Users Manual

Model: ***FETAMP1***

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Introduction:

The Mathews Engineering FETAMP1 is a high impedance RF amplifier intended for industrial and laboratory use. This amplifier has very flat frequency response and is useable up to and above 400 MHz. Input impedance is 1 MΩ. Output impedance is 50Ω. The output of this amplifier will directly drive a 50Ω spectrum analyzer input with a 1X system gain (0 dB) and will drive high impedance loads with 2X gain.

Applications:

- Turns any 50 ohm input into a 1 MΩ oscilloscope type input
- Allows remote use of scope probes in hard to reach places
- Signal distribution and monitoring
- Allows the use of oscilloscope probes with 50Ω test equipment
- Network analysis (Hi-Z A/B sweeps on 50Ω gear)
- Control system stability analysis
- IF Strip Engineering, RF engineering
- Makes "50Ω only" oscilloscopes work with probes

Features:

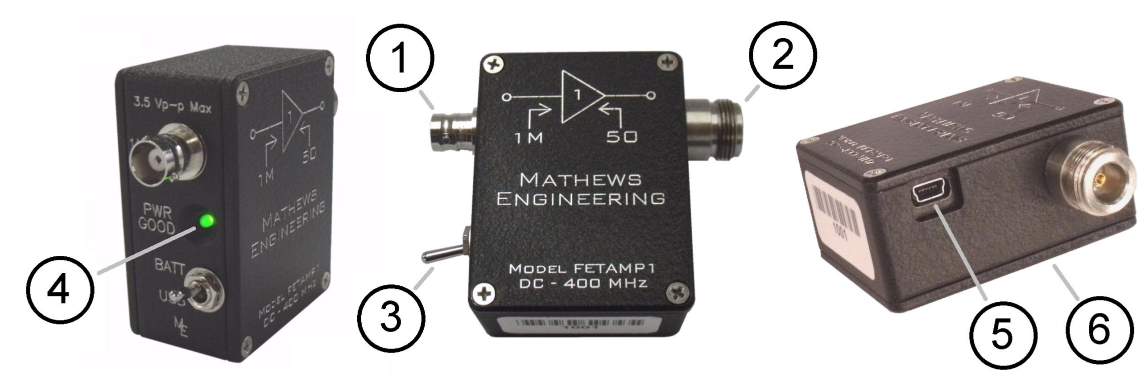

Figure 1 – Features

Features:

1) **High impedance BNC(f) input:**

   Warning! The ports are ESD sensitive.
   Avoid direct ESD discharge to the center pin of the connector.

2) **50Ω output N(f):**

   Warning! The ports are ESD sensitive.
   Avoid direct ESD discharge to the center pin of the connector.

3) **BATT/USB switch:**

   BATT Position: The amplifier operates from internal AAA cells
   USB Position: The amplifier operates from external power. To turn the unit off, use this position and disconnect the external power source.

4) **Power Good LED:**

   The power good LED indicates that the unit has sufficient power for normal operation.
   LED ON: Power source is good.
   LED OFF: Power source not present or batteries are dead.
   LED Toggles slowly ON then OFF: The batteries are at end of life. Replace the batteries or use USB port power.

5) **USB power entry point:**

   Female "Mini B" style USB power entry port. Power is drawn from this port only when the BATT/USB switch is in the USB position. No power is drawn from the batteries when the switch is in this position. The batteries do not charge when external power is applied. Rechargeable batteries are not recommended.

6) **Battery cover:**

   Remove this cover with a #1 Phillips screwdriver to install three AAA alkaline batteries. Typical battery life is 6 hours. Be careful to install the batteries in accordance with the polarity markings. <u>Permanent device damage is possible if the batteries are installed incorrectly.</u> If the amplifier is to be stored for a long period, remove the batteries and store separately.

