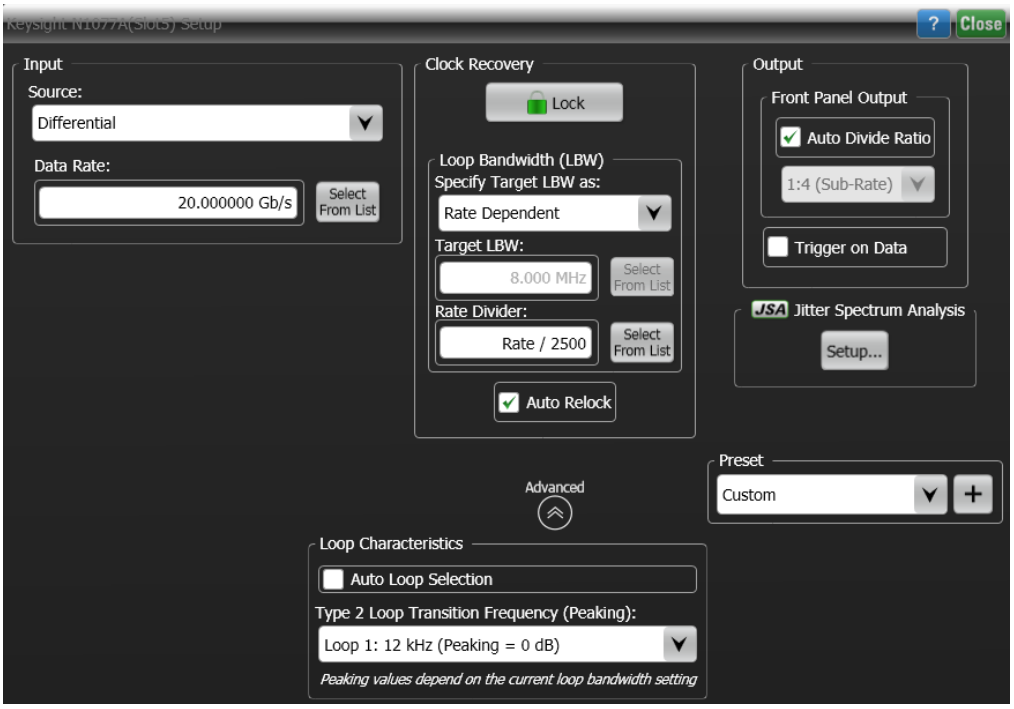

Figure 12. Easily configure the N1076A/77A clock recovery data rate, loop bandwidth, and peaking using the N1010A FlexDCA user interface running on an 86100D DCA-X mainframe or standalone PC.

