GPIB BUS EXTENDERS

4897 & 4897L

HIGH SPEED IEEE 488 BUS EXTENDERS

Description

ICS Electronics's 4897 series GPIB Bus Extenders dramatically improve the IEEE 488 bus use by extending the maximum GPIB cable distance and by adding more GPIB devices to the system. The 4897 and 4897L provide high-speed GPIB bus extension with a variety of fiber-optic and metallic cables. The Model 4897 extends the bus over 5,000 meters with multimode fiber-optic cable. The Model 4897L extends the bus over 15 km with single-mode fiber-optic cable. Both 4897s provide isolated differential signals for driving dual twisted shielded pair cables or a pair of coaxial cables. Extension distances of 600 feet are possible with the dual twisted shielded pair cable or up to 1,000 feet with some coaxial cables.

The 4897 series Bus Extenders are completely transparent to all bus commands and do not require any program changes when added to most systems. They are also fully compatible with the IEEE-488.2 Standard. Unlike older bus extenders that respond to all GPIB addresses, the 4897 responds correctly to the FindLstn protocol, making it ideal for use with application programs that use the newer 488.2 protocols.

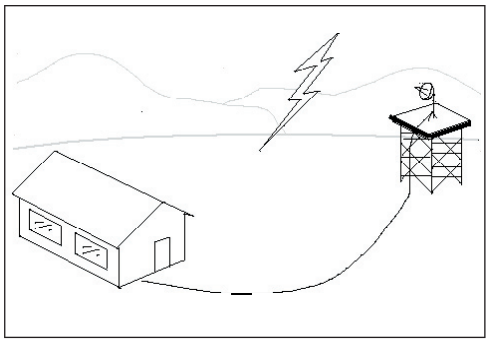
GPIB Bus Limitations

The IEEE-488 Standard limits the GPIB bus distance to a maximum of 20 meters with 2 meters of cable between devices for full data transfer rates. The IEEE-488 Standard also limits the number of devices that the System Controller can drive to 14. ICS's 4897 series Bus Extenders overcome both limitations by extending the maximum cable distance up to 15 km and by adding drive capability for 13 additional devices.

4897 Bus Extender

Hostile Environment, Noise Immunity and Data Security

In addition to greatly increased bus extension distance, the 4897's fiber-optic link capability offers a several advantages to industrial and security conscious users by providing electrical isolation between local and remote sites. In electrically hostile environments, the fiber-optic link eliminates the possibility of EMI/RFI interference disturbing the transmitted data. The fiber-optic link also protects indoor equipment from damage due to external lightning strikes. Lightning or remote voltage transients do not propagate down the fiber-optic cable. The same properties that make the links immune to outside interference also prevent signal radiation or detection through ordinary means. The 4897's fiber-optic link will not interfere with the most sensitive equipment.



Fiber-optic data link provides secure error free data even in severe environments and protects base equipment against lightning caused damage.

- Extends the GPIB bus over 15,000 meters with fiber-optic cable or over 200 meters with metallic cables.
  Wide selection of cable types for long and short distance applications.
- Fiber-optic link provides isolated data that is immune to EMI/RFI interference.
  Secure data always.
- High > 660,000 bytes per second data transfer rate.
  High data transfer speed regardless of distance.
- IEEE-488.2 Compatible
  Responds correctly to the Findlstn and other protocols.
- Transparent to all 488 Bus commands including Parallel Poll and Pass Control.
  No special programming
- Adds up to 13 more GPIB devices to the system.
  Overcomes Bus device limit.
- Includes a full set of diagnostic indicators.
  Easy troubleshooting of system problems.

CE Approved

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Multiple Interfaces

Each 4897 series Bus Extender includes both fiber-optic and metallic cable drivers and receivers for maximum flexibility. This gives the user a wide choice of cable types for short distances and makes the 4897 the ideal replacement for older Bus Extenders that used fiber-optic or coaxial cables. Multimode fiber cables with ST connectors plug directly into the Model 4897. Single-mode fiber cables with SC connectors will plug directly into the Model 4897L. Other fiber-optic cables will have to be re-connectorized or used with short adapter cables to connect to the 4897 or 4897L.