Specifications:

Parameter	Conditions	Min	Typical	Max	Units
Dynamic Performance			$T_a = 25C$		
Small Signal -3dB Bandwidth	Vin = 22.4 mV (-20dBm)	350.0	400.0		Mhz
	Vin = 70.7 mV (-10dBm)		390.0		Mhz
	Vin = 223.6 mV (0dBm)		225.0		Mhz
Full Power Bandwidth	Vin = 3.3 $V_{p.p}$		48.0		Mhz
Output Slew Rate	R_{load} = 50 Ω		325.0		V/usec
Gain Flatness	-20 dBm, DC to 250 MHz	-1.0	+/-0.5	1.0	dB
Noise Performance					
Input referred voltage noise	f = 100 kHz		4.0		nV/√Hz
Input referred current noise	f = 100 kHz		2.5		fA/√Hz
Output Noise Density	f = 100 MHz, Rinput = 50 Ω, Rload = 50 Ω		-155.0	-150.0	dBm/Hz
Harmonic distortion (HD2,HD3)	f = 100 MHz, Vout = 0 dBm, R_{load} = 50 Ω		-35.0	-30.0	dBc
	f = 100 MHz, Vout = -10 dBm, R_{load} = 50 Ω		-46.0	-40.0	dBc
Spurious output signals	Rinput = 50 Ω, DC to 1.5 GHz		-84.0	-80.0	dBm
DC Performance					
Input Offset Voltage		-2.0	+/-0.4	2.0	mV
Input Offset Voltage Drift			7.0		uV/C
Input Bias Current			2.0		pA
Input Characteristics					
Input Impedance	Vtest = 1V	0.98	1.00	1.02	MΩ
Input Capacitance	f = 100 MHz		4.0	8.0	pF
Input CMVR			3.5		V_{p-p}
Output Characteristics					
Output Voltage Swing	R_{load} = 50 Ω	3.0	3.5		V_{p-p}
Unloaded Output Voltage Swing	R_{load} = 1 MΩ	7.5	7.8		V_{p-p}
Internal voltage rails	+5V and -5V				
Power Supply					
Power Modes	Battery, USB, or 120 VAC (60 Hz)				
Battery Type	(3) AAA Alkaline				
Battery Life	V_{in} = 0 mV		6.0		Hours
Supply Current	V_{in} = 0 mV, V_{batt}=4.5V		62.0		mA
Supply Current with Signal	V_{in}=3.3 V_{p-p}, 1MHz, V_{batt} = 4.5V, R_{load} = 50 Ω		84.0		mA
Operating Temperature Range		0	25	50	C

Accessories (included):

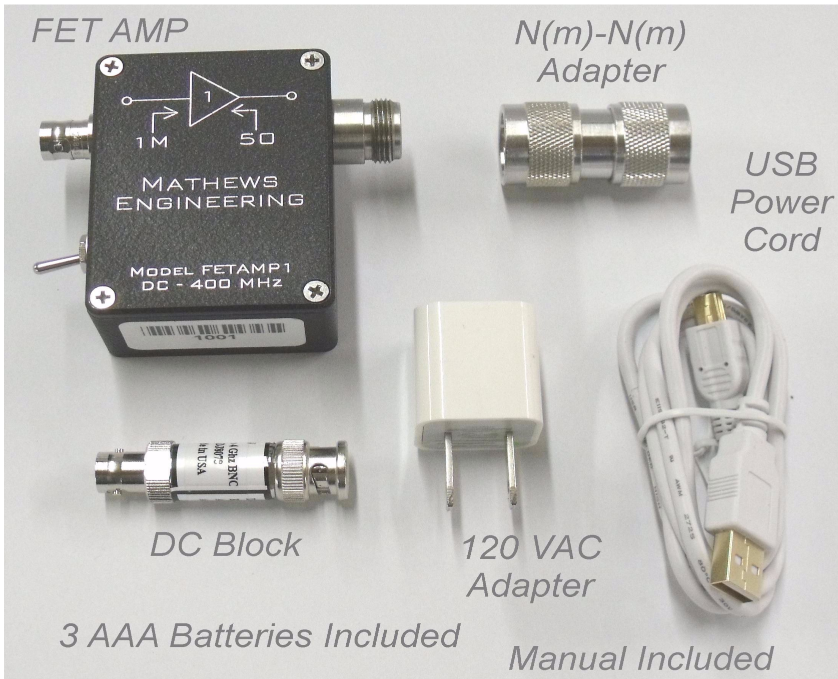

Figure 2 – Accessories

- **N(m)-N(m) Adapter:** This adapter is useful for connecting to spectrum analyzers. It provides a mechanically stable connection as well as sufficient setback of the amplifier when used with most laboratory equipment.

  Warning!: *Although the N connector on the FETAMP1 is very firmly pressed into the case it is wise to avoid excessive bending force when using this adapter.*

- **USB Power Cord:** Use this to draw power from any standard USB port (often available on the front of oscilloscopes and spectrum analyzers).

