# User's Guide


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## OMB-PER-488/W95
## OMB-PER-488/WNT

PC/IEEE 488 Controllers
For Windows 95/NT

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# Introduction to this Manual

This manual is the *Personal488 User s Manual for Windows 95 and Windows NT*.

The material in this manual discusses PC/IEEE 488 controller interface hardware and their accompanying 32-bit driver software. This material is divided into the following sections:

- ***Chapter 1: Personal488 Overview*** gives a general description of both the interface hardware and the driver software associated with each of the Personal488 PC/IEEE 488 controller interface packages discussed in this manual.
- ***Chapter 2: Personal488/PCI (with PCI488)*** provides a discussion of the hardware specifications, and the instructions for the installation of the "plug-&-play" PCI488 interface and its drivers.
- ***Chapter 3: Personal488/ATpnp (with AT488pnp)*** provides a discussion of the hardware specifications, and the instructions for the installation of the "plug-&-play" AT488pnp interface and its drivers.
- ***Chapter 4: Personal488/CARD (with CARD488)*** provides a discussion of the hardware specifications, and the instructions for the installation of the "plug-&-play" CARD488 interface and its drivers.
- ***Chapter 5: Personal488/AT (with AT488)*** provides a discussion of the hardware specifications, and the instructions for the installation and configuration of the AT488 interface and its drivers.
- ***Chapter 6: Personal488 (with GP488B)*** provides a discussion of the hardware specifications, and the instructions for the installation and configuration of the GP488B interface and its drivers.
- ***Chapter 7: Personal488/MM (with GP488B/MM)*** provides a discussion of the hardware specifications, and the instructions for the installation and configuration of the GP488B/MM interface and its drivers.
- ***Chapter 8: Driver488/W95 & Driver488/WNT*** gives a more-detailed description of the 32-bit Windows-based driver software implemented with each of the Personal488 products in this manual, and includes instructions for the configuration of this software.
- ***Chapter 9: API Command Reference*** provides descriptions for the entire API command set combining both 32-bit versions of Driver488 – *Driver488/W95* and *Driver488/WNT* – and covering each of the Personal488 products in this manual. The description format of the individual API commands includes the command syntax, returned response, operating mode, bus states, and an example program excerpt.
- ***Chapter 10: Troubleshooting*** provides a reference for possible solutions to technical problems. Before calling for technical assistance, refer to this chapter.
- The ***Appendix*** provides background information concerning the IEEE 488 bus, the serial bus, and ASCII controls.
- The ***Index*** provides a comprehensive alphabetical listing of the main terms and topics in this manual. Also, the *Abbreviations* on the last pages of this manual, provides an overall list of abbreviations, including acronyms and ASCII control codes, as an additional reference for this manual and for other related literature.

Since many of the hardware names and boards discussed in this manual appear very similar to each other, make sure you view the material which corresponds to your specific hardware board. For example, although the GP488B and GP488B/MM names are very similar, the interface boards are not identical; some material will apply to only one of these boards.

Information which may have changed since the time of printing will be found in a **`README.TXT`** file on disk, or in an addendum to the manual.

***Notes***

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# Personal488 Overview 1

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## *Hardware Products*

The family of Personal488 PC/IEEE 488 controller interfaces includes the six (6) interfaces which are discussed in this manual. All of them are IEEE 488.2 compatible and are supported by 32-bit Driver488 software for Windows 95 and for Windows NT, named Driver488/W95 and Driver488/WNT respectively. These interfaces are discussed in the following Personal488 packages:

### Personal488/PCI (with PCI488)

The PCI488 interface board features plug-and-play and 32-bit PCI local bus compatibility. Provides 1 Mbyte/s data transfer rate. Offers full IEEE 488.2 support. Supported by Windows 95 and Windows NT drivers. Provides eight (8) channels of general-purpose digital I/O.

### Personal488/ATpnp (with AT488pnp)

The AT488pnp interface board features plug-and-play and 16-bit ISA-bus compatibility. Provides 1 Mbyte/s data transfer rate. Offers full IEEE 488.2 support. Supported by Windows 95 and Windows NT drivers. Provides eight (8) channels of general-purpose digital I/O. CE compliant.

### Personal488/CARD (with CARD488)

The CARD488 interface features "hot swapping" PC Card (PCMCIA) compatibility. Provides 1 Mbyte/s data transfer rate. Offers full IEEE 488.2 support. Supported by Windows 95 and Windows NT drivers.

### Personal488/AT (with AT488)

The AT488 interface board features 16-bit ISA-bus compatibility. Provides 1 Mbyte/s data transfer rate. Offers full IEEE 488.2 support. Supported by Windows 95 and Windows NT drivers. Provides eleven (11) interrupt lines and seven (7) DMA channels. CE compliant.

### Personal488 (with GP488B)

The GP488B interface board features 8-bit ISA-bus compatibility. Provides 330 Kbyte/s data transfer rate. Offers full IEEE 488.2 support. Supported by Windows 95 and Windows NT drivers. Provides six (6) interrupt lines and three (3) DMA channels. CE compliant.

### Personal488/MM (with GP488B/MM)

The GP488B/MM interface board features a compact PC/104 form-factor. Features 8-bit PC/104 bus compliance. Provides 330 Kbyte/s data transfer rate. Offers full IEEE 488.2 support. Supported by Windows 95 & Windows NT drivers. CE compliant.

## Hardware Accessories

The available hardware accessories are listed below by part number. Refer to your product catalog for details.

### *Connector Cable*

- ***CA-7-3:*** Shielded IEEE 488 cable, 6 ft.

### *Controller Device*

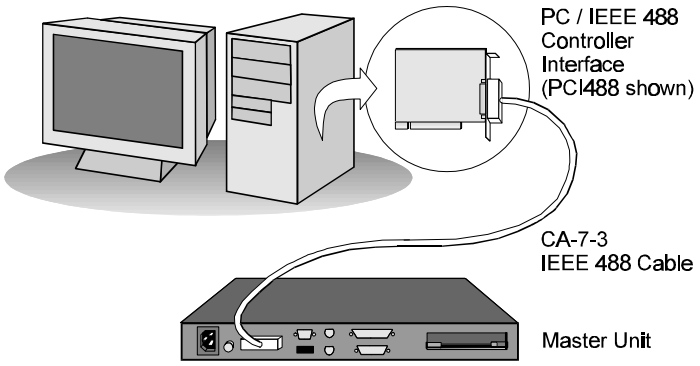
- ***IOT7210(P/T):*** IEEE 488 Controller Chip.

**Note:** These specifications are subject to change without notice.

**Name:** IOT7210 IEEE 488 Controller Chip
**Compatibility:** 100% compatible with the NEC μPD7210 chip; TTL-compatible and CMOS; 8080/85/86-compatible
**Power Consumption:** 98% less consumption than the NEC μPD7210 chip
**Power Supply:** 5 V single power supply
**Capabilities:** Programmable data transfer rate; End-Of-String (EOS) message automatic detection; automatic command processing and undefined command read capability; DMA-capable; 1-MHz to 8-MHz clock range
**Configurations:** 40-pin plastic DIP or 44-pin plastic TQFP

# *Hardware Connection*

For successful data acquisition, the Personal488 controller interface must be properly connected to a data acquisition device. The following diagram depicts an IEEE 488 connection from a Personal488 PC/IEEE 488 controller interface board to a data acquisition master unit.




*IEEE 488 Connection*
*(PC to Master Unit)*

# *Software Products*

## Driver488/W95 & Driver488/WNT

This driver software integrates IEEE 488.2 control into Windows 95 & Windows NT applications. Supports the PCI488, AT488pnp, CARD488, AT488, GP488B, and GP488B/MM controller interfaces (discussed above). Provides true multi-tasking device locking. Specifically designed for the 32-bit Windows environment. Includes interactive control application for exercising instruments.

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## *Introduction*

### The Package

The Personal488/PCI, including the IEEE 488 interface board and the Driver488 software, is carefully inspected, both mechanically and electrically, before shipment. When you receive the product, unpack all items carefully from the shipping carton and check for any obvious signs of physical damage that may have occurred during shipment. Report any such damage to the shipping agent immediately. Remember to retain all shipping materials in the event shipment back to the factory becomes necessary.

The Personal488/PCI (with PCI488) package includes:

- PCI488 "Plug-&-Play" IEEE 488 Bus Interface PCI Board
- Driver488 Software Disks for Windows 95 or Windows NT (Driver488/W95 or Driver488/WNT)
- *Personal488 User s Manual for Windows 95 and Windows NT*

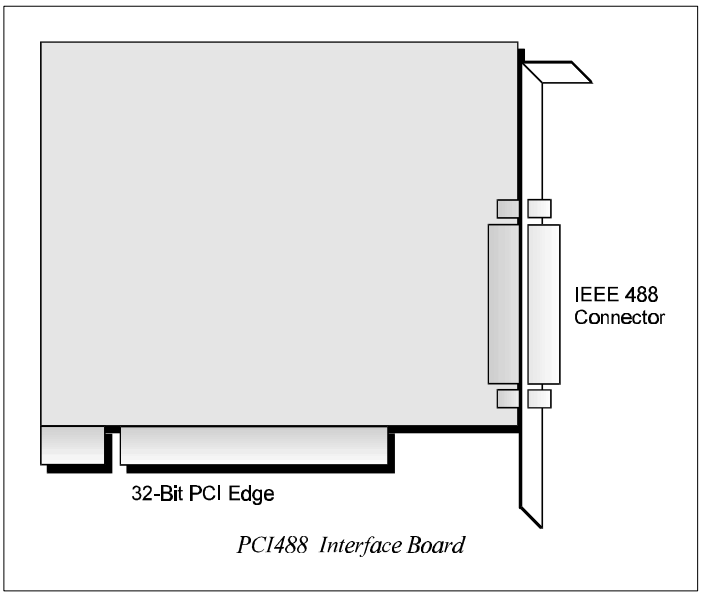
### PCI488 Specifications

**Note:** These specifications are subject to change without notice.

**IEEE 488 Controller Device:** IOT7210
**Maximum Transfer Rate:** 32-bit: 1 Mbyte/s (reads and writes)
**Dimensions:** Half-size board; occupies one PCI slot
**IEEE 488 Connector:** Accepts standard IEEE 488 connector with metric studs
**Digital I/O Connector:** Standard 9-pin female DSUB connector
**Power:** 500 mA max @ 5 V from PC
**Environment:** 0 to 70°C, 0 to 95% RH, non-condensing
**Digital I/O:** Each signal can source 2 mA @ 3.7 V (6 mA @ 3.2 V) and sink 2 mA @ 0.4 V (6 mA @ 0.9 V)
**Multiple Boards:** Up to four PCI488 boards can be installed into one PC

### Controller Interface

The PCI488 interface board provides the convenience of plug-and-play installation. The physical configuration of hardware is not necessary. Instead, after installing your board as described in the following text, the board is configured automatically.




