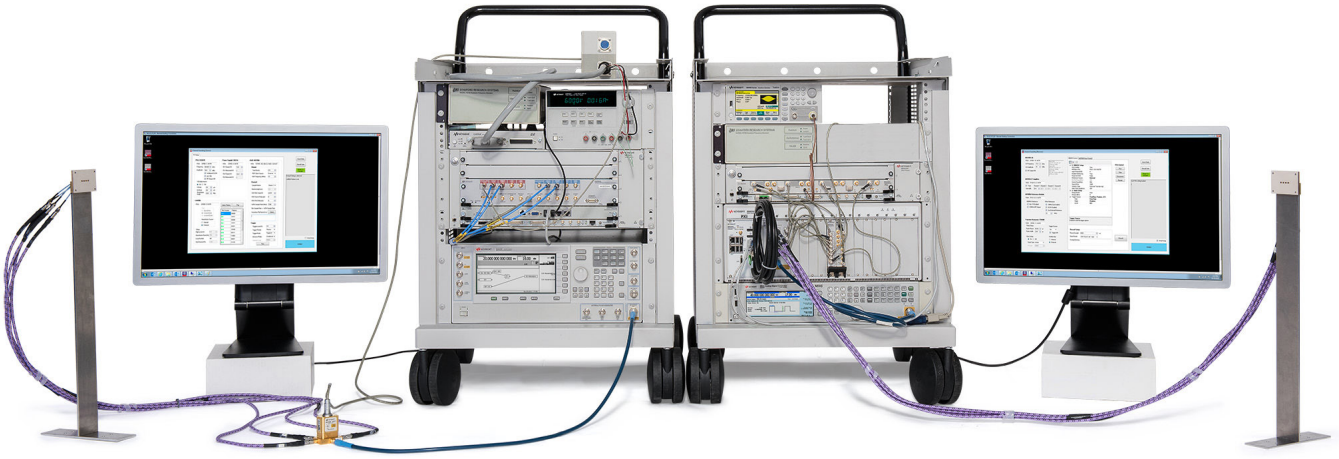
Keysight Technologies
5G Channel Sounding, Reference Solution

Configuration Guide



KEYSIGHT TECHNOLOGIES

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The following are the recommended options indicated by ● below, for the 5G channel sounding reference solution up to 40 GHz with 1 GHz bandwidth and 4 channels. Other frequency ranges, bandwidths and number of channels are available.

Select Options for the Transmitter Subsystem

A1. M8190A AXIe AWG and related chassis and controller

Used to create wideband differential IQ for the channel sounding signal

Step 1. Choose frequency range	
○	M8190A-001: 1-channel
●	M8190A-002: 2-channel
Step 2. Choose memory size and resolution bits	
●	M8190A-02G: (Qty 2) Upgrade from 128 MSa to 2 GSa memory /channel
○	M8190A-12G: 12-bit resolution with 12 GSa/s
●	M8190A-14B: 14- bit resolution with 8 GSa/s
Step 3. Add cable assembly and 50 ohms load	
●	M8190A-811: (Qty 4) Cable assembly, SMA to SMA 1220 mm length
Step 4. Select AXIe chassis and optional rack mount kit	
●	M9505A AXIe 5-slot chassis
●	Y1226A Rack mount kit
Step 5. Add AXIe embedded controller	
●	M9537A AXIe embedded controller
●	M9537A-WE6: Microsoft Windows Embedded Standard 7 (64-bit)
○	M9537A-W16: Microsoft Windows 10 (64-bit)
●	M9537A-M16: Upgrade memory from 8 to 16 GB
●	82357B: USB to GPIB cable

A2. E8267D PSG vector signal generator

Used to upconvert differential IQ into RF/uW carriers

Step 1. Choose frequency range	
○	E8267D-520: Frequency range from 250 kHz to 20 GHz
○	E8267D-532: Frequency range from 250 kHz to 31.8 GHz
●	E8267D-544: Frequency range from 250 kHz to 44 GHz
Step 2. Add wideband modulation configuration and rack mount kit	
●	E8267D-016: Wideband differential external I/Q inputs
○	E8267D-H18: Wideband modulation (2 GHz) less than 3.2 GHz carrier frequency
●	E8267D-1CM: Rack mount flange kit
Step 3. Add low phase noise	
●	E8267D-UNX: Ultra-low phase noise
○	E8267D-UNY: Enhanced ultra-low phase noise

A3. Other instruments in the transmitter subsystem

Step 1. Start with a microwave solid state switch (4 channels, upgradable to multiple channels)	
●	85332B: Solid state switch, 50 GHz, SP4T
●	85332B-002: 2 meter length
●	85332B-201: Switch control unit
Step 2. Choose a 64-bit digital I/O with memory and counter to control the switch Used to control microwave solid state switch to different switching modes	
●	L4450A: 64-bit digital I/O with memory and counter
●	L4450A-GPIB: Add GPIB
●	Y1160A: L4450A EIA rack sliding shelf installation kit
●	Y1137A: 1.5 m 78-pin M/F Dsub cable
Step 3. Choose a power supply for 85332B -201 controller Used to provide DC power for 85332B SCU	
●	E36311A: 80W Triple output power supply, 6V, 5A & ±25V, 1A
●	E36311A-0E9: AC 100V single-phase 3-wire. 100 VAC ±10V operation, 47 to 63 Hz
●	E3600A-100: Test lead kit