- **120 VAC Adapter:** Use this adapter with the USB power cord to power the amplifier from 120 VAC.

- **DC Block:** The amplifiers input is normally DC coupled. Use the DC block on the amplifier's input to block DC signals or when DC signals are saturating the FETAMP1.

Use with scope probes:

The FETAMP1 amplifier is designed to work alone or with most 10X and 100X oscilloscope probes (not included). Most oscilloscope probes will have their own bandwidth limitation. Remember to take this into account and adjust bandwidth expectations accordingly. For best performance use the FETAMP1 with 500 MHz probes. For optimal frequency response, probe calibration is recommended prior to use. The probe calibration setup is shown in figure 3. Connect the output of the FETAMP1 to the oscilloscope input using a BNC "Tee". Terminate the signal at the tee with a 50Ω BNC load. Alternately, some oscilloscopes may have a switched internal 50Ω termination. Using an appropriate screwdriver, adjust the probe for optimal square wave edges.

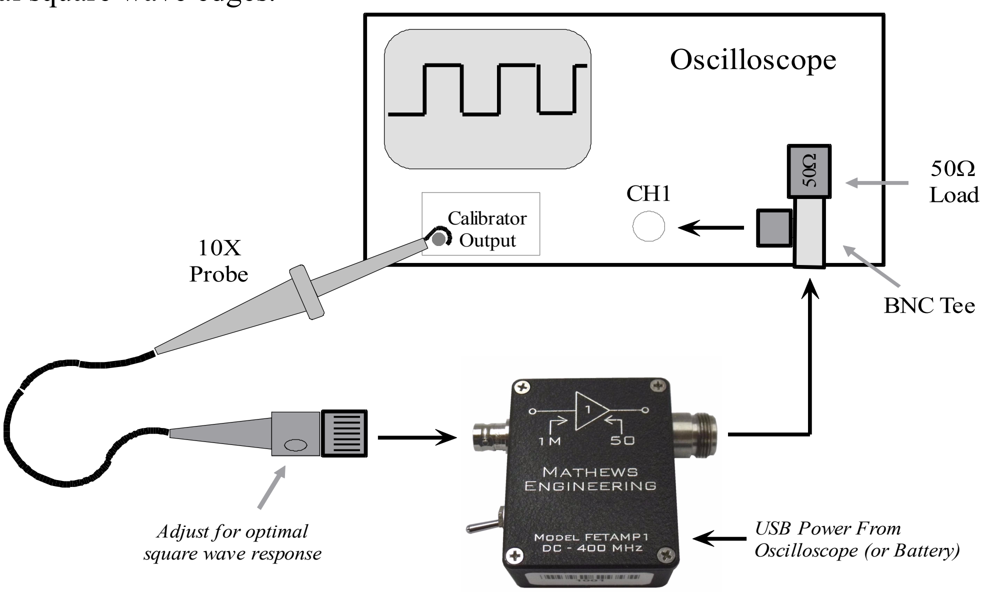

Figure 3 – Calibrating with Oscilloscope Probes

Slew rate limit and full power bandwidth:

Although FETAMP1 has more than 400 MHz of bandwidth there is an additional limitation imposed by output slew rate. When driving a 50Ω load the slew rate is typically 400 V/usec and 800 V/usec into 1 MΩ.. The bandwidth reduction due to slew rate can be seen in figure 4. The full power bandwidth (typically 48 MHz) is the bandwidth below which the output can swing from rail to rail (3.3Vp-p into 50Ω). When using a 10X probe, signals up to 10 dBm will generally not experience the effects of slew rate limiting.