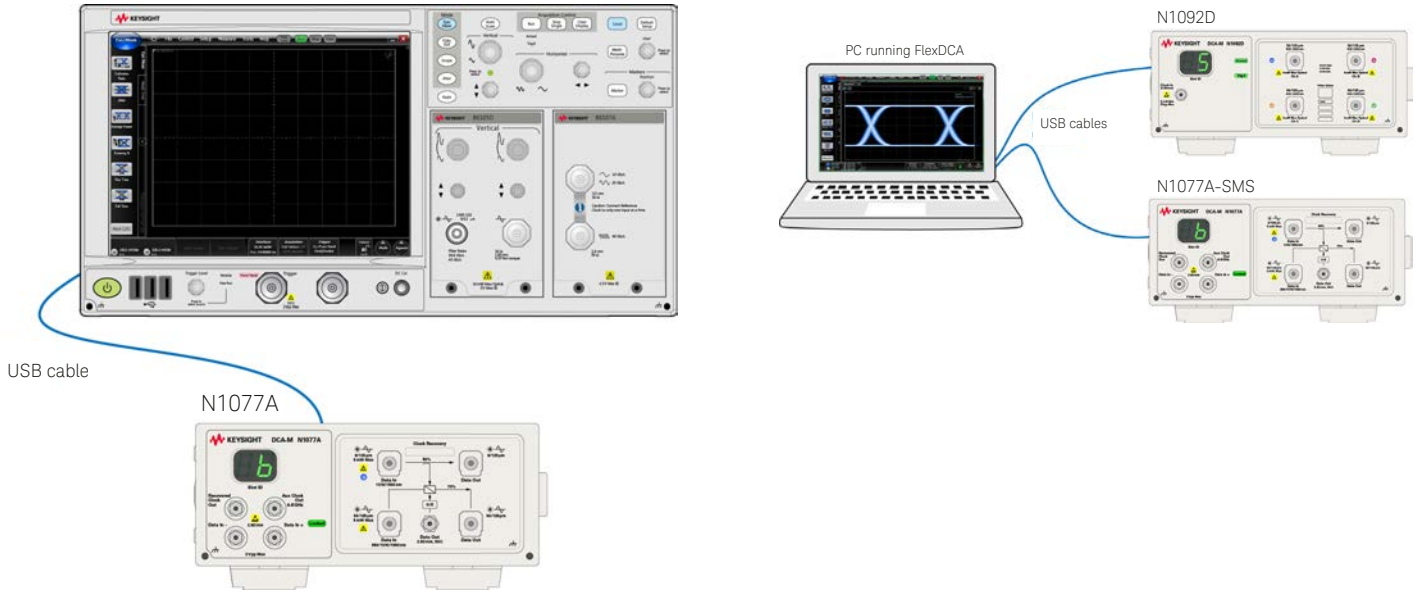

Figure 13. The N1076A/77A clock recovery instrument is controlled via a rear-panel USB connection to an 86100D DCA-X mainframe (left), or to a standalone PC (right) running the N1010A FlexDCA user interface.

Electrical Application Example

Clock recovery for sampling scope with high-bandwidth sampling heads and precision time base

Sampling scopes are the ideal choice for transmitter characterization when high-bandwidth, low noise floor and low intrinsic jitter are required. The N1076A/77A, with its ultra-low jitter auxiliary clock output, provides a clean sine wave for a precision time-base module or integrated precision timebase enabling the most accurate measurements (precision timebase is not required). The main recovered clock output, with its divide stages, triggers the front panel trigger input.