*PCI488 Interface Board*

## Installing the New Hardware & Hardware Drivers

Typical IEEE 488 interface boards are installed into expansion slots inside the PC's system unit. Typical PCs have the following types of expansion slots

- ***ISA expansion slots.*** ISA slots can either be an 8-bit slot with one card-edge receptacle (PC-bus compatible), or a 16-bit slot with two card-edge receptacles (AT-bus compatible). Eight-bit ISA boards may be used in either the 8-bit or 16-bit ISA slot, while 16-bit ISA boards may only be used in the 16-bit ISA slot.
- ***PCI expansion slots.*** PCI slots are 32-bit slots, used only by PCI boards.

For technical assistance, see chapter *Troubleshooting* on page 119 in this manual, or the troubleshooting section in your PC's manual. If you are still not sure of the problem, contact the dealer or manufacturer of your interface board or PC.

### *Step 1: Installing the PCI488 Interface Board into a PCI Slot*

General instructions for installing the board are given since the design of computer cases varies. Refer to your PC's reference manual whenever in doubt.

1. Turn OFF the power to your computer and any other connected peripheral devices. Follow the precautions for static electricity discharge.
   - Touch a large grounded metal surface to discharge any static electricity build up in your body.
   - Avoid any contact with internal parts. Handle cards only by their edges.
   - Disconnect the AC power before removing the cover.
2. Unplug all power cords and cables that may interfere from the back of the computer.
3. Remove your computer's cover by removing its mounting screws with a screwdriver. Slide the cover OFF. If necessary, refer to your PC's manual.
4. Your IEEE 488 controller interface must be installed in a 32-bit PCI-bus expansion slot. Select an available PCI expansion slot and remove its slot cover by unscrewing the holding screw and sliding it out. Save this screw for securing the interface after it is installed.
5. To install the IEEE 488 controller interface, carefully align the card edge connector with the PCI slot on the motherboard, fitting the IEEE 488 port through the rear panel opening. Push the board down firmly, but gently, until it is well seated.

6. Replace the cover slot holding screw to secure the board in place.
7. Replace the computer's cover and screws. Then reconnect all power cords and cables to the back of the computer. If available, connect your external data acquisition instrument to the IEEE 488 port connector on the interface.
8. Turn on your PC.

At this point, the hardware installation is complete. Continue to *Step 2*.

### *Step 2: Detecting the PCI488 Interface Board in "Add New Hardware"*

1. After installing the IEEE 488 controller interface, turn on your computer. Windows will detect the new hardware and prompt for a Manufacturer's Disk.
2. Insert the disk labeled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive. Click *OK*.
3. The hardware will now be recognized and configured by Windows; the "Add New Hardware Wizard" will auto-assign an available I/O base address, IRQ (Interrupt), and DMA channel. (Additional PCI488 interfaces may share the same IRQ and DMA values.)

   Continue as prompted to load the interface driver, but DO NOT restart Windows. Select No to NOT shut down and go directly to the *Device Manager* to verify the presence of the new hardware device.

At this point, the hardware detection is complete. Continue to *Step 3*.

### *Step 3: Verifying the PCI488 Interface Installation & Driver488 Software Settings*

1. To confirm proper installation, open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers" and below it, verify the presence of the new hardware device.
2. During Driver488 installation, a new *Control Panel* applet titled "IEEE 488" was installed under the *Control Panel* with default settings selected.

   To verify or configure the Driver488 software settings for your IEEE 488 interface(s) and IEEE 488 external device(s), see chapter *Driver488/W95 & Driver488/WNT* on page 41.
3. Restart Windows and once again verify the hardware installation and Driver488 configuration in *Device Manager*.

At this point, the hardware and driver verification is complete. Continue to *Step 4*.

### *Step 4: Installing the PCI488 Interface Software Support Files*

1. Insert the disk titled "IEEE 488 Software Installation Disk, 1 of 2" into the floppy disk drive.
2. To install, you can do one of the following:
   - Select *Run* from the *Start Menu*, type in **`A:\SETUP.EXE`**, then click *OK*.
   - Go to *My Computer* or *Windows Explorer*, double-click on the *Floppy Drive* icon, then double-click on the *Setup* icon.
   - Or go to the *Control Panel* from the *Start > Settings* menu, double-click on the *Add/Remove Programs* icon, then click the *Install* button.
3. The Installation program will step you through various options on installing these software support files.

   **Note:** These files are NOT required to get the hardware to work properly, but it is recommended if any software development is desired or Help files are needed.
4. Any or all of the installed software support files may be removed by going to the *Control Panel* from the *Start > Settings* menu, double-clicking on the *Add/Remove Programs* icon, then selecting "Personal IEEE 488 v 2.0", and clicking the *Add/Remove* button.

At this point, the installation of software support files is complete.

# Updating the Existing Hardware Drivers

### Updating the PCI488 Interface Hardware Drivers

1. Insert the disk titled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive.
2. Open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers".
3. Highlight the device you want to update under "IEEE488.2 Controllers".
4. Click on the *Properties* button. Click on the *Driver* tab.
5. Highlight the driver file named "C:\Windows\System___488.vxd". (For example, "…\vpci488.vxd".)
6. Click on the *Change Driver* button.
7. Select the model that you are updating. Click *OK*.

   **Note:** DO NOT select the *Have Disk...* button.
8. Windows will return you to the *Driver* tab. Click *OK*. The hardware drivers will now be updated from the Driver Disk.
9. Windows will prompt you if you wish to restart the system. Select *Yes*. Otherwise the hardware will continue to use the outdated drivers until the next time the system is restarted.

# Personal488/ATpnp (with AT488pnp) 3

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## *Introduction*

### The Package

The Personal488/ATpnp, including the IEEE 488 interface board and the Driver488 software, is carefully inspected, both mechanically and electrically, before shipment. When you receive the product, unpack all items carefully from the shipping carton and check for any obvious signs of physical damage that may have occurred during shipment. Report any such damage to the shipping agent immediately. Remember to retain all shipping materials in the event shipment back to the factory becomes necessary.

The Personal488/ATpnp (with AT488pnp) package includes:

- AT488pnp "Plug-&-Play" IEEE 488 Bus Interface ISA Board
- Driver488 Software Disks for Windows 95 or Windows NT (Driver488/W95 or Driver488/WNT)
- *Personal488 User s Manual for Windows 95 and Windows NT*

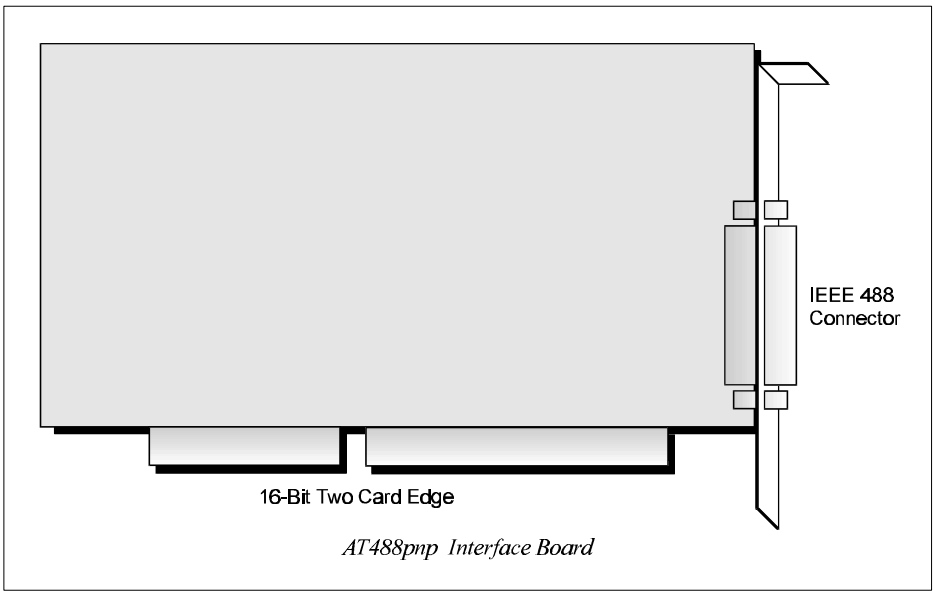
### AT488pnp Specifications

**Note:** These specifications are subject to change without notice.

**IEEE 488 Controller Device:** IOT7210
**Maximum Transfer Rates:** 16-bit DMA: 1 Mbyte/s (reads), 800 Kbyte/s (writes)
**Dimensions:** Full-size board, two card edges; occupies one ISA slot
**IEEE 488 Connector:** Accepts standard IEEE 488 connector with metric studs
**Digital I/O Connector:** Standard 9-pin female DSUB connector
**Power:** 1.0 A max @ 5 V from PC
**Environment:** 0 to 70°C, 0 to 95% RH, non-condensing
**DMA:** 16-bit DMA on channels 5, 6, and 7
**Interrupts:** IRQ 3, 4, 5, 7, 10, 11, 12, or 15
**Digital I/O:** Each signal can source 2 mA @ 3.7 V (6 mA @ 3.2 V) and sink 2 mA @ 0.4 V (6 mA @ 0.9 V)
**Multiple Boards:** Up to three AT488pnp boards can be installed into one PC

### Controller Interface

The AT488pnp interface board provides the convenience of plug-and-play installation. The physical configuration of hardware is not necessary. Instead, after installing your board as described in the following text, the board is configured automatically.