The 4897's metallic cable interface is a DE-9S connector for easy connection to twisted shielded pair cable. A DE-9 to BNC Adapter provides two female BNC connector for connecting dual coaxial cables to the 4897 or to the 4897L

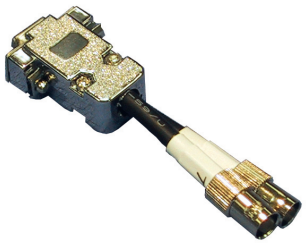

Figure 2 DE-to-BNC Adapter

Applications

The 4897 Series Bus Extenders can be used in a number of configurations from short, across the room links to long site-to-site links. The 4897s can even be used in star configurations to connect a central site to multiple remote locations. Figure 1 shows the star link application.

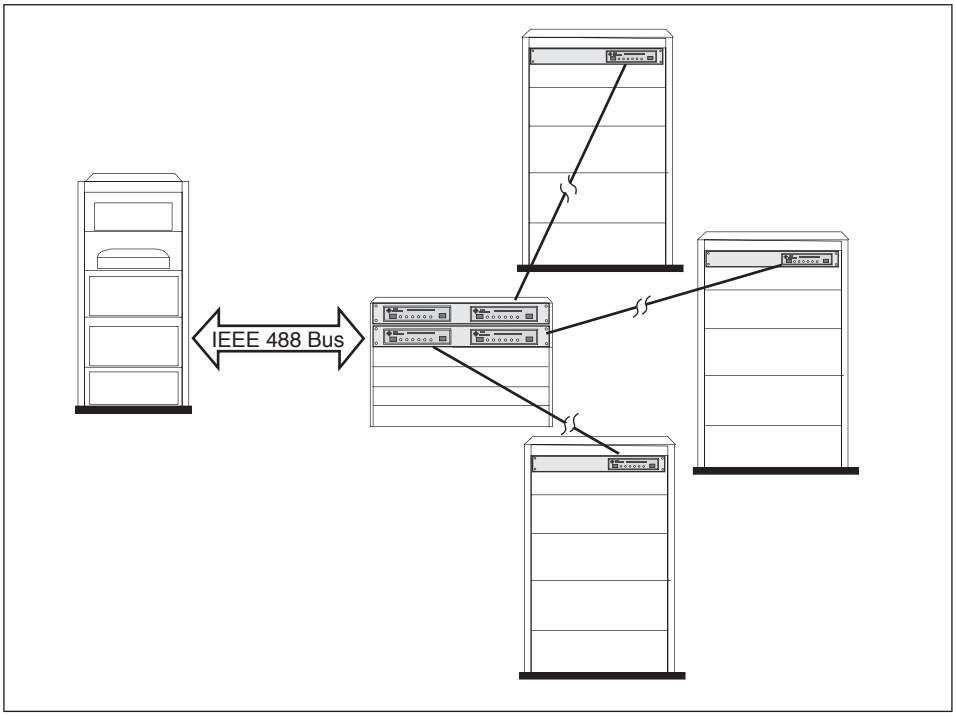

Figure 1 4897s in a Star Connection to drive multiple remote sites

The 4897 Series Bus Extenders with their multiple interfaces can be used to replace a number of older Bus Extenders. Replacement candidates are: Hewlett-Packard 37204, ICS 4887, ICS 4887A, and all ICS 4889s, National Instrument 101A, and IOtech 488/F.

Data Transfer Rate

The 4897's uses a two techniques to transfer data, unbuffered and buffered. In the normal or unbuffered mode, all GPIB bytes are handshaked simultaneously on both the local and remote buses. Data rate declines as bus extension distance increases due to increasing cable delays between the two extender locations. Table 1 shows that the data rate stays above 30 kbytes per second for bus extension distances up to 2 km. Extender data rates above 25 kbytes per second will have very little affect on most GPIB systems since the typical instrument handshakes data somewhere between 5 to 20 kbytes per second.

In the buffered mode, data is transferred at the maximum transfer rate between the two bus extenders, buffered and then handshaked out at the local bus rate. The data transfer rate remains constant regardless of the cable length between the two extenders. Bus control bytes are not buffered. For the Model 4897, the maximum transfer rate distance is limited to 4,000 meters due to dispersion affects in the multimode fiber-optic cable. Beyond 4,000 meters, the Model 4897 operates at 1/2 speed which cuts the bus transfer rate in half. The Model 4897L can operate at its maximum transfer rate out to 15 km. The buffered mode saves time when large amounts of data are being transferred, when the bus extension distance is beyond 2 km or when used with a high-speed bus device.