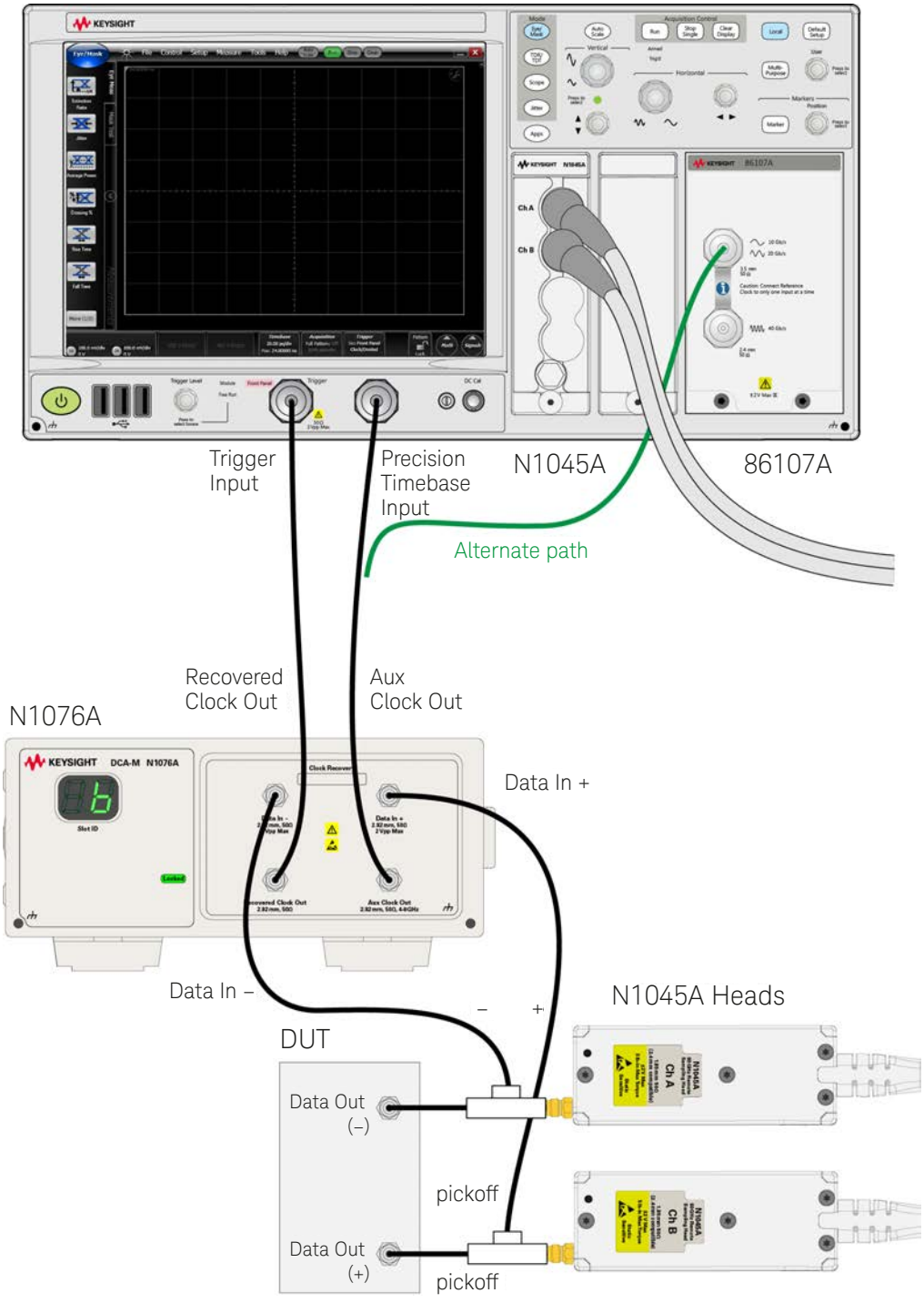

Figure 14. Connection diagram showing an N1076A connected to an 86100D DCA-X and remote head modules using high-bandwidth electrical pick-offs (optional accessory).

Optical Application Examples

N1077A with N109xA DCA-M

The N1077A is an ideal companion product for the N109x DCA-M Series of oscilloscopes.

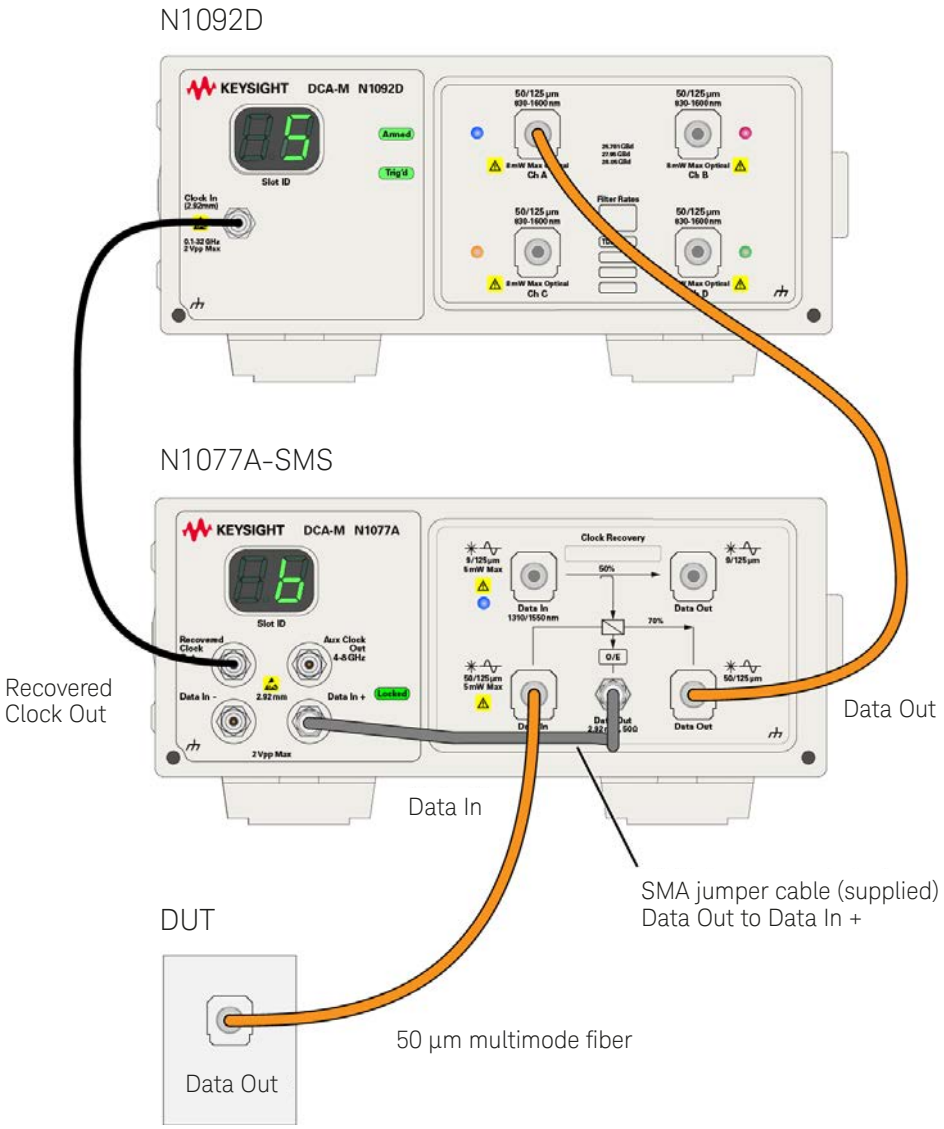

Figure 15. Connection diagram showing an N1077A with Option SMS connected to an N1092D DCA-M.