*AT488pnp Interface Board*

## Installing the New Hardware & Hardware Drivers

Typical IEEE 488 interface boards are installed into expansion slots inside the PC's system unit. Typical PCs have the following types of expansion slots

- ***ISA expansion slots.*** ISA slots can either be an 8-bit slot with one card-edge receptacle (PC-bus compatible), or a 16-bit slot with two card-edge receptacles (AT-bus compatible). Eight-bit ISA boards may be used in either the 8-bit or 16-bit ISA slot, while 16-bit ISA boards may only be used in the 16-bit ISA slot.
- ***PCI expansion slots.*** PCI slots are 32-bit slots, used only by PCI boards.

For technical assistance, see chapter *Troubleshooting* on page 119 in this manual, or the troubleshooting section in your PC's manual. If you are still not sure of the problem, contact the dealer or manufacturer of your interface board or PC.

### Step 1: Installing the AT488pnp Interface Board into an ISA Slot

General instructions for installing the board are given since the design of computer cases varies. Refer to your PC's reference manual whenever in doubt.

1. Turn OFF the power to your computer and any other connected peripheral devices. Follow the precautions for static electricity discharge.
   - Touch a large grounded metal surface to discharge any static electricity build up in your body.
   - Avoid any contact with internal parts. Handle cards only by their edges.
   - Disconnect the AC power before removing the cover.
2. Unplug all power cords and cables that may interfere from the back of the computer.
3. Remove your computer's cover by removing its mounting screws with a screwdriver. Slide the cover OFF. If necessary, refer to your PC's manual.
4. Your IEEE 488 controller interface must be installed in a 16-bit ISA-bus expansion slot. Select an available ISA expansion slot and remove its slot cover by unscrewing the holding screw and sliding it out. Save this screw for securing the interface after it is installed.
5. To install the IEEE 488 controller interface, carefully align the card edge connector with the ISA slot on the motherboard, fitting the IEEE 488 port through the rear panel opening. Push the board down firmly, but gently, until it is well seated.

6. Replace the cover slot holding screw to secure the board in place.
7. Replace the computer's cover and screws. Then reconnect all power cords and cables to the back of the computer. If available, connect your external data acquisition instrument to the IEEE 488 port connector on the interface.
8. Turn on your PC.

At this point, the hardware installation is complete. Continue to *Step 2*.

### *Step 2: Detecting the AT488pnp Interface Board in "Add New Hardware"*

1. After installing the IEEE 488 controller interface, turn on your computer. Windows will detect the new hardware and prompt for a Manufacturer's Disk.
2. Insert the disk labeled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive. Click *OK*.
3. The hardware will now be recognized and configured by Windows; the "Add New Hardware Wizard" will auto-assign an available I/O base address, IRQ (Interrupt), and DMA channel. (Additional AT488pnp interfaces may share the same IRQ and DMA values.)

   Continue as prompted to load the interface driver, but DO NOT restart Windows. Select No to NOT shut down and go directly to the *Device Manager* to verify the presence of the new hardware device.

At this point, the hardware detection is complete. Continue to *Step 3*.

### *Step 3: Verifying the AT488pnp Interface Installation & Driver488 Software Settings*

1. To confirm proper installation, open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers" and below it, verify the presence of the new hardware device.
2. During Driver488 installation, a new *Control Panel* applet titled "IEEE 488" was installed under the *Control Panel* with default settings selected.

   To verify or configure the Driver488 software settings for your IEEE 488 interface(s) and IEEE 488 external device(s), see chapter *Driver488/W95 & Driver488/WNT* on page 41.
3. Restart Windows and once again verify the hardware installation and Driver488 configuration in *Device Manager*.

At this point, the hardware and driver verification is complete. Continue to *Step 4*.

### *Step 4: Installing the AT488pnp Interface Software Support Files*

1. Insert the disk titled "IEEE 488 Software Installation Disk, 1 of 2" into the floppy disk drive.
2. To install, you can do one of the following:
   - Select *Run* from the *Start Menu*, type in **`A:\SETUP.EXE`**, then click *OK*.
   - Go to *My Computer* or *Windows Explorer*, double-click on the *Floppy Drive* icon, then double-click on the *Setup* icon.
   - Or go to the *Control Panel* from the *Start > Settings* menu, double-click on the *Add/Remove Programs* icon, then click the *Install* button.
3. The Installation program will step you through various options on installing these software support files.

   **Note:** These files are NOT required to get the hardware to work properly, but it is recommended if any software development is desired or Help files are needed.
4. Any or all of the installed software support files may be removed by going to the *Control Panel* from the *Start > Settings* menu, double-clicking on the *Add/Remove Programs* icon, then selecting "Personal IEEE 488 v 2.0", and clicking the *Add/Remove* button.

At this point, the installation of software support files is complete.

# Updating the Existing Hardware Drivers

### Updating the AT488pnp Interface Hardware Drivers

1. Insert the disk titled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive.
2. Open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers".
3. Highlight the device you want to update under "IEEE488.2 Controllers".
4. Click on the *Properties* button. Click on the *Driver* tab.
5. Highlight the driver file named "C:\Windows\System___488.vxd". (For example, "…\vpci488.vxd".)
6. Click on the *Change Driver* button.
7. Select the model that you are updating. Click *OK*.

   **Note:** DO NOT select the *Have Disk...* button.
8. Windows will return you to the *Driver* tab. Click *OK*. The hardware drivers will now be updated from the Driver Disk.
9. Windows will prompt you if you wish to restart the system. Select *Yes*. Otherwise the hardware will continue to use the outdated drivers until the next time the system is restarted.

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## *Introduction*

### The Package

The Personal488/CARD, including the IEEE 488 interface PC Card and the Driver488 software, is carefully inspected, both mechanically and electrically, before shipment. When you receive the product, unpack all items carefully from the shipping carton and check for any obvious signs of physical damage that may have occurred during shipment. Report any such damage to the shipping agent immediately. Remember to retain all shipping materials in the event shipment back to the factory becomes necessary.

The Personal488/CARD (with CARD488) package includes:

- CARD488 "Plug-&-Play" IEEE 488 Bus Interface PC Card
- Driver488 Software Disks for Windows 95 or Windows NT (Driver488/W95 or Driver488/WNT)
- *Personal488 User s Manual for Windows 95 and Windows NT*

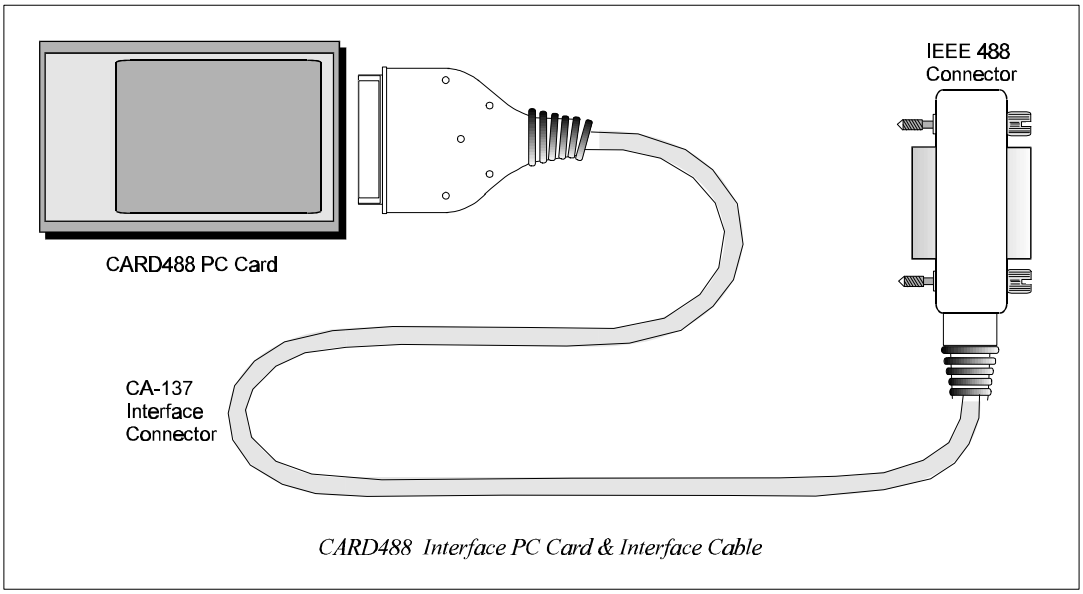
### CARD488 Specifications

**Note:** These specifications are subject to change without notice.

**IEEE 488 Controller Device:** IOT7210
**Maximum Transfer Rate:** 1 Mbyte/s (reads and writes)
**Dimensions:** Type II (5 mm) PCMCIA card
**Bus Interface:** PCMCIA PC Card Standard 2.1
**IEEE 488 Connector:** Accepts standard IEEE 488 connector with metric studs via custom cable
**Cable:** PCMCIA to IEEE 488, CA-137 (included)

### Controller Interface

The CARD488 interface PC Card provides the convenience of plug-and-play installation. The physical configuration of hardware is not necessary. Instead, after installing your PC Card as described in the following text, the interface is configured automatically.