Select Options for Receiver Subsystem

B1. Select a M9537A AXIe embedded controller

Step 1. Select a M9537A AXIe embedded controller	
●	M9537A: AXIe embedded controller
●	M9537A-WE6: Microsoft Windows Embedded Standard 7 (64-bit)
○	M9537A-W16: Microsoft Windows 10 (64-bit)
●	M9537A-M16: Upgrade memory from 8 to 16 GB RAM
●	82357B: USB to GPIB cable

B2. Select an external host computer for raw data streaming

Note: If an external desktop host computer is selected, the M9537A AXIe embedded controller is not needed in Step B1. Contact a Keysight representative to help you select an external storage device and host computer for raw data streaming

To use your desktop PC as a controller:			
○	M9049A	PCIe® desktop adapter	2 units
○	Y1202A	PCIe cable	2 units
			Connect the M9502A to the first M9049A
			Connect the M9022A to the second M9049A
○	M9022A	PCIe cable interface	1 unit
○	82357B	USB to GPIB cable	1 unit

B3. Select a PXIe chassis and accessories

Step 1. Select a chassis		
●	M9010A	PXIe 10-slot chassis, Gen 3, 24 GB/s
○	M9022A	PXIe system module: single port (x8), Gen 3
Step 2. Choose a rack mount kit		
●	Y1217A	PXIe chassis rack rail kit
●	Y1271A	Rackmount kit for M9010A
Step 3. Choose accessories		
●	Y1203A	PCIe cable: x8, 0.5 m
●	Y1212A	Slot Blockers (qty 3) , each order covers 5 slots
●	Y1213A	EMC Filters (qty 3), each order covers 5 slots

B4. Select a PXIe IF amplifier, quad downconverter and frequency reference

Step 1. Choose options for the M9352A PXI hybrid IF amplifier		
●	M9352A	PXI hybrid quad IF amplifier/attenuator
●	M9352A-H02	2 GHz bandwidth coverage
Step 2. Choose options for the M9362A PXIe quad downconverter		
●	M9362AD01	PXIe quad downconverter
○	M9362AD01-F26	Frequency range from 10 MHz to 26.5 GHz
●	M9362AD01-F40	Frequency range from 10 MHz to 40 GHz
○	M9362AD01-F50	Frequency range from 10 MHz to 50 GHz
Step 3. Add a M9300A PXIe frequency reference		
●	M9300A	PXIe frequency reference: 10 MHz and 100 MHz

B5. Select a local oscillator (LO) for quad downconverter

Used to provide LO for M9362AD01 quad downconverter

Step 1. Choose option for frequency range			
○	N5183B - 532	Frequency range, 9 kHz to 32 GHz	LO for M9362AD01-F26
●	N5183B - 540	Frequency range, 9 kHz to 40 GHz	LO for M9362AD01-F40 or F50
Step 2. Add low phase noise			
●	N5183B - UNY	Enhanced low phase noise	
Step 3. Add high output power			
●	N5183B - 1EA	High output power	
Step 4. Accessories			
○	11667C	Power splitter, DC to 50 GHz	LO power splitter in 8-channel MIMO
●	1CM010A	N5183B Rack mount flange kit 88.1mm H (2U)	

B6. M9703B AXIe 12-bit high-speed digitizer

Used to acquire multiple channel IF signals

Step 1. Choose sampling rate and interleave mode			
○	M9703B - SR1	Maximum sampling rate, 1 GS/s per channel	
●	M9703B - SR2	Maximum sampling rate, 1.6 GS/s per channel	
●	M9703B - INT	Interleaved sampling enabled	
Step 2. Choose bandwidth			
○	M9703B - F05	Bandwidth, 650 MHz maximum	
●	M9703B - F10	Bandwidth, 1 GHz path enabled	
Step 3. Choose memory size			
○	M9703B - M10	Memory, 1 GB, 64 MSamples/ch	
○	M9703B - M40	Memory, 4 GB, 256 MSamples/ch	
●	M9703B - M16	Memory, 16 GB, 1024 MSamples/ch	
Step 4. Choose real-time CIR and raw data streaming			
●	M9703B - FDK	FPGA programming access	FDK is needed for real-time CIR
○	M9703B - CB2	Digital downconverter streaming at 1.6 GS/s	CB2 is needed for raw data streaming

B7. Select an AXIe chassis

Step 1. Choose base configuration		
●	M9502A	2-slot AXIe chassis
●	Y1225A	M9502A AXIe rack mount kit