Optical Application Examples (Continued)

N1077A with 86100D + 86105C/D optical plug-in

When using the N1077A-SMS with any wide-wavelength module such as the 86105C/D, use the N1077A's 50-µm path so as to minimize loss through the internal coupler.

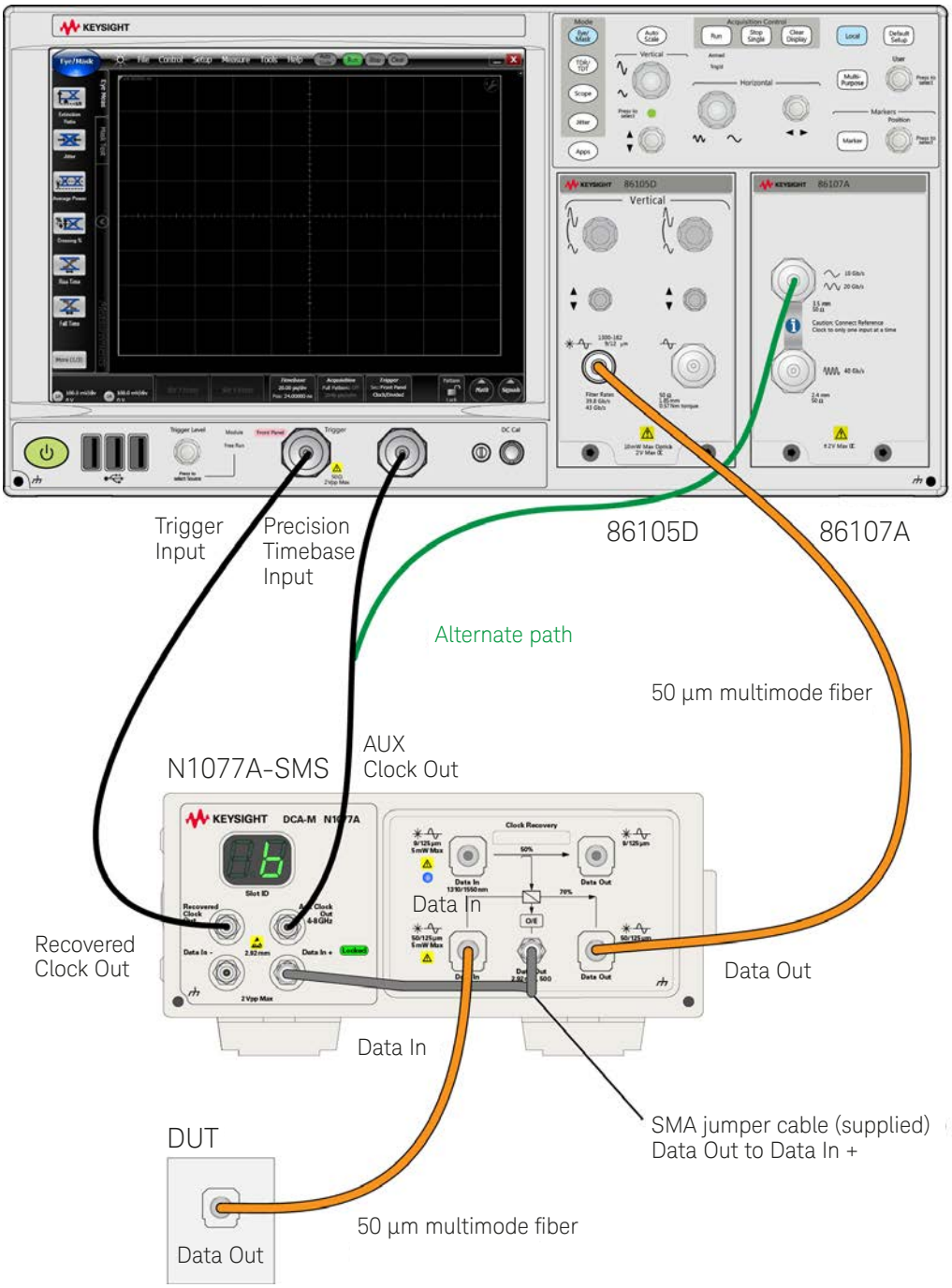

Figure 16. Connection diagram showing an N1077A with Option SMS connected to an 86100D DCA-X mainframe (precision timebase is optional) and 86105C/D wide-wavelength plug-in module.