*CARD488 Interface PC Card & Interface Cable*

## Installing the New Hardware & Hardware Drivers

Unlike typical IEEE 488 interface boards which are installed into expansion slots inside the PC's system unit, the CARD488 PC Card interface is installed into the PC Card slot of the computer. The computer does not need to be turned off.

For technical assistance, see chapter *Troubleshooting* on page 119 in this manual, or the troubleshooting section in your PC's manual. If you are still not sure of the problem, contact the dealer or manufacturer of your interface board or PC.

### Step 1: Installing the CARD488 Interface into a PC Card Slot

Refer to your PC's reference manual whenever in doubt.

1. Install the IEEE 488 controller interface into the PC Card slot of the computer. The computer does not need to be turned off.

   **Note:** It is assumed the user has a properly installed PC Card adapter in the computer.

At this point, the hardware installation is complete. Continue to *Step 2*.

### Step 2: Detecting the CARD488 Interface in "Add New Hardware"

1. After installing the IEEE 488 controller interface, turn on your computer. Windows will detect the new hardware and prompt for a Manufacturer's Disk.
2. Insert the disk labeled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive. Click *OK*.
3. The hardware will now be recognized and configured by Windows; the "Add New Hardware Wizard" will auto-assign an available I/O base address, IRQ (Interrupt), and DMA channel. (Additional CARD488 interfaces may share the same IRQ and DMA values.)

   Continue as prompted to load the interface driver, but DO NOT restart Windows. Select No to NOT shut down and go directly to the *Device Manager* to verify the presence of the new hardware device.

At this point, the hardware detection is complete. Continue to *Step 3*.

### *Step 3: Verifying the CARD488 Interface Installation & Driver488 Software Settings*

1. To confirm proper installation, open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers" and below it, verify the presence of the new hardware device.
2. During Driver488 installation, a new *Control Panel* applet titled "IEEE 488" was installed under the *Control Panel* with default settings selected.

   To verify or configure the Driver488 software settings for your IEEE 488 interface(s) and IEEE 488 external device(s), see chapter *Driver488/W95 & Driver488/WNT* on page 41.
3. Restart Windows and once again verify the hardware installation and Driver488 configuration in *Device Manager*.

At this point, the hardware and driver verification is complete. Continue to *Step 4*.

### *Step 4: Installing the CARD488 Interface Software Support Files*

1. Insert the disk titled "IEEE 488 Software Installation Disk, 1 of 2" into the floppy disk drive.
2. To install, you can do one of the following:
   - Select *Run* from the *Start Menu*, type in **`A:\SETUP.EXE`**, then click *OK*.
   - Go to *My Computer* or *Windows Explorer*, double-click on the *Floppy Drive* icon, then double-click on the *Setup* icon.
   - Or go to the *Control Panel* from the *Start > Settings* menu, double-click on the *Add/Remove Programs* icon, then click the *Install* button.
3. The Installation program will step you through various options on installing these software support files.

   **Note:** These files are NOT required to get the hardware to work properly, but it is recommended if any software development is desired or Help files are needed.
4. Any or all of the installed software support files may be removed by going to the *Control Panel* from the *Start > Settings* menu, double-clicking on the *Add/Remove Programs* icon, then selecting "Personal IEEE 488 v 2.0", and clicking the *Add/Remove* button.

At this point, the installation of software support files is complete.

# Updating the Existing Hardware Drivers

### Updating the 32-Bit Personal488/CARD Hardware Drivers

1. Insert the disk titled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive.
2. Open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers".
3. Highlight the device you want to update under "IEEE488.2 Controllers".
4. Click on the *Properties* button. Click on the *Driver* tab.
5. Highlight the driver file named "C:\Windows\System___488.vxd". (For example, "…\vpci488.vxd".)
6. Click on the *Change Driver* button.
7. Select the model that you are updating. Click *OK*.

   **Note:** DO NOT select the *Have Disk...* button.
8. Windows will return you to the *Driver* tab. Click *OK*. The hardware drivers will now be updated from the Driver Disk.
9. Windows will prompt you if you wish to restart the system. Select *Yes*. Otherwise the hardware will continue to use the outdated drivers until the next time the system is restarted.

### Updating the 16-Bit Personal488/CARD Installation

1. If an older 16-bit installation for the Personal488/CARD (with CARD488) was done in Windows 95/NT, then the following steps must be taken. This older installation is identified by the device description "*IEP-488* Personal488/CARD".

   **Note:** The 32-bit installation, which does not require the following steps, is identified by the device description “Personal488/CARD”. To update the 32-bit driver, follow the directions under the previous section *Updating the 32-Bit Personal488/CARD Hardware Drivers.*
2. To find this device description "*IEP-488* Personal488/CARD", open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. (The CARD488 should already have been installed and inserted in the computer).
3. Remove the CARD488 from the computer.
4. Insert the disk labeled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive.
5. To run the file **`CLEANCRD.BAT`** found on the "Driver Disk", you can do one of the following:
   - Go to *My Computer* or *Windows Explorer*, double-click on the *Floppy Drive* icon, then double-click on the **`CLEANCRD.BAT`** icon.
   - Select the MS-DOS prompt from the *Start Menu* to open the MS-DOS command window, type in **`A:\CLEANCRD.BAT`** and press the **`<Enter>`** key.
6. Once the **`CLEANCRD.BAT`** program has finished, re-insert the CARD488 into the computer.
7. Windows will detect the new hardware and prompt for a Manufacturer’s Disk. With the disk labeled “Driver488 Driver Disk, 1 of 1” still in the floppy disk drive, click *OK*.
8. The hardware will now be recognized and configured by Windows. To confirm proper installation, open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers" with the new hardware device below it.
9. A new *Control Panel* applet titled "IEEE 488" will exist under the *Control Panel* with default settings installed. Refer to the Help documents on changing these settings.

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## *Introduction*

### The Package

The Personal488/AT, including the IEEE 488 interface board and the Driver488 software, is carefully inspected, both physically and electronically, before shipment. When you receive the product, unpack all items carefully from the shipping carton and check for any obvious signs of physical damage that may have occurred during shipment. Report any such damage to the shipping agent immediately. Remember to retain all shipping materials in the event shipment back to the factory becomes necessary.

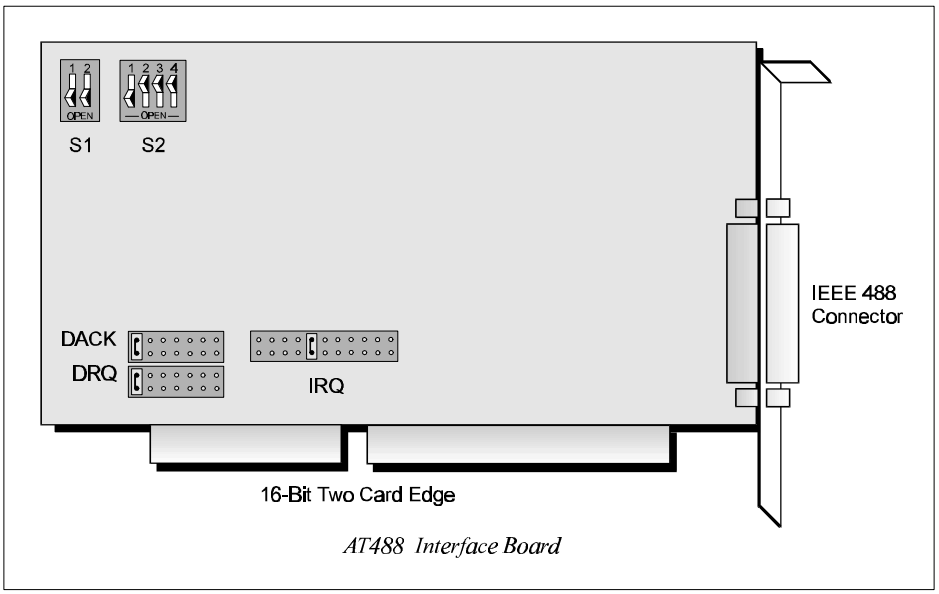
The Personal488/AT (with AT488) package includes:

- AT488 IEEE 488 Bus Interface ISA Board
- Driver488 Software Disks for Windows 95 or Windows NT (Driver488/W95 or Driver488/WNT)
- *Personal488 User s Manual for Windows 95 and Windows NT*

### AT488 Specifications

**Note:** These specifications are subject to change without notice.

**IEEE 488 Controller Device:** IOT7210
**Maximum Transfer Rates:** 16-bit DMA: 1 Mbyte/s (reads), 800 Kbyte/s (writes); 8-bit DMA: 330 Kbyte/s (reads), 220 Kbyte/s (writes)
**Dimensions:** Full-size board, two card edges; occupies one ISA slot
**IEEE 488 Connector:** Accepts standard IEEE 488 connector with metric studs
**Power:** 1.0 A max @ 5 V from PC
**Environment:** 0 to 70°C, 0 to 95% RH, non-condensing
**DMA:** 16-bit DMA on channels 5, 6, and 7; 8-bit DMA on channels 0, 1, 2, and 3 (jumper selectable)
**Interrupts:** IRQ 2, 3, 4, 5, 6, or 7 (8-bit slot); IRQ 3-7, 9-12, 14, or 15 (16-bit slot)
**IEEE 488 I/O Base Address:** **`&H02E1`**, **`&H22E1`**, **`&H42E1`**, or **`&H62E1`**
**Multiple Boards:** Up to four AT488 boards can be installed, sharing a single DMA channel and interrupt line




*AT488 Interface Board*

## Configuring the New Hardware

The following text will guide you through the setup of your IEEE 488 controller interface. It includes instructions on how to verify the resource settings of ports in your system, and how to properly configure the switches/jumpers on your interface board.