B8. Select a 33511B waveform generator

Used to trigger the transmitter and receiver simultaneously

Step 1. Choose base configuration		
●	33511B	Waveform generator
●	34190A	Rack mount kit

B9. Select a power attenuator

Used for system impulse response calibration

Step 1. Choose base configuration		
●	M9168E	PXI programmable step attenuator module, DC to 50 GHz

Select Accessories for Transmitter and Receiver Subsystems - 4x4 MIMO

C1. Select a rubidum clock and GPS antenna

Note: If fiber optic interface is needed, use option 1204-2A (1 in/2 out 1 PPS module) instead of option 1204-01A

Model	Vendor	Qty	Description
1200-153	Spectracom	2	AC/DC power; low phase-noise rubidium; commercial GPS receiver
1204-01	Spectracom	2	1 PPS input / 1 PPS output / frequency input module
1204-1C	Spectracom	2	10 MHz output module (3 outputs)
8230	Spectracom	2	GPS antenna
CA01-0N0N-3050	Spectracom	2	GPS antenna cable

C2. Select a power amplifier (PA) and low noise amplifier (LNA)

Note: Please contact Keysight if other frequency bands are needed

Model	Vendor	Qty	Description
N16-5631	Norden Millimeter	1	18-44 GHz PA, 4 channel
N16-5619	Norden Millimeter	1	18-44 GHz LNA, 4 channel
NRE-N16-5619	Norden Millimeter	1	NRE for plate and wire harness used on N16-5619 and N16-5631

C3. Select an antenna array

Note: Please contact Keysight if other frequency bands are needed

Model	Vendor	Qty	Description
SAM-2732931332-2F-L1	Sage Millimeter	2	Microstrip patch array antenna, Ka band; 27 – 29 GHz; 13 dBi typical gain; 1x4 elements; 2.4 mm (f) connector
SAM-2732931332-2F-L1-TES	Sage Millimeter	1	Antenna pattern test, linear polarized antenna
SAM-2732931332-2F-L1-DES	Sage Millimeter	1	Engineering setup charge (microstrip patch array antenna, Ka band)
SAM-3732931332-2F-L1	Sage Millimeter	2	Microstrip patch array antenna, Ka aand; 38 – 40 GHz; 13 dBi typical gain; 1x4 elements; 2.4mm (f) connector
SAM-3732931332-2F-L1-TES	Sage Millimeter	1	Antenna pattern test, linear polarized antenna
SAM-3732931332-2F-L1-DES	Sage Millimeter	1	Engineering setup charge (microstrip patch array antenna, Ka band)

C4. Select a rotator

Note: Please review local requirements and local vendors. This information is provided as an example.

Model	Vendor	Qty	Description
X-RST120AK-DE50-KX14A	Zaber Technologies	2	Custom antenna positioner Motorized rotary stage, integrated controller and direct reading encoder, 360-degree rotation, 120 mm diameter, fine resolution, high torque https://www.zaber.com/products/product_detail.php?detail=X-RST120AK-DE50

C5. Select a rack, cart, rackmount and monitor

Model	Vendor	Qty	Description
Z2234-30401	Keysight Technologies	2	Customized solid rack, EIA standard width; 18U high (UTB Lite Rack); approximately 41" height x 24" width x 34" depth (with casters, rack rails, etc.)
OROAD-400	Vestil	2	Platform Truck; self-propelled; electric motor; pneumatic rubber tires; 600 lb. capacity; 52.5" L x 31.5" W x 15.75" H deck; 12Vdc batteries; 4 hours' usage per charge http://www.vestilmfg.com/products/mhequip/carts-ecart.htm
RACKCONS1901	StarTech	2	Rackmount 1U flip-up 19" LCD display, keyboard, & mouse console; on sliding rack mount https://www.startech.com/Server-Management/Rackmount-KVM-Consoles/1U-19-inch-Rack-Mount-LCD-Console-USB-PS2~RACKCONS1901

C6. Select a calibration kit

Model	Vendor	Qty	Description
PD4-0150	Marki Microwave	1	4-way Wilkinson power divider, 1 to 50 GHz in-phase power splitting http://www.markimicrowave.com/Assets/datasheets/PD4-0150.pdf