Optical Application Examples (Continued)

N1077A with 86100D + 86116C optical plug-in

When using the N1077A-SMS with any single-mode module such as the 86116C, take advantage of the internal single-mode splitter using the 9 µm path on the N1077A front panel (Option SMS).

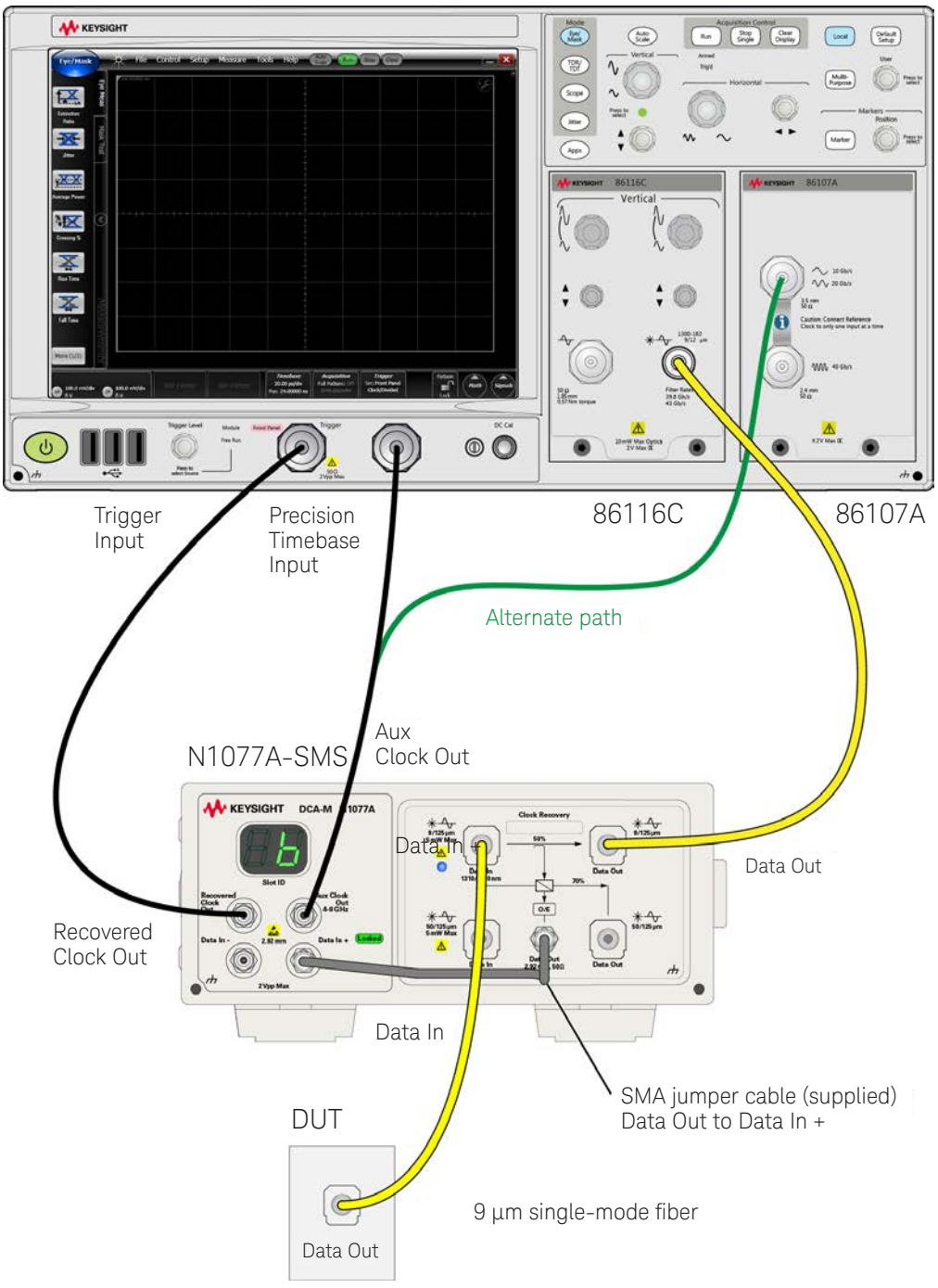

Figure 17. Connection diagram showing an N1077A with Option SMS connected to an 86100D DCA-X mainframe (precision timebase is optional) and 86116C single-mode plug-in module.