To avoid a configuration conflict, you must first verify which I/O addresses, IRQs, and DMAs are being used by existing ports in your system, prior to configuring and installing the IEEE 488 controller interface.

### Step 1: Verifying/Recording the Current System Settings

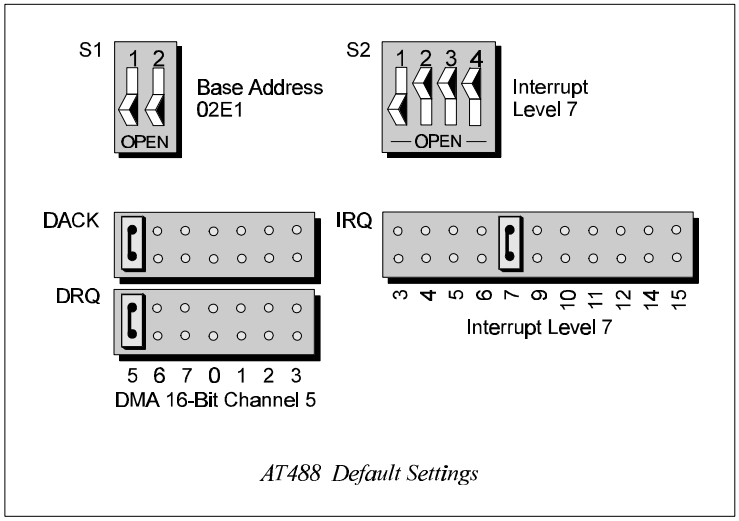
The Windows *Control Panel* enables you to easily determine and configure the I/O addresses, IRQ setting, and DMA settings in your system for proper operation. Perform the following steps to verify your system settings.

1. Open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Under the line "Ports (COM & LPT)", look for a list of used ports. For each port, highlight the port and click on the *Properties* button.
2. Properties already being used in the system are displayed under the *Resources* tab. Values NOT listed are available.
    - For each listed port, record which Input/Output (I/O) address, if any, is being used.
    - For each listed port, record which Interrupt Request (IRQ) value, if any, is being used.
    - For each listed port, record which Direct Memory Access (DMA) value, if any, is being used.
3. Exit Windows and turn the system OFF.

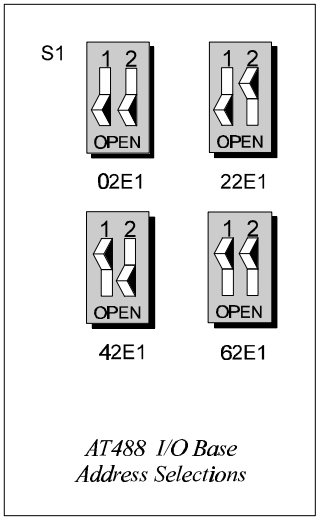
The I/O base address, IRQ, and DMA settings are switch/jumper selectable via the following locations on the AT488 interface board: One 2-microswitch DIP switch labelled S1, one 4-microswitch DIP switch labelled S2, two 14-pin headers labelled DACK and DRQ, and one 22-pin header labelled IRQ. The DIP switch settings, and the arrangement of the jumpers on the headers set the hardware configuration.

For the next steps, make sure that the I/O address, IRQ, and DMA, set on the interface board are different from any existing ports in your system. A conflict results when two I/O addresses, IRQs, or DMAs are the same. (As the exception, additional AT488 interfaces may share the same IRQ and DMA values.) If there is a conflict, perform the following steps to select new switch/jumper settings.

### *Step 2: Configuring the AT488 Interface I/O Base Address*




*AT488 Default Settings*




*AT488 I/O Base Address Selections*

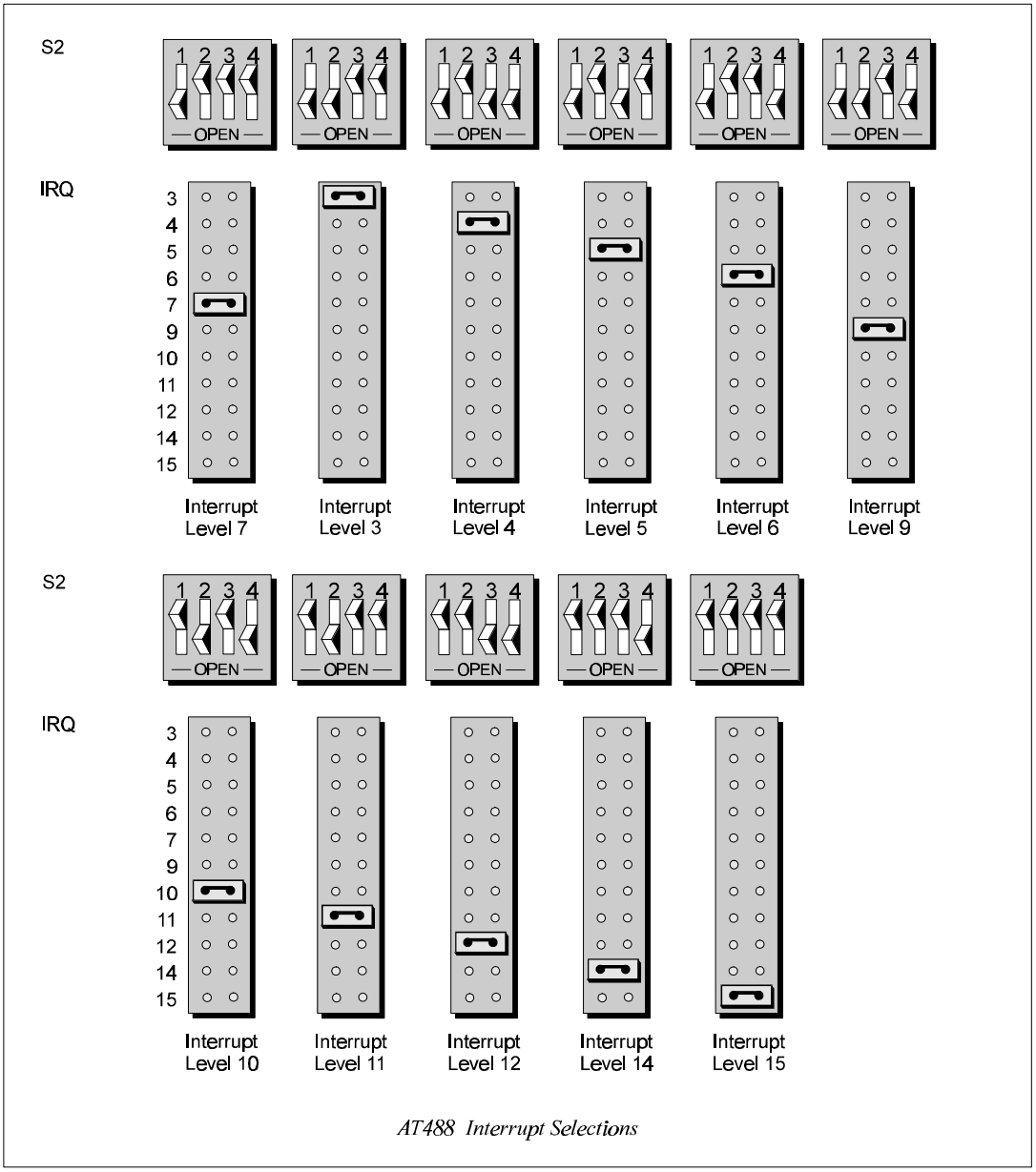
1. The factory default I/O base address is **02E1**. If this creates a conflict, reset switch S1 according to the figure and following table. The register addresses will be automatically relocated at fixed offsets from the base address.
2. If reset, record the new Input/Output (I/O) address being used.

| Selected I/O Base Address | | | | Register | |
|---|---|---|---|---|---|
| **02E1** | **22E1** | **42E1** | **62E1** | | |
| **Automatic Offset Addresses** | | | | **Read Register** | **Write Register** |
| **02E1** | **22E1** | **42E1** | **62E1** | Data In | Data Out |
| **06E1** | **26E1** | **46E1** | **66E1** | Interrupt Status 1 | Interrupt Mask 1 |
| **0AE1** | **2AE1** | **4AE1** | **6AE1** | Interrupt Status 2 | Interrupt Mask 2 |
| **0EE1** | **2EE1** | **4EE1** | **6EE1** | Serial Poll Status | Serial Poll Mode |
| **12E1** | **32E1** | **52E1** | **72E1** | Address Status | Address Mode |
| **16E1** | **36E1** | **56E1** | **76E1** | CMD Pass Through | Auxiliary Mode |
| **1AE1** | **3AE1** | **5AE1** | **7AE1** | Address 0 | Address 0/1 |
| **1EE1** | **3EE1** | **5EE1** | **7EE1** | Address 1 | End of String |

The I/O base address sets the addresses used by the computer to communicate with the IEEE 488 interface hardware on the board. The address is normally specified in hexadecimal and can be **02E1**, **22E1**, **42E1**, or **62E1**. The registers of the IOT7210 IEEE 488 controller chip and other auxiliary registers are then located at fixed offsets from the base address.