Table 1 Bus Extender Data Rates vs Bus extension Distance

Extension Distance (meters)	20	200	1000	2000	4000	5000	7,500	10,000	15,000
Normal Handshake Rate (unbuffered) (Kbytes per second)	83	71	45	31	19	16	11.4	8.9	6.1
Buffered handshake Rate (Kbytes per second)	660	660	660	660	660	660	660	660	660

Notes: Model 4897 operates with 50 MHz carrier for distances beyond 4,000 meters
Rates do not include Controller or device delays.

Parallel Poll Response

The 4897 requires more than the IEEE Standard's minimum time of 2 μsec to output a current response to a Parallel Poll due to the time it takes for the Parallel Poll Request to get to the remote site and for the response from the remote devices to get back to the local bus. The local 4897 stores the last Parallel Poll Response from the remote bus and outputs it when next Parallel Polled. At the same time, the local extender sends a Parallel Poll Request to the remote bus. When the local extender receives the remote response, it updates its local Parallel Poll Response. GPIB Controllers with Parallel Poll times greater than the 4897's Parallel Poll Response time, will see the current response for each Parallel Poll. Table 2 lists the 4897's Parallel Poll Response times.

GPIB Controllers with Parallel Poll times less than the 4897's Parallel Poll response time will not see the current response for each Parallel Poll. The user can lengthen the GPIB Controller's Parallel Poll time to give the 4897 time to return the current response with only one Parallel Poll. Most GPIB Controllers let you set the Parallel Poll time in their configuration file. If the Parallel Poll time cannot be lengthened, the user can conduct a second parallel poll after the 4897 has updated its stored value to obtain the current response.

In the rare case where the local 4897's Parallel Poll response update time conflicts with the GPIB Controller's Parallel Poll time, a rear panel switch on the 4897 inhibits changes to the local 4897's Parallel Poll Response while the Parallel Poll is active. The local 4897 updates its stored value when the current Parallel Poll ends. The user can then conduct a second Parallel Poll to read the current value.

Transmission Medium

ICS's 4897 series Bus Extenders can use either dual fiber or dual metallic conductor cables to extend the GPIB bus. Dual conductor cables are required for the 4897's full-duplex style of operation. Fiber-optic cable is recommended for outdoor and for long distance applications.

Metallic Cable - Each 4897 Bus Extender includes differential driver and receivers which work with a variety of dual conductor metallic cables. The data rate for metallic cables is the same rate as for fiber-optic cables. The preferred metallic cable is a dual twisted shielded cable such as IBM Type 1 or Belden 9688. These cables have two pairs of twisted wires that are individually shielded. This type of cable provides bus extension distances of up to 600 feet (182 meters). Coaxial cables can also be used with the 4897 to extend the GPIB bus. 75 ohm and 93 ohm cables work best. A pair of RG-6 cables will provide bus extension distances up to 1000 feet. RG-59 and RG-62 cables provide distances up to 500 and 700 feet respectively. Use ICS's DE-9 to BNC adapter shown in Figure 2 to connect coaxial cables with BNC plugs to the 4897. Unshielded metallic cables like Cat 5 cable are not recommended for use with the 4897 due to their high cross talk at the 4897's transmission frequency. The affect is shown in the reduced distance listed for Cat 5 cables in the Specifications Section.

Multimode Fiber-Optic Cable - The Model 4897 Bus Extenders provide duplex ST receptacles for connecting to multimode fiber. The recommended fiber is 62.5/125 or 50/125 μm diameter fiber. The 4897 operates at 1300 nm and provides a guaranteed Optical Flux Budget for either size fiber as shown in Table 3. Bus extension distances in excess of 4 km are possible with low attenuation fibers.