Specifications

N1076A/N1077A clock recovery

Electrical data input (±)	**Option 216**	**Option 232**
Data rate input range	50 MBaud to 16 GBaud	50 MBaud to 32 GBaud
	50 MBaud to 16.4 GBaud (characteristic)	50 MBaud to 32.8 GBaud (characteristic)
Minimum input level to acquire lock	30 mVpp (for rates ≤ 27 GBd)	
	35 mVpp (for rates > 27 GBd)	
	25 mVpp at 25.78125 Gbd (characteristic)	
Input voltage levels (min/max)	± 2.2 Vpp max	
Minimum transition density	20%	
Interface	Differential or single-ended, AC coupled, 50 Ω	
Connector type	2.92 mm (f)	
Recovered clock output	**Option 216/232**	
Clock output range	50 MHz to 16 GHz	
Recovered clock random jitter	220 fs max at ≥ 2 Gbd, 130 fs at 16 GHz (characteristic)	
Loop bandwidth range	0.015 to 20 MHz	
Loop bandwidth accuracy	± 30%, characteristic	
Clock recovery peaking range	Up to 4 settings (dependent on loop BW)	
Tracking range (includes SSC tracking)	± 2500 ppm ± 0.25%, characteristic	
Acquisition range	± 5000 ppm, characteristic	
Auto relocking	Yes	
Residual spread spectrum	–84 dB ± 3 dB at 33 kHz, characteristic	
Front panel recovered clock amplitude	≥320 mVpp @ 5 GHz	
Front panel recovered clock divide ratio (user selectable)	1, 2, 4, 8, 16	
Internal frequency counter accuracy	± 10 ppm	
Interface	Single-ended, AC coupled, 50 Ω	
Connector type	2.92 mm (f)	
Aux clock output		
Output frequency	4 to 8 GHz	
Output voltage	550 mVpp, characteristic	
Output jitter	< 50 fs RMS, characteristic	
Interface	Single-ended, AC coupled, 50 Ω	
Connector type	2.92 mm (f)	
Rear panel		
Connectors	USB 2.0, IEC power connector	
General characteristics for N1076A/N1077A		
Line power	100/120 Vac 50/60/400 Hz	
	220/240 Vac 50/60 Hz	
	50 W maximum	
	The products can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage	
Operating temperature	10 to +40 °C (50 to +104 °F)	
Non-operating temperature	–40 to +70 °C (–40 to +158 °F)	
Dimensions		
Without front connectors and rear feet	88.26 mm H x 207.40 mm W x 485 mm D (3.48 inch x 8.17 inch x 19.01 inch)	
With front connectors and rear feet	103.31 mm H x 219.56 mm W x 517.80 mm D (4.07 inch x 8.64 inch x 20.39 inch)	
With front cover and rear feet	110.18 mm H x 219.56 mm W x 550.71 mm D(4.34 inch x 8.64 inch x 21.68 inch)	
Remote control interface		
Connectivity	USB 2.0 rear panel (connected to 86100D DCA-X or external PC running N1010A FlexDCA)	
Programming language	Command line programming interface, SCPI	
System requirements	See FlexDCA download page at **www.keysight.com/find/flexdca_download**	

Specifications (Continued)

N1077A optical/electrical clock recovery

Optical data input/output	**9/125 µm**	**50/125 µm**
Optical data rate range	Determined by Option 216/232	
Internal split ratio (Optical out/Internal O/E)	50/50 (nominal)	70/30 (nominal)
Optical signal type/mode	Single-mode only	Single-mode or multimode
Wavelength range	N/A	850 nm (830 to 1360 nm)
	1310 nm (1260 to 1360 nm)	1310 nm (1260 to 1360 nm)
	1550 nm (1490 to 1600 nm)	1550 nm (1490 to 1600 nm)
Insertion loss	4 dB (characteristic)	2.8 dB (characteristic)
Return loss	18 dB (characteristic)	16 dB (characteristic)
Minimum optical modulation amplitude (OMA) to achieve lock (Option SMS)	1310 nm/1550 nm: 200 µW – 100 µW at 25 Gbps (characteristic) – 60 µW at 10 Gbps (characteristic)	850 nm: 260 µW – 170 µW at 25 Gbps (characteristic) – 90 µW at 10 Gbps (characteristic)
		1310 nm/1550 nm: 200 µW – 100 µW at 25 Gbps (characteristic) – 60 µW at 10 Gbps (characteristic)
Minimum optical modulation amplitude (OMA) to achieve lock (Option SXT)	1310 nm/1550 nm: 80 µW – 43 µW at 25 Gbps (characteristic) – 23 µW at 10 Gbps (characteristic)	850 nm: 90 µW – 53 µW at 25 Gbps (characteristic) – 33 µW at 10 Gbps (characteristic)
		1310 nm/1550 nm: 80 µW – 43 µW at 25 Gbps (characteristic) – 23 µW at 10 Gbps (characteristic)
Maximum input power	8 mW	8 mW
Optical input/output connector type	FC/PC 9/125 µm	FC/PC 50/125 µm
Electrical O/E - output connector type	2.92 mm (f)	