Most versions of Driver488 are capable of managing as many as four IEEE 488 interfaces. To do so, the interface configurations must be arranged to avoid conflict among themselves. No two boards may have the same I/O address; but they may, and usually should, have the same DMA channel and interrupt level.

### *Step 3: Configuring the AT488 Interface Interrupt (IRQ)*



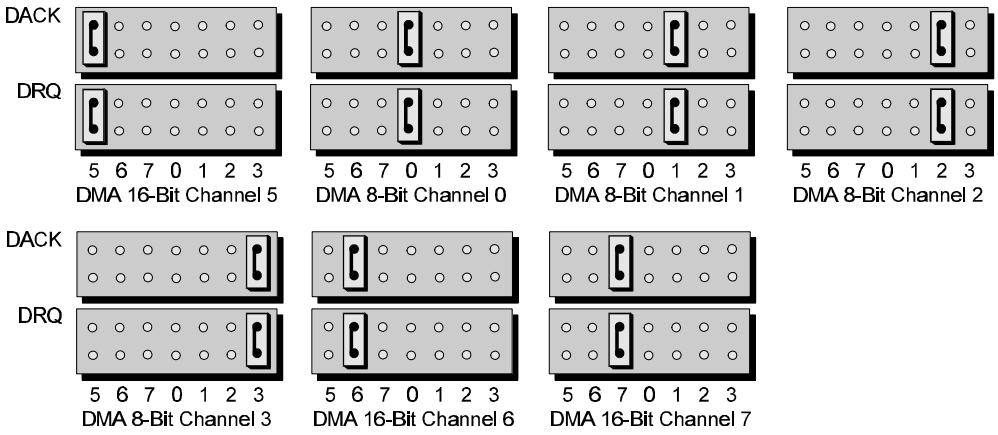

*AT488 Interrupt Selections*

1. The factory default Interrupt (IRQ) is 7. If this creates a conflict, reset switch S2 and jumper IRQ according to the figure. The switch and jumper settings must both indicate the same interrupt level for correct operation with interrupts.
2. If reset, record the new Interrupt (IRQ) being used.

The AT488 interface board may be set to interrupt the PC on the occurrence of certain hardware conditions. The main board interrupt may be set to IRQ level 3 through 7, 9 through 12, 14, or 15. Interrupts 10 through 15 are only available in a 16-bit slot on an AT-class machine. Interrupt 9 becomes synonymous with Interrupt 2 when used in a PC/XT bus.

The selected interrupt may be shared among several AT488s in the same PC/AT chassis. The AT488 adheres to the "AT-style" interrupt sharing conventions. When the AT488 requires service, the IRQ jumper determines which PC interrupt level is triggered. When an interrupt occurs, the interrupting device must be reset by writing to an I/O address which is different for each interrupt level. The switch settings determine the I/O address to which the board's interrupt rearm circuitry responds.

### *Step 4: Configuring the AT488 Interface DMA Channel*




*AT488 DMA Channel Selections*

1. The factory default DMA channel is 5. If this creates a conflict, reset jumpers DACK and DRQ according to the figure. Both the DRQ and DACK jumpers must be set to the desired DMA channel for proper operation.
2. If reset, record the new DMA channel being used.

Direct Memory Access (DMA) is a high-speed method of transferring data from or to a peripheral, such as a digitizing oscilloscope, to or from the PC's memory. The AT class machine has seven DMA channels. Channels 0 to 3 (8-bit), 5, 6, and 7 (16-bit) are available only in a 16-bit slot on a PC/AT-class machine. Channel 2 is usually used by the floppy disk controller, and is unavailable. Channel 3 is often used by the hard disk controller in PCs, XTs, and the PS/2 with the ISA bus, but is usually not used in ATs. Channels 5 to 7 are 16-bit DMA channels and offer the highest throughput (up to 1 Megabyte per second). Channels 0 to 3 are 8-bit DMA channels and although slower, they offer compatibility with existing GP488B applications that only made use of 8-bit DMA channels. Under some rare conditions, it is possible for high-speed transfers on DMA Channel 1 to demand so much of the available bus bandwidth that simultaneous access of a floppy controller will be starved for data due to the relative priorities of the two channels.

## Installing the New Hardware & Hardware Drivers

Typical IEEE 488 interface boards are installed into expansion slots inside the PC's system unit. Typical PCs have the following types of expansion slots

- ***ISA expansion slots.*** ISA slots can either be an 8-bit slot with one card-edge receptacle (PC-bus compatible), or a 16-bit slot with two card-edge receptacles (AT-bus compatible). Eight-bit ISA boards may be used in either the 8-bit or 16-bit ISA slot, while 16-bit ISA boards may only be used in the 16-bit ISA slot.
- ***PCI expansion slots.*** PCI slots are 32-bit slots, used only by PCI boards.

For technical assistance, see chapter *Troubleshooting* on page 119 in this manual, or the troubleshooting section in your PC's manual. If you are still not sure of the problem, contact the dealer or manufacturer of your interface board or PC.

### Step 1: Installing the AT488 Interface Board into an ISA Slot

General instructions for installing the board are given since the design of computer cases varies. Refer to your PC's reference manual whenever in doubt.

1. Turn OFF the power to your computer and any other connected peripheral devices. Follow the precautions for static electricity discharge.
   - Touch a large grounded metal surface to discharge any static electricity build up in your body.
   - Avoid any contact with internal parts. Handle cards only by their edges.
   - Disconnect the AC power before removing the cover.
2. Unplug all power cords and cables that may interfere from the back of the computer.
3. Remove your computer's cover by removing its mounting screws with a screwdriver. Slide the cover OFF. If necessary, refer to your PC's manual.
4. Your IEEE 488 controller interface must be installed in a 16-bit ISA-bus expansion slot. Select an available ISA expansion slot and remove its slot cover by unscrewing the holding screw and sliding it out. Save this screw for securing the interface after it is installed.
5. To install the IEEE 488 controller interface, carefully align the card edge connector with the ISA slot on the motherboard, fitting the IEEE 488 port through the rear panel opening. Push the board down firmly, but gently, until it is well seated.
6. Replace the cover slot holding screw to secure the board in place.
7. Replace the computer's cover and screws. Then reconnect all power cords and cables to the back of the computer. If available, connect your external data acquisition instrument to the IEEE 488 port connector on the interface.
8. Turn on your PC.

At this point, the hardware installation is complete. Continue to *Step 2*.

### Step 2: Detecting the AT488 Interface Board in "Add New Hardware"

1. After installing the IEEE 488 controller interface, turn on your computer. Windows will detect the new hardware and prompt for a Manufacturer's Disk.
2. Insert the disk labeled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive. Click *OK*.
3. The hardware will now be recognized by Windows; the "Add New Hardware Wizard" will assign the available I/O base address, IRQ (Interrupt), and DMA channel, which were configured earlier. (Additional AT488 interfaces may use the same IRQ and DMA values.)

   Continue as prompted to load the interface driver, but DO NOT restart Windows. Select No to NOT shut down and go directly to the *Device Manager* to verify the presence of the new hardware device.

At this point, the hardware detection is complete. Continue to *Step 3*.

### *Step 3: Verifying the AT488 Interface Installation & Driver488 Software Settings*

1. To confirm proper installation, open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers" and below it, verify the presence of the new hardware device.
2. During Driver488 installation, a new *Control Panel* applet titled "IEEE 488" was installed under the *Control Panel* with default settings selected.

   To verify or configure the Driver488 software settings for your IEEE 488 interface(s) and IEEE 488 external device(s), see chapter *Driver488/W95 & Driver488/WNT* on page 41.

   - When the I/O base address, IRQ (Interrupt), and DMA channel settings match the jumpered board, select OK and restart Windows below.
   - If any of these settings do not match, manually reset each value. When all of the settings are correct, select OK and restart Windows below.
3. Restart Windows and once again verify the hardware installation and Driver488 configuration in *Device Manager*.

At this point, the hardware and driver verification is complete. Continue to *Step 4*.

### *Step 4: Installing the AT488 Interface Software Support Files*

1. Insert the disk titled "IEEE 488 Software Installation Disk, 1 of 2" into the floppy disk drive.
2. To install, you can do one of the following:
   - Select *Run* from the *Start Menu*, type in **A:\SETUP.EXE**, then click *OK*.
   - Go to *My Computer* or *Windows Explorer*, double-click on the *Floppy Drive* icon, then double-click on the *Setup* icon.
   - Or go to the *Control Panel* from the *Start > Settings* menu, double-click on the *Add/Remove Programs* icon, then click the *Install* button.
3. The Installation program will step you through various options on installing these software support files.

   **Note:** These files are NOT required to get the hardware to work properly, but it is recommended if any software development is desired or Help files are needed.
4. Any or all of the installed software support files may be removed by going to the *Control Panel* from the *Start > Settings* menu, double-clicking on the *Add/Remove Programs* icon, then selecting "Personal IEEE 488 v 2.0", and clicking the *Add/Remove* button.

At this point, the installation of software support files is complete.

# Updating the Existing Hardware Drivers

### Updating the AT488 Interface Hardware Drivers

1. Insert the disk titled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive.
2. Open the *Control Panel* window from the *Start* > *Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers".
3. Highlight the device you want to update under "IEEE488.2 Controllers".
4. Click on the *Properties* button. Click on the *Driver* tab.
5. Highlight the driver file named "C:\Windows\System___488.vxd". (For example, "…\vpci488.vxd".)
6. Click on the *Change Driver* button.
7. Select the model that you are updating. Click *OK*.

   **Note:** DO NOT select the *Have Disk...* button.
8. Windows will return you to the *Driver* tab. Click *OK*. The hardware drivers will now be updated from the Driver Disk.
9. Windows will prompt you if you wish to restart the system. Select *Yes*. Otherwise the hardware will continue to use the outdated drivers until the next time the system is restarted.