C7. Other accessories

Label	Model	Vendor	Qty	Description
A	M8190A-811	Keysight	4	Cable assembly, SMA to SMA 1220 mm M8190A differential IQ output to E8267D differential IQ input
B	FMC4050914-36	Fairview Microwave	1	2.4 mm (F) to 2.4 mm (M) cable, FM160FLEX Coax in 36 Inch and RoHS compliant. E8267D RF output to 85332B RF Input http://www.fairviewmicrowave.com/2.4mm-male-2.4mm-female-cable-fm-160flex-coax-fmc4050914-36-p.aspx
C	FMC4040914-150CM	Fairview Microwave	4	2.4 mm (M) to 2.4 mm (M) cable FM160FLEX Coax in 150 cm and RoHS Connect 1 channel rotary joint (F) to 85332B RF output (F) https://www.fairviewmicrowave.com/2.4mm-male-2.4mm-male-cable-fm-160flex-coax-fmc4040914-150cm-p.aspx
	835077	Spinner Group	4	1 channel rotary joint DC-50 GHz Connect 4 channel PA (M) to 1 channel rotary joint (F) directly https://products.spinner-group.com/1-channel-rotary-joint-dc-50-ghz-bn835077
D	FMC4050914-36	Fairview Microwave	4	2.4 mm (M) to 2.4 mm (F) cable FM160FLEX Coax in 36 Inch and RoHS Compliant 4 port Tx antenna array (F) to 4 channel PA (M) Output https://www.fairviewmicrowave.com/2.4mm-male-2.4mm-female-cable-fm-160flex-coax-fmc4050914-36-p.aspx
E	FMC0202085LF-48	Fairview Microwave	1	SMA (M) to SMA (M) Cable FM-F086 Coax in 48 Inch and RoHS Compliant Used with customized cable https://www.fairviewmicrowave.com/standard-sma-male-sma-male-cable-fmf086-coax-fmc0202085lf-48-p.aspx
	165-26	Amphenol	1	Adapter for 85332B-201 SCU to customized cable https://www.alliedelec.com/amphenol-industrial-165-26/70143330/
F	10833A	Keysight	1	GPIB cable 1 meter L4450A to E8267D GPIB interface
G	SCB15371-36	Fairview Microwave	2	BNC (M) to SMA (M) cable RG-316 Coax in 36 Inch Tx rubidium clock to M8190A REF IN33511B trigger output to M8190A trigger input https://www.fairviewmicrowave.com/bnc-male-sma-male-cable-rg316-coax-scb15371-36-p.aspx
H	SCA23316-24	Fairview Microwave	1	BNC (M) to BNC (M) cable RG-316 Coax in 24 Inch and RoHS Compliant Tx rubidium clock 10 MHz output to E8267D 10 MHz reference input https://www.fairviewmicrowave.com/bnc-male-bnc-male-cable-rg-316ds-coax-sca23316-24-p.aspx
	SCA23316-72	Fairview Microwave	1	BNC (M) to BNC (M) cable RG-316 Coax in 72 Inch and RoHS Compliant Rx rubidium 1pps output to Tx rubidium 1pps input https://www.fairviewmicrowave.com/bnc-male-bnc-male-cable-rg-316ds-coax-sca23316-72-p.aspx
I	FMC0216315LF-24	Fairview Microwave	4	SMA (M) to SMB (F) cable, 24 inches longM9352A IF output to M9703B IF Input https://www.fairviewmicrowave.com/standard-sma-male-smb-plug-cable-rg316-coax-fmc0216315lf-24-p.aspx
J	FMC0716316-36	Fairview Microwave	1	SMB (F) to MCX (M) cable, 24 inch or longer. MCX plug to SMB plug cable RG-316 coax in 36 Inch M9300A 100 MHz output to M9703B Ref IN http://www.fairviewmicrowave.com/mcx-male-smb-plug-cable-m17-113-rg316-coax-fmc0716316-p.aspx