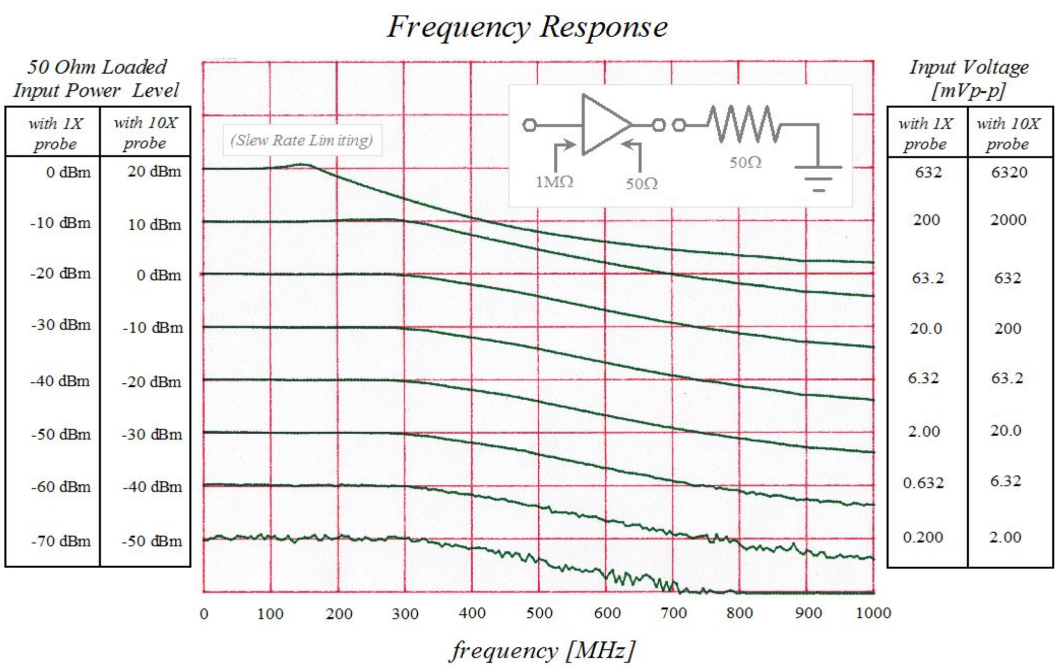

Figure 4 – Frequency Response and Slew Rate Limit

Application Example: Multidrop scope probe

Figure 5 shows an application example where the FETAMP1 is used to drive multiple test and measurement loads while still maintaining proper amplitude calibration. This setup is particularly useful for a production test bench.