Table 3 4897 Fiber Cable Lengths

Fiber Diameter (μm)	Optical Power Budget (dBm)	Fiber Attenuation (dB/km)	Allowable Cable Length* (km)
62.5/125	12	1.0	0 to 4.0
50/125	9	1.0	0 to 4.0

Note: Table 3 includes allowances for LED aging, splices, and connectors and is based on an industry accepted model.
* Cable length is limited by fiber attenuation, chomatic and modal dispersion losses, not by optical power losses.

Table 3 shows that the 4897 has more optical flux than needed to drive 4 km of 62.5/125 diameter fiber. The 4 km limit is not due to a lack of optical power but instead it is due to dispersion affects that introduce bit rate errors. The 4897 has an internal clock setting that cuts its signaling rate in half. This lower bit rate doubles the bit interval which reduces the dispersion effects and allows the use of longer fiber-optic cables. This makes Bus extension distances over 5,000 meters possible with low attenuation fiber. The trade-off for the longer bus extension distance is a 50% reduction in the 4897's data rate.

Single-mode Fiber-Optic Cable - The Model 4897L Bus Extenders provide duplex SC receptacles for connecting to single-mode 8/125 μm diameter fiber. The 4897L incorporates a lazer diode that operates at 1300 nm and provides a guaranteed optical flux budget of 9 dBm. This amount of optical flux makes bus extension distances up to 22 km possible with today's low attenuation fiber (0.4 dBm/km). ICS guarantees 4897L bus extension distances up to 15 km.

No Program Changes

The 4897 can operate in most systems with no program changes. The only time a program change may be required is if the system is parallel polling a device at the remote location.

Table 2 4897 Response Times vs Cable Length

Coaxial cable length, meters	20	100	200						
Service Request (SRQ) delay, μs	4	4.5	5						
Parallel Poll response time, μs	9	10	11						
Fiber cable length, meters	20	100	500	1,000	2,000	5,000	7,500	10,000	15,000
Service Request (SRQ) delay, μs	4	4.5	6.5	9	14	29	41	54	79
Parallel Poll response time, μs	9	10	14	19	29	59	85	110	160

SPECIFICATIONS

IEEE 488 Bus Interface Functions

The local 4897 transparently passes all bus commands and data to the remote 4897

Local Bus Capabilities

SH1, AH1, T0, TE0, L0, LE0, SR0, PP2, RL0, DC0, DT0, C0, E1/E2.

Remote Bus Capabilities

SH1, AH1, C1, C2, C3, C9, E1/E2.

Parallel Poll Response:

Normal - Prior remote response stored and outputted during next parallel poll. Output updated when the current response is received from the remote unit.

Inhibited - Prior remote response stored and outputted during next parallel poll. Stored value updated after the current parallel poll.

Own response - Outputs linked status on DIO8 bit when enabled by an internal switch.

Data Transfer Rate:

Normal:	>80 Kbytes/sec at 20 m
Buffered:	660 Kbytes/sec up to 4 km
	330 Kbytes/sec beyond 4 km

Transfer Delay (SRQ):

4 μs min plus 5 ns/meter of cable.

Parallel Poll Response Delay:

10 μs min plus 10 ns/meter of cable.

Link Specifications

Each 4897 Bus Extender has coaxial and fiber-optic link capability. All 4897 links are full-duplex links with transmit and receive paths.

4897 Fiber-optic Link

Connectors:	ST
Wavelength:	1300 nm
Signal Freq	100 MHz/50 MHz
Output Pwr:	-19 dBm min,-16 dBm typ into 62.5/125 μm fiber
	-23 dBm min,-20 dBm typ into 50/125 μm fiber
Receiver:	-31 dBm min with a BER < 2.5×10^{10}
	-14 dBm max input
Flux Budget:	12 dBm
Distance:	with 62.5/125 μm fiber and atten < 2 dBm/km
	> 4 km full speed
	> 5 km half speed
	7 km max

4897L Fiber-optic Link

Connectors:	SC
Wavelength:	1300 nm
Signal Freq	100 MHz/50 MHz
Output Pwr:	-20 dBm min,-14 dBm typ into 9/125 μm fiber
Receiver:	-31 dBm min with a FDDI Test Patern
	-14 dBm max input
Flux Budget:	9 dBm
Distance:	with 9/125 μm fiber and atten.< 0.5 dBm/km
	> 15 km full speed