C7. Other accessories, continued

Label	Model	Vendor	Qty	Description
K	FMC0708315LF-36	Fairview Microwave	1	MCX Plug to BNC (M) cable RG-316 Coax in 36 Inch and RoHS with LF Solder 33511B output to M9703B TRIGGER IN https://www.fairviewmicrowave.com/mcx-plug-bnc-male-cable-rg316-coax-fmc0708315lf-36-p.aspx
L	FMC0216315LF-06	Fairview Microwave	4	SMA (M) to SMB (F) cable, 6 inches long M9362AD01 IF output to M9352A IF input for 4 channels https://www.fairviewmicrowave.com/standard-sma-male-smb-plug-cable-rg316-coax-fmc0216315lf-06-p.aspx
M	FMC4040914-150CM	Fairview Microwave	4	2.4 mm (M) to 2.4 mm (F) cable FM160FLEX Coax in 12 inches and RoHS Compliant Connect 1 channel rotary joint (F) to M9362AD01 RF input (F) https://www.fairviewmicrowave.com/2.4mm-male-2.4mm-male-cable-fm-160flex-coax-fmc4040914-150cm-p.aspx
	835077	Spinner Group	4	1 channel rotary joint DC-50 GHz Connect 4 channel LNA(M) to 1 channel rotary joint (F) directly https://products.spinner-group.com/1-channel-rotary-joint-dc-50-ghz-bn835077
N	FMC4050914-36	Fairview Microwave	4	2.4 mm (M) to 2.4 mm (F) cable FM160FLEX Coax in 36 Inch and RoHS Compliant 4 port Rx antenna array (F) to 4 channel LNA (M) Input https://www.fairviewmicrowave.com/2.4mm-male-2.4mm-female-cable-fm160flex-coax-fmc4050914-36-p.aspx
O	FMC4050914-36	Fairview Microwave	1	2.4 mm (F) to 2.4 mm (M) cable, FM160FLEX Coax in 36 Inch and RoHS compliant N5183B RF output to M9362AD01 LO input http://www.fairviewmicrowave.com/2.4mm-male-2.4mm-female-cable-fm-160flex-coax-fmc4050914-36-p.aspx
P	E3600A-100	Keysight	1	Test lead kit, banana plug to SMT grabber
Q	FMC0816315LF-36	Fairview Microwave	1	BNC (M) to SMB (F) plug cable RG-316 Coax in 36 Inch and RoHS Rx rubidium clock 10MHz output to M9300A REF IN https://www.fairviewmicrowave.com/standard-bnc-male-smb-plug-cable-rg316-coax-fmc0816315lf-36-p.aspx
R	SCA23316-24	Fairview Microwave	3	BNC (M) to BNC (M) cable RG-316 Coax in 24 Inch and RoHS Compliant Rx rubidium clock 10 MHz output to N5183B 10 MHz REF IN Rx rubidium clock 10 MHz output to M9010A 10 MHz REF IN Rx rubidium clock 10 MHz output to 33511B 10 MHz REF IN https://www.fairviewmicrowave.com/bnc-male-bnc-male-cable-rg-316ds-coax-sca23316-24-p.aspx
S	10833A	Keysight	1	GPIB cable 1 meterN5183B to 33511B
T	SM3448	Fairview Microwave	1	BNC T Adapter (F-M-F) 33511B Output to M8190A TRIGGER IN and M9703B Trigger Input https://www.fairviewmicrowave.com/bnc-female-male-female-tee-adapter-sm3448-p.aspx
U W V	SM3020	Fairview Microwave	6	2.4 mm (M) to 2.4 mm (M) adapter http://www.markimicrowave.com/Assets/datasheets/PD4-0150.pdf
X	ST5039	Fairview Microwave	3	RF Load 1 Watts To 50 GHz Passivated Stainless Steel 2.4 mm (F) https://www.fairviewmicrowave.com/rf-load-1-watts-50-ghz-precision-2.4mm-female-st5039-p.aspx

Select Software and Services

D1. Select software for sounding signal generation and channel parameter extraction

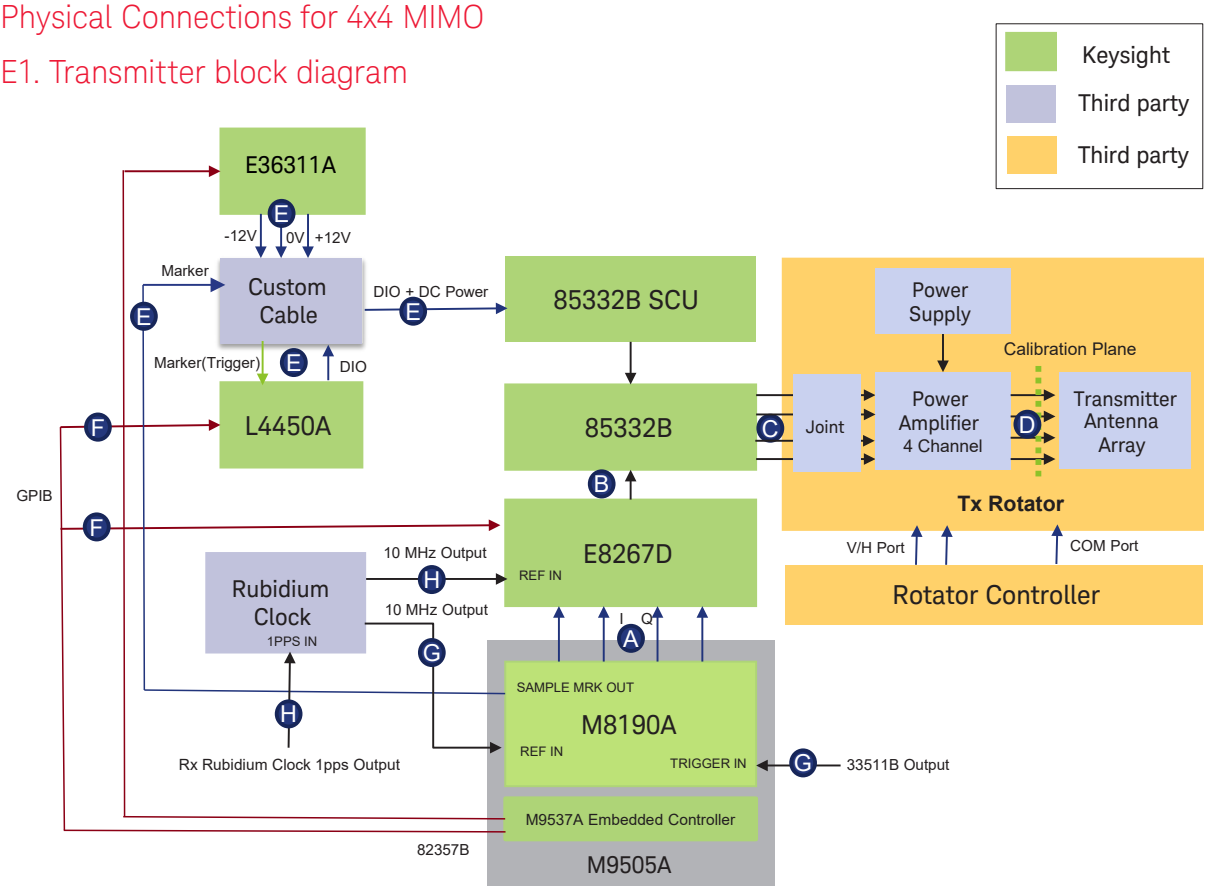
Step 1: Start with a reference solution startup kit		
●	Y1299A-006	5G channel sounding IO control software
Step 2: Add signal acquisition and recording software		
●	89601B	89600 VSA software, used to capture IQ data for analysis
●	89601B-200	Basic vector signal analysis and hardware connectivity
Step 3: Add software for sounding parameter extraction and real-time CIR		
●	W1462BP	SystemVue FPGA architect
●	E4729A	Channel sounding MIMO and real-time CIR