# Personal488 (with GP488B) 6

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## *Introduction*

### The Package

The Personal488, including the IEEE 488 interface board and the Driver488 software, is carefully inspected, both mechanically and electrically, before shipment. When you receive the product, unpack all items carefully from the shipping carton and check for any obvious signs of physical damage that may have occurred during shipment. Report any such damage to the shipping agent immediately. Remember to retain all shipping materials in the event shipment back to the factory becomes necessary.

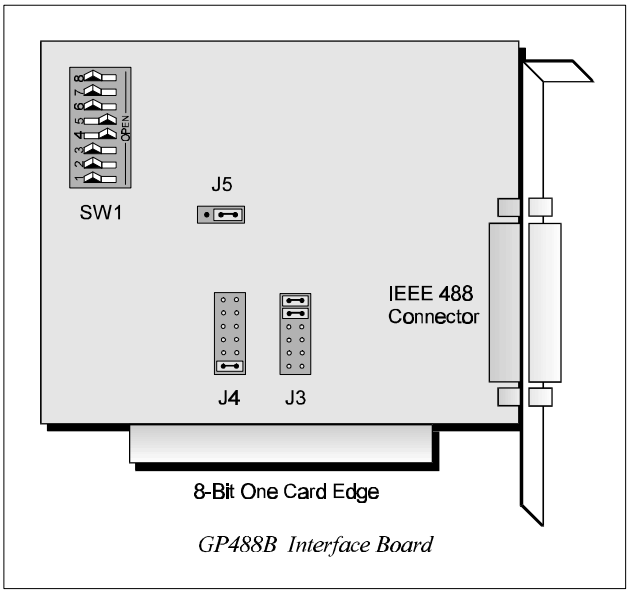
The Personal488 (with GP488B) package includes:

- GP488B IEEE 488 Bus Interface ISA Board
- Driver488 Software Disks for Windows 95 or Windows NT (Driver488/W95 or Driver488/WNT)
- *Personal488 User s Manual for Windows 95 and Windows NT*

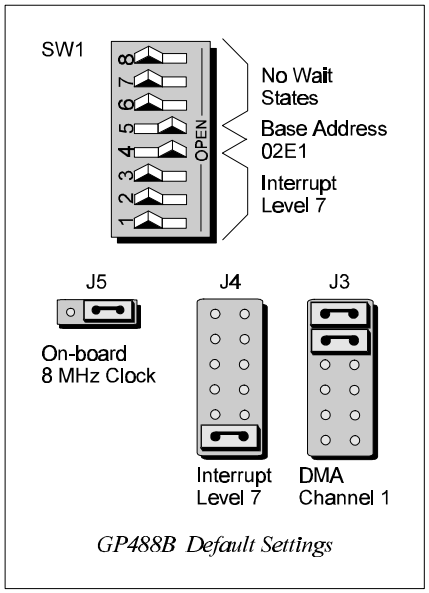
### GP488B Specifications

**Note:** These specifications are subject to change without notice.

**IEEE 488 Controller Device:** IOT7210
**Maximum Transfer Rate:** 8-bit DMA: 330 Kbyte/s (reads and writes)
**Dimensions:** Half-size board, one card edge; occupies one ISA slot
**IEEE 488 Connector:** Accepts standard IEEE 488 connector with metric studs
**Power:** 650 mA max @ 5 V from PC
**Environment:** 0 to 70°C, 0 to 95% RH, non-condensing
**DMA:** 8-bit DMA on channels 0, 1, 2, and 3 (jumper selectable)
**Interrupts:** IRQ 2, 3, 4, 5, 6, or 7
**IEEE 488 I/O Base Address:** **`&H02E1`**, **`&H22E1`**, **`&H42E1`**, or **`&H62E1`**
**Multiple Boards:** Up to four GP488B boards can be installed, sharing a single DMA channel and interrupt line




*GP488B Interface Board*




*GP488B Default Settings*

## *Configuring the New Hardware*

The following text will guide you through the setup of your IEEE 488 controller interface. It includes instructions on how to verify the resource settings of ports in your system, and how to properly configure the switches/jumpers on your interface board.

To avoid a configuration conflict, you must first verify which I/O addresses, IRQs, and DMAs are being used by existing ports in your system, prior to configuring and installing the IEEE 488 controller interface.

### *Step 1: Verifying/Recording the Current System Settings*

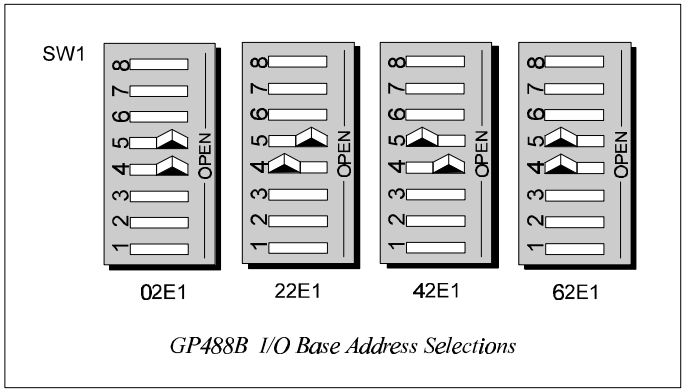
The Windows *Control Panel* enables you to easily determine and configure the I/O addresses, IRQ setting, and DMA settings in your system for proper operation. Perform the following steps to verify your system settings.

1. Open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Under the line "Ports (COM & LPT)", look for a list of used ports. For each port, highlight the port and click on the *Properties* button.
2. Properties already being used in the system are displayed under the *Resources* tab. Values NOT listed are available.
   - For each listed port, record which Input/Output (I/O) address, if any, is being used.
   - For each listed port, record which Interrupt Request (IRQ) value, if any, is being used.
   - For each listed port, record which Direct Memory Access (DMA) value, if any, is being used.
3. Exit Windows and turn the system OFF.

The I/O base address, IRQ, and DMA settings are switch/jumper selectable via the following locations on the GP488B interface board: One 8-microswitch DIP switch labelled SW1, two 12-pin headers labelled J3 and J4, and one 3-pin header labelled J5. The DIP switch settings, and the arrangement of the jumpers on the headers set the hardware configuration.

For the next steps, make sure that the I/O address, IRQ, and DMA, set on the interface board are different from any existing ports in your system. A conflict results when two I/O addresses, IRQs, or DMAs are the same. (As the exception, additional GP488B interfaces may share the same IRQ and DMA values.) If there is a conflict, perform the following steps to select new switch/jumper settings.

### *Step 2: Configuring the GP488B Interface I/O Base Address*




*GP488B I/O Base Address Selections*

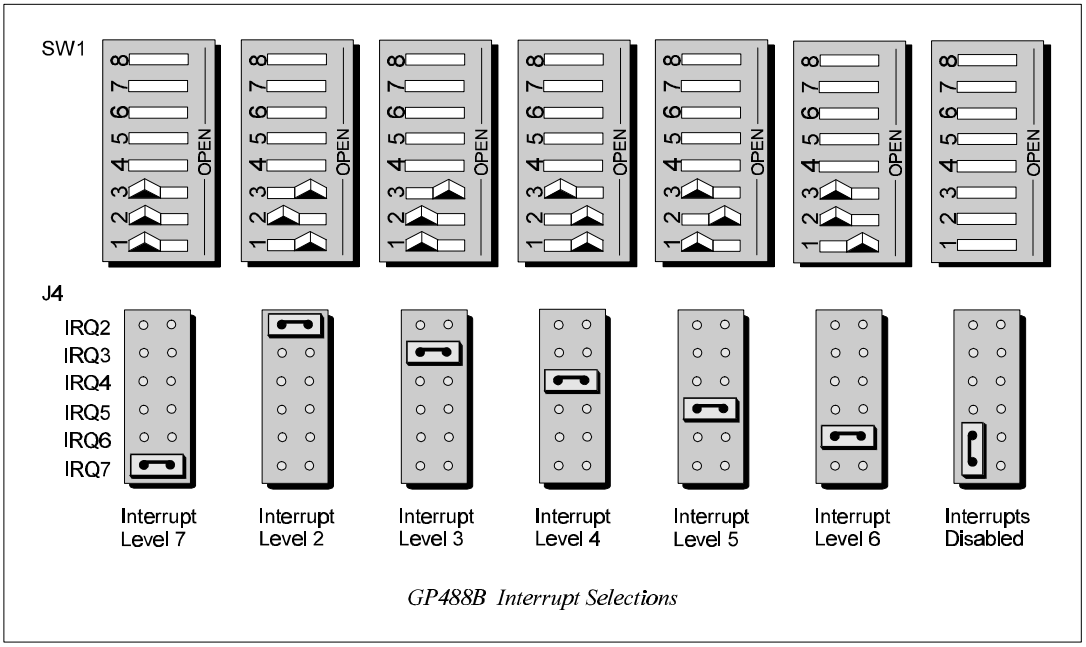
1. The factory default I/O base address is **02E1**. If this creates a conflict, reset SW1 microswitches 4 and 5 according to the figure and following table. The register addresses will be automatically relocated at fixed offsets from the base address.
2. If reset, record the new Input/Output (I/O) address being used.

| Selected I/O Base Address | | | | Register | |
|---|---|---|---|---|---|
| **02E1** | **22E1** | **42E1** | **62E1** | | |
| **Automatic Offset Addresses** | | | | **Read Register** | **Write Register** |
| **02E1** | **22E1** | **42E1** | **62E1** | Data In | Data Out |
| **06E1** | **26E1** | **46E1** | **66E1** | Interrupt Status 1 | Interrupt Mask 1 |
| **0AE1** | **2AE1** | **4AE1** | **6AE1** | Interrupt Status 2 | Interrupt Mask 2 |
| **0EE1** | **2EE1** | **4EE1** | **6EE1** | Serial Poll Status | Serial Poll Mode |
| **12E1** | **32E1** | **52E1** | **72E1** | Address Status | Address Mode |
| **16E1** | **36E1** | **56E1** | **76E1** | CMD Pass Through | Auxiliary Mode |
| **1AE1** | **3AE1** | **5AE1** | **7AE1** | Address 0 | Address 0/1 |
| **1EE1** | **3EE1** | **5EE1** | **7EE1** | Address 1 | End of String |

The I/O base address sets the addresses used by the computer to communicate with the IEEE 488 interface hardware on the board. The address is normally specified in hexadecimal and can be **02E1**, **22E1**, **42E1**, or **62E1**. The registers of the IOT7210 IEEE 488 controller chip and other auxiliary registers are then located at fixed offsets from the base address.