Coaxial Link

Connectors:	DE-9S
Signal Freq	100 MHz/50 MHz
Signal type:	Balanced
Output:	1.7 V min into 75 ohms
Isolation:	1500 Vdc
Cable Type:	Dual Twisted Shielded Pair, 150 ohm IBM Type 1, Cat 6 or Belden 9688
Distance:	Up to 600 feet
Cable Type:	Dual Coaxial Cable RG-6, RG-62, RG-59
Distance:	Up to 600 feet
Cable Type:	Dual Twisted Pair, 100 ohm, Cat 5
Distance:	Up to 300 feet

Pinouts:

Pin	Signal
1	Chassis
2-7	Tx Data
4-9	Rx Data
5	Ground
6	5 Vdc

Device Compatibility

The 4897 has been successfully tested with a number of IEEE-488.2 devices and some older 488.1 devices. The only incompatibly found was with an old device that used the obsolete Motorola 3447 drivers.

SPECIFICATIONS

Front-Panel Indicators

The 4897 includes a full complement of indicators for visual display of the extender's status and link performance.

PWR	Lights when unit is powered on
LINK	Lights when remote-to-local is established and operational
DATA I/O	Blinks or on when data is passing through the extender
SERIAL ERROR	Indicates a carrier loss or a serial transmission error found or the unit is retransmitting data.
SYSTEM ERROR	Lights when 4897 detects presence of two bus controllers
TEST	Lights when 4897 is in test mode and unable to send data

Rear-Panel Controls

FO	Enables FO receiver input when on, metallic input when off.
PPI	Inhibits updating the current parallel poll response until the current poll is completed.
BUFF	Enables buffered data transfer mode.
LPBK	Enables remote loopback.

Internal Controls

Internal controls enable remote data hold, Parallel Poll response of lnk status and half speed select.

Front-Panel Controls

POWER	Turns as power on/off
RESET	Resets internal 4897 logic and remote unit.

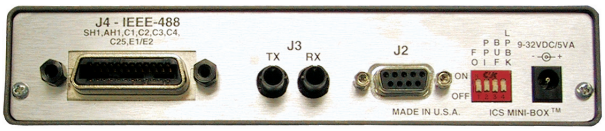

Figure 3 4897/97L Rear Panel

Physical

Connectors:
IEEE 488 Bus interface:
Amphenol 57-20240, metric lock studs
Metallic conductor cable I/O:
DE-9S connector with lockstuds
Optical transmitter and receiver:
Dual ST connectors
Dimensions: WxHxD
7.45 x 1.52 x 7.29 inches
(18.92 x 3.86 x 18.52 cm)
Weight
1.9 lbs. (0.9 kg.)
Temperature
Operating 0 °C to +55 °C
Storage -40 °C to + 85 °C
Humidity
0-90% RH without condensation
Shock/Vibration
Normal handling only
Power
9 to 32 Vdc @ 5 VA

Included Accessories

Instruction manual
DE-9P plug and hood.
UL/CSA/VDE/CE approved AC power adapter provided for:
US - 115 V ± 10 %, 60 Hz std
Universal - 115/230 V ± 10 %, 50/60 Hz with US, UK, Europe, Australia/China and Japan plugs.

Approvals/Certificates

EMI/RFI Approved for Class A, Part 15 of FCC Docket 20780, EEC Standards EN55022 and 50082-2
UL/IEC Designed for UL 1950, and IEC 950 Compliance.

Ordering Guide

	Part Number
4897 Bus Extender, with 115 VAC adapter.	4897
4897L Bus Extender, with 115 VAC adapter.	4897L
4897 Bus Extender, with 230 VAC adapter. and universal plugs for US/UK/Europe/Australia/China/Japan	4897-U
4897L Bus Extender, with 230 VAC adapter. and universal plugs for US/Japan,UK/Europe,Australia/China	4897L-U
Dual fiber cable assembly, 62.5/125 fiber with ST connectors. L = 001 to 999 meters	114049-L
Dual twisted shielded pair cable assembly, DE-9P connectors. L= 001 to 200 meters.	115363-L
DE-9 to BNC Adapter for BNC terminated coaxial cables	115364
Rack Mounting Kits and GPIB Bus Cables	see separate data sheets