D2. Select services

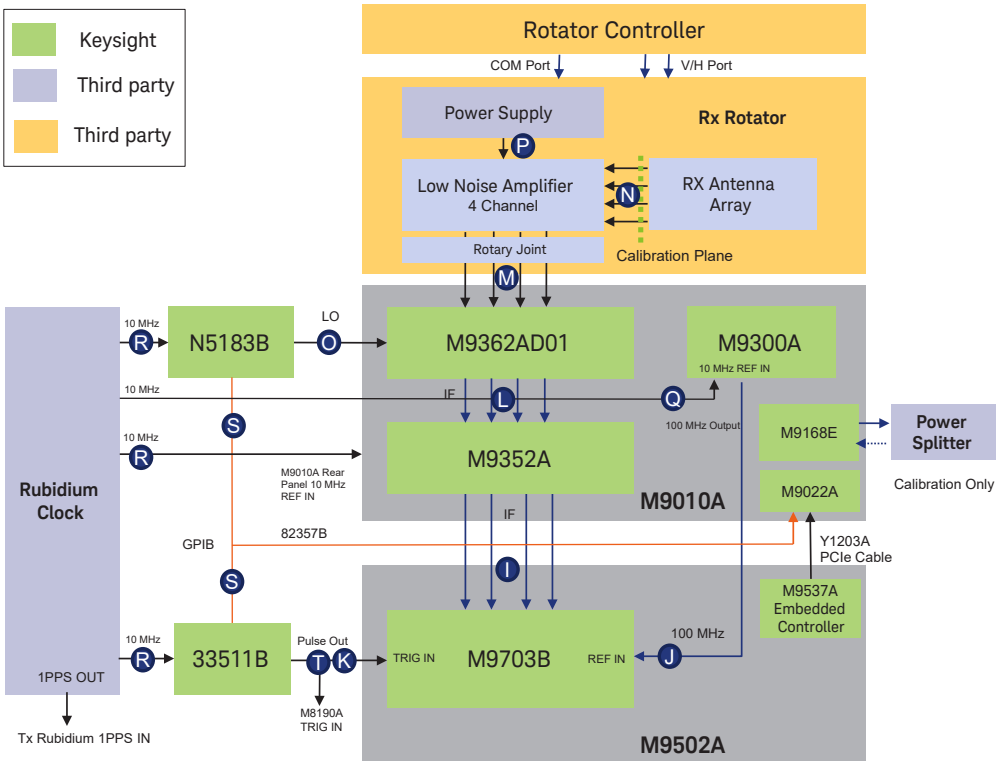
Step 1: Start with reference solution startup kit		
●	PS-S20-100	Daily instrument and application consulting with customer equipment, Recommend 3 to 5 days for initial system set up
●	PS-X10-100	Application specific technical assistance Recommend 3 to 10 days of post sales application support.