Ordering Information

N1076A electrical clock recovery

Model number	Description
N1076A	Electrical clock recovery
Baud rate (choose ONE)	**Description**
Option 216	Supported input rates: 50 MBaud to 16 GBaud
Option 232	Supported input rates: 50 MBaud to 32 GBaud
Advanced options	**Description**
Option JSA	Jitter spectrum analysis and clock recovery emulation
Optional accessories	**Description**
N1076A-CR1	Clock recovery phase matching kit for N1076A elec (re-order N1027A-76A)
	Kit includes cables, 18.2 ns delay line, two pick-offs, two 6 dB equalizers, and two 9 dB equalizers
N1076A-EQ6	Equalizer, 2.92 mm (m) to 2.92 mm (f), 6 dB (re-order N1027A-EQ6)
N1076A-EQ9	Equalizer, 2.92 mm (m) to 2.92 mm (f), 9 dB (re-order N1027A-EQ9)
N1076A-2P2	Microwave pick-off tee 2.4 mm connectors, matched pair (re-order N1027A-2P2)
N1076A-2P3	Microwave pick-off tee 2.92 mm connectors, matched pair (re-order N1027A-2P3)
N1076A-DC1	Assembly, delay cable, 18.2 ns
N1076A-1CM	Single instrument rack mount kit (re-order N1027A-1CM)
N1076A-1CN	Dual instrument side-by-side rack mount kit (re-order N1027A-1CN)
R1280A	Return to Keysight service center - warranty and service plan
R1282A	Return to Keysight service center - calibration plan

N1077A optical/electrical clock recovery

Model number	Description
N1077A	Optical/electrical clock recovery
Baud rate (choose ONE)	**Description**
Option 216	Supported input rates: 50 MBaud to 16 GBaud
Option 232	Supported input rates: 50 MBaud to 32 GBaud
Splitter options (choose ONE)	**Description**
Option SMS	Internal single-mode (9/125 µm) and multimode (50/125 µm) splitter
Option SXT	No splitter (external splitter supplied by user)
Advanced options	**Description**
Option JSA	Jitter spectrum analysis and clock recovery emulation
Optional accessories	**Description**
N1077A-CR1	Clock recovery phase matching kit for N1077A optical (re-order N1027A-77A)
	Kit includes optical delay matching SM/MM cables, one 6-dB equalizer, one 9-dB equalizer.
N1077A-EQ6	Equalizer, 2.92 mm (m) to 2.92 mm (f), 6 dB (re-order N1027A-EQ6)
N1077A-EQ9	Equalizer, 2.92 mm (m) to 2.92 mm (f), 9 dB (re-order N1027A-EQ9)
N1077A-1CM	Single instrument rack mount kit (re-order N1027A-1CM)
N1077A-1CN	Dual instrument side-by-side rack mount kit (re-order N1027A-1CN)
R1280A	Return to Keysight service center - warranty and service plan
R1282A	Return to Keysight service center - calibration plan

N1076/7 clock recovery instruments are controlled via a USB connection to an 86100D DCA-X mainframe, or to a standalone PC, running N1010A FlexDCA software. The latest version of FlexDCA may be downloaded from: **www.keysight.com/find/flexdca_download**.