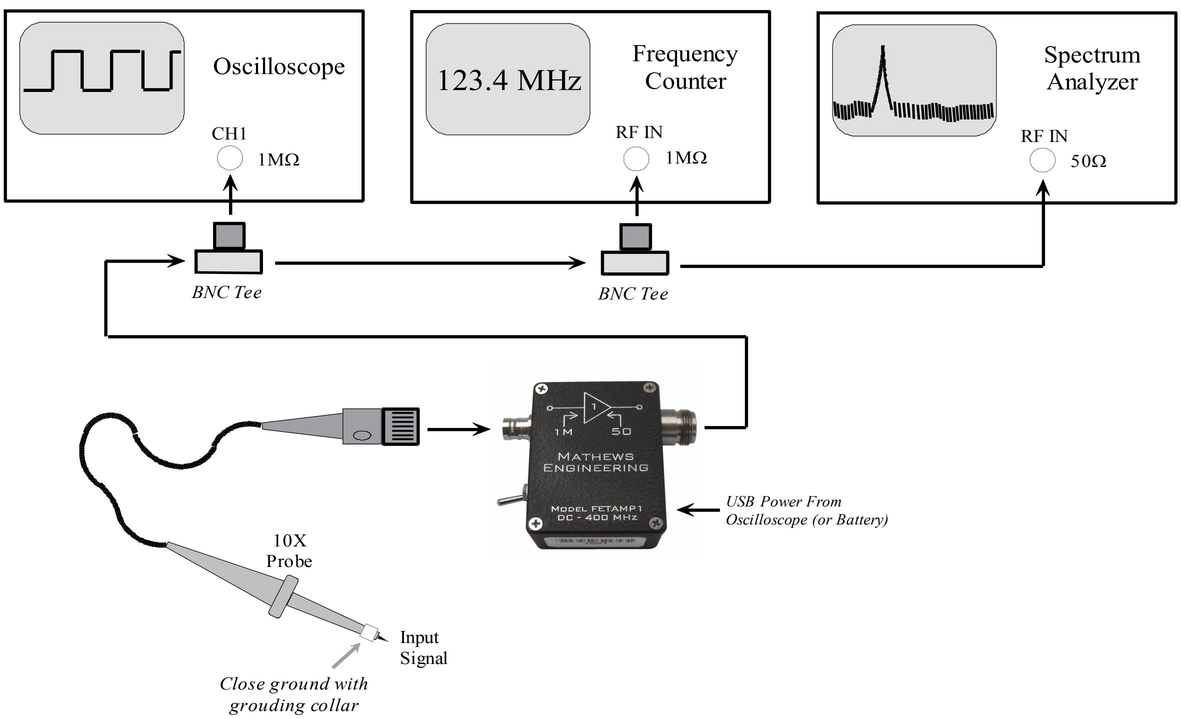

Figure 5 – Multidrop Probing

Application Example: Spectrum analyzer Hi-Z probe

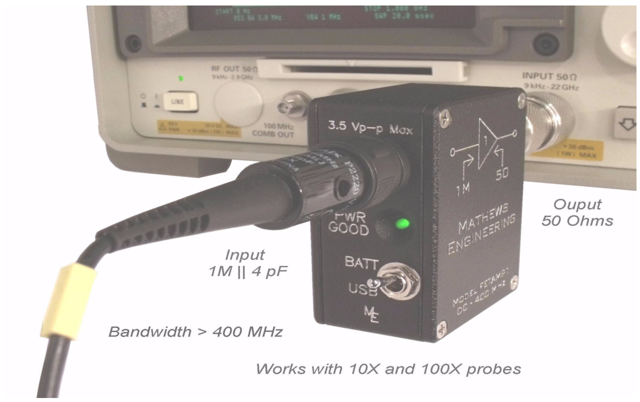

Figure 6 shows FETAMP1 used with a spectrum analyzer. In this example, the 1 MΩ input can be used directly or with a 10X probe. Without the FETAMP1, the 9 MΩ series resistor inside the 10X probe would cause excessive signal loss into the 50Ω spectrum analyzer. When the FETAMP1 is used, signal levels are accurately displayed on the spectrum analyzer with no signal loss.

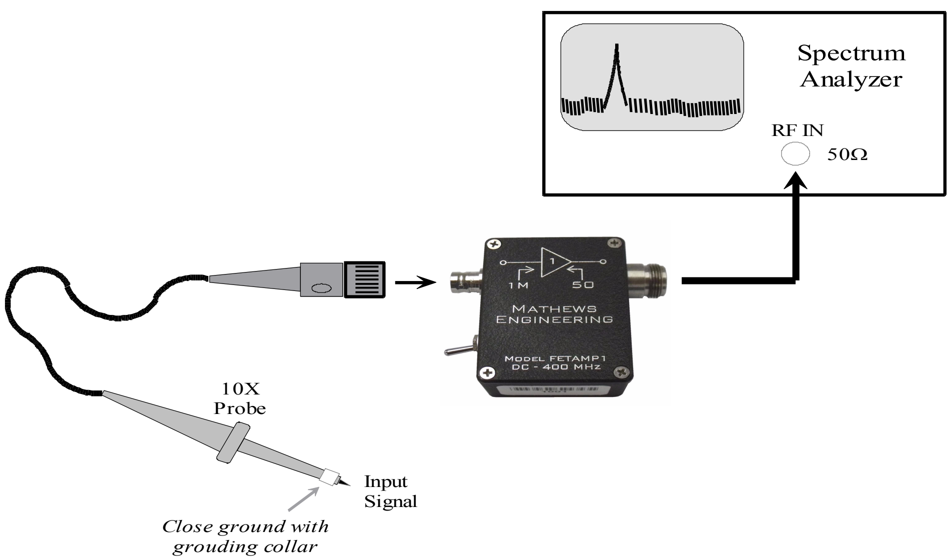

Figure 6 – High-Z Spectrum Analyzer Probe

Application Example: Network analyzer A/B probing

Two FETAMP1s can be used with 50Ω network analyzers. In this case, the swept RF output of the network analyzer is routed through the circuit under test. High impedance probes can now be used to test the swept response at various points along the signal path. Use the network analyzer's A/B mode to check the in circuit response of filters, amplifiers, etc.

The N(m)-N(m) adapter provides a solid connection and is ideal for for mounting the FETAMP1 directly to the front of the spectrum analyzer.

The FETAMP1 is also useful for sweeping high impedance filters, transformers, and other devices with unusual impedance requirements.