Physical Connections for 4x4 MIMO

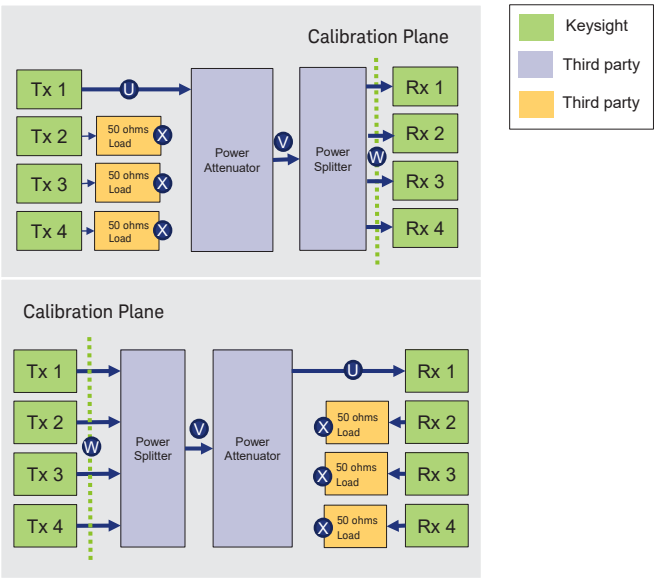
E1. Transmitter block diagram



E2. Receiver block diagram

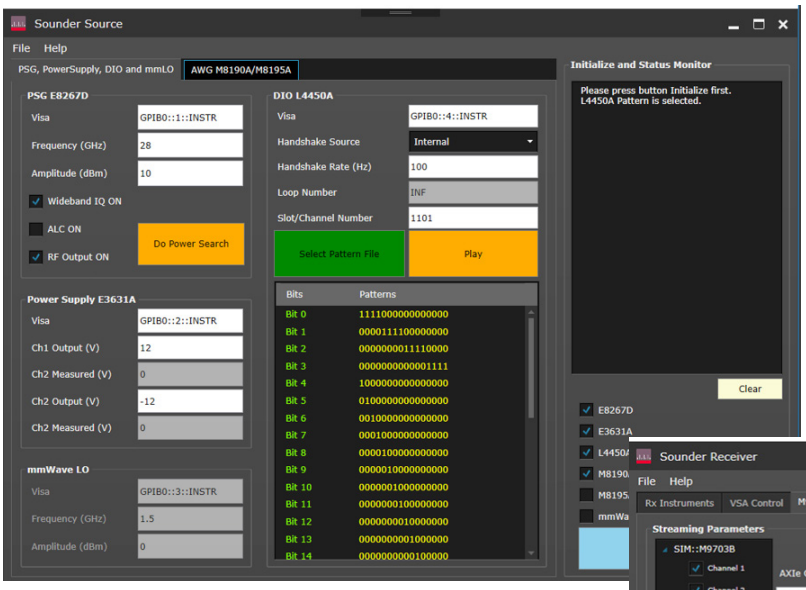


E3. Calibration connection block diagram

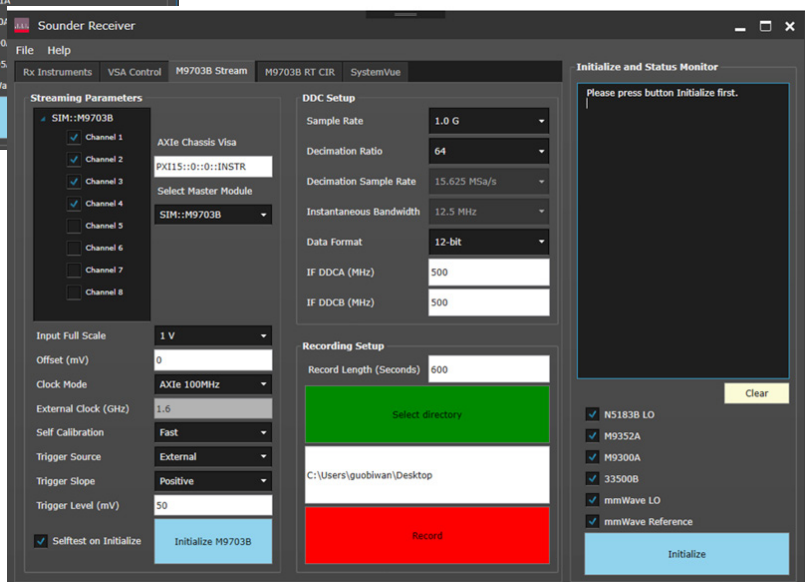


E4: IO control software

Transmitter IO Control



Receiver IO Control



Quantities of Instruments Needed for 4 and 8 Channel Systems Up to 40 GHz

Model	Description	Qty for 4-Channel	Qty for 8-Channel
Transmitter Subsystem			
M8190A	**Arbitrary waveform generator 14-bit / 8 GSa/s**	**1**	**1**
M8190A-002	2-channel	1	1
M8190A-02G	2 GSa memory /channel	2	2
M8190A-14B	14-bit resolution with 8GSa/s	1	1
M8190A-811	Cable assembly, SMA to SMA 1220 mm length	4	4
M9505A	**AXIe 5-slot chassis**	**1**	**1**
Y1226A	Rack mount kit for M9505A	1	1
M9537A	**AXIe embedded controller**	**1**	**1**
M9537A-WE6	Microsoft Windows Embedded Standard 7 (64-bit)	1	1
M9537A-M16	Upgrade memory from 8 to 16 GB RAM	1	1
82357B	USB to GPIB cable	1	1
E8267D	**Vector signal generator and wideband IQ up converter**	**1**	**1**
E8267D-544	Frequency range from 250 kHz to 44 GHz	1	1
E8267D-016	Wideband differential external I/Q inputs	1	1
E8267D-UNX	Ultra-low phase noise	1	1
E8267D-1CM	E8267D rack mount flange kit	1	1
85332B	**Solid state switch, 50 GHz, SP4T**	**1**	**2**
85332B-002	2 meter length cable	1	2
85332B-201	Switch control unit	1	2
85331B	**Solid state switch, 50 GHz, SPDT**	**0**	**1**
85331B-002	2 meter length cable	0	1
85331B-201	Switch control unit	0	1
L4450A	**64-bit digital I/O with memory and counter**	**1**	**1**
L4450A-GPIB	Add GPIB	1	1
Y1160A	EIA rack sliding shelf installation kit for L4450A	1	1
Y1137A	1.5 m 78-pin M/F Dsub cable	1	1
E36311A	**80W Triple Output Power Supply, 6V, 5A & ±25V, 1A**	**1**	**1**
E36311A-0E9	AC 100V single-phase 3-wire. 100 VAC ±10V operation, 47 to 63 Hz	1	1
E3600A-100	Test lead kit	1	1