Accessories

Part number when ordered with a new N1076/N1077 purchase	Part number when ordered AFTER original purchase	Description	Comment
N1076A/N1077A-1CM	N1027A-RM1	Single instrument rack mount kit	
N1076A/N1077A-1CN	N1027A-RM2	Dual instrument side-by-side rack mount kit	
N1076A/N1077A-EQ6	N1027A-EQ6	Equalizer, 2.92 mm (m) to 2.92 mm (f), 6 dB	See Note 1 below.
N1076A/N1077A-EQ9	N1027A-EQ9	Equalizer, 2.92 mm (m) to 2.92 mm (f), 9 dB	See Note 1 below.
N1076A-2P2	N1027A-2P2	Microwave pick-off tee 2.4 mm connectors, matched pair	See Note 2 below.
N1076A-2P3	N1027A-2P3	Microwave pick-off tee 2.92 mm connectors, matched pair	See Note 2 below.
N1076A-DC1	N1027A-DC1	Assembly, delay cable, 18.2 ns	Install on the rear-panel of an 86100D-ETR mainframe to match clock-to-data delays.
N1076A-CR1	N1027A-76A	Clock recovery phase matching kit for N1076A electrical	Recommended for 86100D DCA-X applications that have significant amounts of low-frequency jitter content (e.g. SSC).
		Electrical kit contents	
		Qty 2 cable assy, coaxial 2.92 mm (m) to 2.92 mm (m) 1 m length	Cable(s) used between CR output and the measurement instrument.
		Qty 2 cable assy, coaxial 2.92 mm (m) to 2.92 mm (m) 0.55 m length	Cable(s) used between pick-off tee and CR input.
		Qty 1 18.2 ns electrical delay line	Install on the rear-panel of an 86100D-ETR mainframe.
		Qty 1 microwave pick-off tee 2.4 mm connectors, matched pair	See Note 2 below.
		Qty 2 equalizer, 2.92 mm (m) to 2.92 mm (f), 6 dB	See Note 1 below.
		Qty 2 equalizer, 2.92 mm (m) to 2.92 mm (f), 9 dB	See Note 1 below.
		Qty 1 T-20 Torx screwdriver	Used to install the electrical delay line.
		Qty 1 T-10 Torx screwdriver	Used to install the electrical delay line.
		Qty 1 wrench - torque 8 lb-in, 5/16 inch	Used to torque electrical connections.
		Qty 1 accessory card	Cabling setup instructions.
N1077A-CR1	N1027A-77A	Clock recovery phase matching kit for N1077A optical	Recommended for optical applications that require clock-to-data delay matching.
		Optical kit contents	
		Qty 1 cable assy, optical 50/125 µm MM, FC/PC 1.0 m length	For general purpose optical measurements when clock-to-data delay is not critical.
		Qty 1 cable assy, optical 50/125 µm MM, FC/PC 2.6 m length	Multimode delay matching for N1077A with 86100D-PTB + DCA Module (86105D, 86116C).
		Qty 1 cable assy, optical 50/125 µm MM, FC/PC 4.75 m length	Multimode delay matching for N1077A with N1092x.
		Qty 1 cable assy, optical 9/125 µm SM, FC/PC 1.0 m length	For general purpose single-mode optical measurements when clock-to-data delay is not critical.
		Qty 1 cable assy, optical 9/125 µm SM, FC/PC 3.5 m length	Single-mode delay matching for N1077A with 86100D-PTB + DCA Module (86105D, 86116C).
		Qty 1 cable assy, optical 9/125 µm SM, FC/PC 5.6 m length	Single-mode delay matching for N1077A with N1092x.
		Qty 1 cable assy, coaxial 2.92 mm (m) to 2.92 mm (m) 12 in ch length	Cable used between O/E output and CR input if an external equalizer is required.
		Qty 2 cable assy, coaxial 2.92 mm (m) to 2.92 mm (m) 1 m length	Cable(s) used between CR output and the measurement instrument.
		Qty 1 equalizer, 2.92 mm (m) to 2.92 mm (f), 6 dB	See Note 1 below.
		Qty 1 equalizer, 2.92 mm (m) to 2.92 mm (f), 9 dB	See Note 1 below.
		Qty 1 accessory card	Cabling setup instructions.

Notes:
1. External equalizers may be placed in front of the electrical clock recovery inputs to “open” a closed eye. They help the instrument recover a clock from a signal that has been severely degraded due to excessive frequency-dependent losses.
2. Microwave pick-off tees are used to direct a small amount of the electrical data signal to the clock recovery input. Refer to Figure 14.

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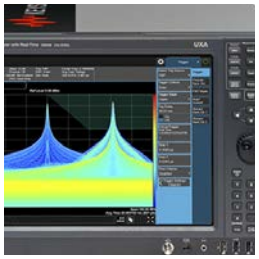

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