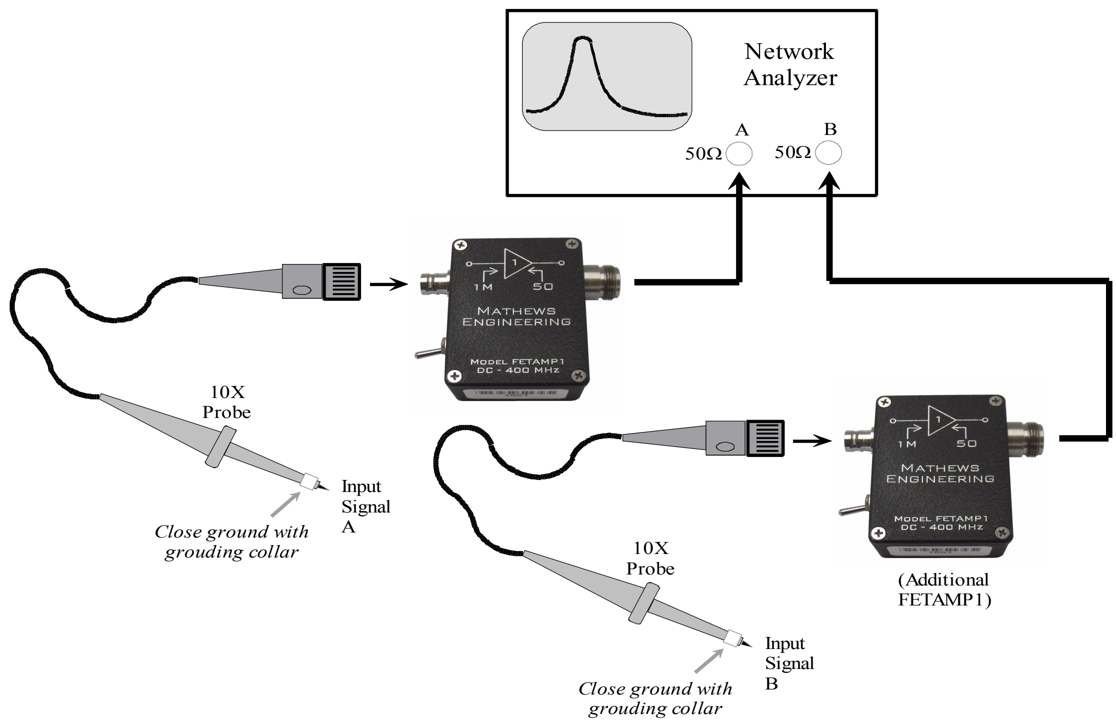

Figure 7 – Network Analyzer A/B Probing

Application Example: Remote use of scope probes

In cases where a signal needs to be probed from a difficult to reach location, the FETAMP1 can be used to extend the reach of the scope probe. This is particularly useful when working on large machinery or other applications where it is not possible to get an oscilloscope or spectrum analyzer close to the probe point. When using this method be sure to correct for transmission loss. RG-58/U coaxial cable, for example, has loss of about 3.9 dB per 100 feet at 100 MHz. This is about a 36% loss and can be corrected at the scope. If the output of the 10X probe were driven directly into the transmission line without the FETAMP1, not only would flatness be horrible, the losses would be 86dB!

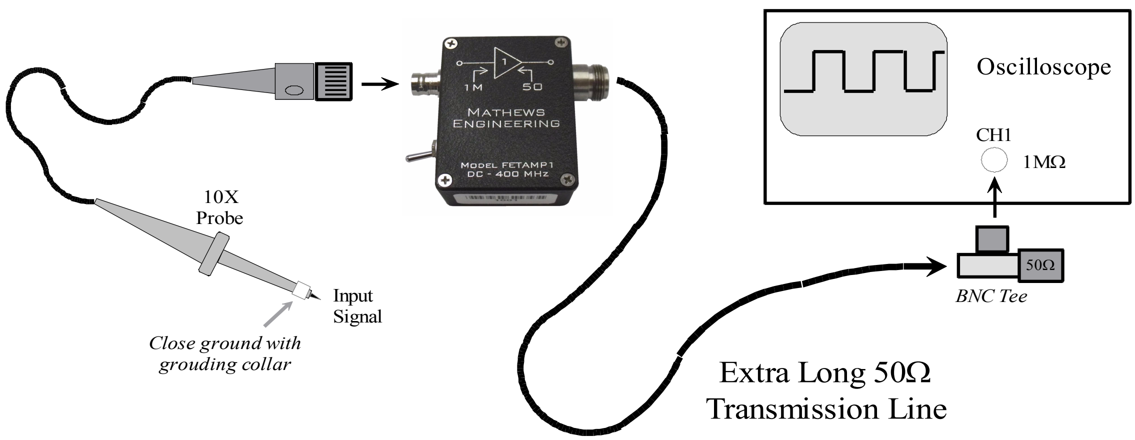

Figure 8 – Remote Use of Scope Probe

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