Receiver Subsystem			
M9537A	**AXIe embedded controller**	**1**	**1**
M9537A-WE6	Microsoft Windows Embedded Standard 7 (64-bit)	1	1
M9537A-M16	Upgrade memory from 8 to 16 GB RAM	1	1
82357B	USB to GPIB cable	1	1
M9010A	**PXIe 10-slot chassis, Gen 3, 24 GB/s**	**1**	**0**
Y1217A	PXI chassis rack rail kit	1	0
Y1271A	Rackmount kit for M9010A	1	0

Model	Description	Qty for 4-Channel	Qty for 8-Channel
Receiver Subsystem (continued)			
M9019A	**PXIe 18-slot chassis, Gen 3, 24 GB/s**	**0**	**1**
Y1217A	PXI chassis rack rail kit	0	1
Y1215C	Rackmount kit for M9019A	0	1
M9022A	**PXIe system module: single port (x8), Gen 3**	**1**	**1**
Y1203A	PCIe cable: x8, 0.5 m	1	1
M9352A	**PXI hybrid quad IF amplifier/attenuator**	**1**	**2**
M9352A-H02	2 GHz bandwidth coverage	1	2
M9362AD01	**PXIe quad downconverter**	**1**	**2**
M9362AD01-F40	Frequency from 10 MHz to 40 GHz Note: 40 GHz quad downnconverter needs 10 dBm LO and -15 dBm RF input to get optimum performance, Power splitter 11667C insertion loss is 8.5 dB.	1	2
M9300A	**PXIe frequency reference: 10 and 100 MHz**	**1**	**1**
N5183B	**MXG X-Series microwave analog signal generator**	**1**	**1**
N5183B - 540	Frequency range, 9 kHz to 40 GHz	1	1
N5183B - UNY	Enhanced low phase noise	1	1
N5183B - 1EA	High output power Note: Option 1EA Max Power output at 40 GHz is 15 dBm (standard is 11 dBm). Power splitter 11667C insertion loss is 8.5 dB.	0	1
1CM010A	Rack mount flange kit 88.1mm H (2U) for N5183B	1	1
11667C	**Power splitter DC to 50 GHz**	**0**	**1**
M9703B	**AXIe 12-bit high-speed digitizer**	**1**	**2**
M9703B - SR2	Maximum sampling rate, 1.6 GS/s per channel	1	2
M9703B - INT	Interleaved sampling enabled	1	2
M9703B - F10	Bandwidth, 1 GHz path enabled	1	2
M9703B - M16	Memory, 16 GB, 1024 M Samples/ch	1	2
M9703B - FDK	FPGA programming access	1	2
M9502A	**2 slot AXIe chassis**	**1**	**1**
Y1225A	AXIe rack mount kit for M9502A	1	1
33511B	**Waveform generator**	**1**	**1**
34190A	Rack mount kit	1	1
M9168E	**PXI programmable step attenuator module, DC to 50 GHz**	**1**	**1**
PD4-0150	Marki Microwave 4-way Wilkinson power divider, 1 to 50GHz in-phase power splitting	1	0
PS8-53-454/4S	Pulse Microwave Corporation: 8-way power divider (10 to 40 GHz)	0	1

Software			
Y1299A-006	5G channel sounding IO control software	1	1
89601B	**89600 VSA software**	**1**	**1**
89601B-200	Basic vector signal analysis and hardware connectivity	1	1
W1462BP	**SystemVue FPGA Architect**	**1**	**1**
E4729A	Channel sounding MIMO and real-time CIR	1	1

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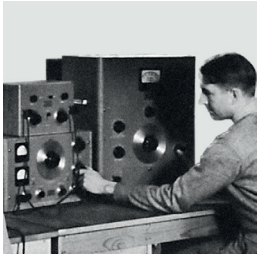

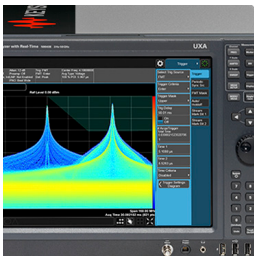

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