Most versions of Driver488 are capable of managing as many as four IEEE 488 interfaces. To do so, the interface configurations must be arranged to avoid conflict among themselves. No two boards may have the same I/O address; but they may, and usually should, have the same DMA channel and interrupt level.

### *Step 3: Configuring the GP488B Interface Interrupt (IRQ)*

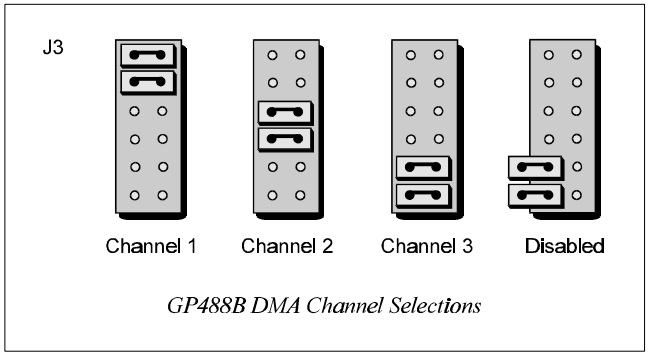



*GP488B Interrupt Selections*

1. The factory default Interrupt (IRQ) is 7. If this creates a conflict, reset SW1 microswitches 1, 2, and 3, and jumper J4 according to the figure. The switch and jumper settings must both indicate the same interrupt level for correct operation with interrupts.
2. If reset, record the new Interrupt (IRQ) being used.

The GP488B interface board may be set to interrupt the PC on the occurrence of certain hardware conditions. The level of the interrupt generated is set by J4. The GP488B adheres to the "AT-style" interrupt sharing conventions. When an interrupt occurs, the interrupting device must be reset by writing to I/O address **`02FX`**, where X is the interrupt level (from 0 to 7). This interrupt response level is set by switches 1, 2, and 3 of SW1 which must be set to correspond to the J4 interrupt level setting.

### *Step 4: Configuring the GP488B Interface DMA Channel*




*GP488B DMA Channel Selections*

1. The factory default DMA channel is 1. If this creates a conflict, reset jumper J3 according to the figure.
2. If reset, record the new DMA channel being used.

Direct Memory Access (DMA) is a high-speed method of transferring data from or to a peripheral, such as a digitizing oscilloscope, to or from the PC's memory. The PC has four DMA channels, but Channel 0 (Disabled) is used for memory refresh and is not available for peripheral data transfer. Channel 2 is usually used by the floppy disk controller, and is also unavailable. Channel 3 is often used by the hard disk controller in PCs, XTs, and the PS/2 with the ISA bus, but is usually not used in ATs. So, depending on your hardware, DMA Channels 1 and possibly Channel 3 are available. Under some rare conditions, it is possible for high-speed transfers on DMA Channel 1 to demand so much of the available bus bandwidth that simultaneous access of a floppy controller will be starved for data due to the relative priorities of the two channels.

# Installing the New Hardware & Hardware Drivers

Typical IEEE 488 interface boards are installed into expansion slots inside the PC's system unit. Typical PCs have the following types of expansion slots:

- ***ISA expansion slots.*** ISA slots can either be an 8-bit slot with one card-edge receptacle (PC-bus compatible), or a 16-bit slot with two card-edge receptacles (AT-bus compatible). Eight-bit ISA boards may be used in either the 8-bit or 16-bit ISA slot, while 16-bit ISA boards may only be used in the 16-bit ISA slot.
- ***PCI expansion slots.*** PCI slots are 32-bit slots, used only by PCI boards.

For technical assistance, see chapter *Troubleshooting* on page 119 in this manual, or the troubleshooting section in your PC's manual. If you are still not sure of the problem, contact the dealer or manufacturer of your interface board or PC.

### Step 1: Installing the GP488B Interface Board into an ISA Slot

General instructions for installing the board are given since the design of computer cases varies. Refer to your PC's reference manual whenever in doubt.

1. Turn OFF the power to your computer and any other connected peripheral devices. Follow the precautions for static electricity discharge.
   - Touch a large grounded metal surface to discharge any static electricity build up in your body.
   - Avoid any contact with internal parts. Handle cards only by their edges.
   - Disconnect the AC power before removing the cover.
2. Unplug all power cords and cables that may interfere from the back of the computer.
3. Remove your computer's cover by removing its mounting screws with a screwdriver. Slide the cover OFF. If necessary, refer to your PC's manual.
4. Your IEEE 488 controller interface must be installed in an 8-bit ISA-bus expansion slot. Select an available ISA expansion slot and remove its slot cover by unscrewing the holding screw and sliding it out. Save this screw for securing the interface after it is installed.
5. To install the IEEE 488 controller interface, carefully align the card edge connector with the ISA slot on the motherboard, fitting the IEEE 488 port through the rear panel opening. Push the board down firmly, but gently, until it is well seated.
6. Replace the cover slot holding screw to secure the board in place.
7. Replace the computer's cover and screws. Then reconnect all power cords and cables to the back of the computer. If available, connect your external data acquisition instrument to the IEEE 488 port connector on the interface.
8. Turn on your PC.

At this point, the hardware installation is complete. Continue to *Step 2*.

### Step 2: Detecting the GP488B Interface Board in "Add New Hardware"

1. After installing the IEEE 488 controller interface, turn on your computer. Windows will detect the new hardware and prompt for a Manufacturer's Disk.
2. Insert the disk labeled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive. Click *OK*.
3. The hardware will now be recognized by Windows; the "Add New Hardware Wizard" will assign the available I/O base address, IRQ (Interrupt), and DMA channel, which were configured earlier. (Additional GP488B interfaces may use the same IRQ and DMA values.)

   Continue as prompted to load the interface driver, but DO NOT restart Windows. Select No to NOT shut down and go directly to the *Device Manager* to verify the presence of the new hardware device.

At this point, the hardware detection is complete. Continue to *Step 3*.

### *Step 3: Verifying the GP488B Interface Installation & Driver488 Software Settings*

1. To confirm proper installation, open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers" and below it, verify the presence of the new hardware device.
2. During Driver488 installation, a new *Control Panel* applet titled "IEEE 488" was installed under the *Control Panel* with default settings selected.

   To verify or configure the Driver488 software settings for your IEEE 488 interface(s) and IEEE 488 external device(s), see chapter *Driver488/W95 & Driver488/WNT* on page 41.

   - When the I/O base address, IRQ (Interrupt), and DMA channel settings match the jumpered board, select OK and restart Windows below.
   - If any of these settings do not match, manually reset each value. When all of the settings are correct, select OK and restart Windows below.
3. Restart Windows and once again verify the hardware installation and Driver488 configuration in *Device Manager*.

At this point, the hardware and driver verification is complete. Continue to *Step 4*.

### *Step 4: Installing the GP488B Interface Software Support Files*

1. Insert the disk titled "IEEE 488 Software Installation Disk, 1 of 2" into the floppy disk drive.
2. To install, you can do one of the following:
   - Select *Run* from the *Start Menu*, type in **`A:\SETUP.EXE`**, then click *OK*.
   - Go to *My Computer* or *Windows Explorer*, double-click on the *Floppy Drive* icon, then double-click on the *Setup* icon.
   - Or go to the *Control Panel* from the *Start > Settings* menu, double-click on the *Add/Remove Programs* icon, then click the *Install* button.
3. The Installation program will step you through various options on installing these software support files.

   **Note:** These files are NOT required to get the hardware to work properly, but it is recommended if any software development is desired or Help files are needed.
4. Any or all of the installed software support files may be removed by going to the *Control Panel* from the *Start > Settings* menu, double-clicking on the *Add/Remove Programs* icon, then selecting "Personal IEEE 488 v 2.0", and clicking the *Add/Remove* button.

At this point, the installation of software support files is complete.

# Updating the Existing Hardware Drivers

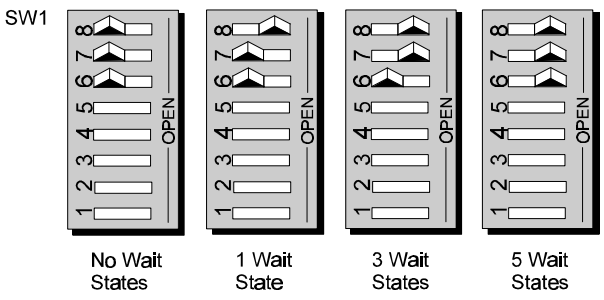
### Updating the GP488B Interface Hardware Drivers

1. Insert the disk titled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive.
2. Open the *Control Panel* window from the *Start* > *Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers".
3. Highlight the device you want to update under "IEEE488.2 Controllers".
4. Click on the *Properties* button. Click on the *Driver* tab.
5. Highlight the driver file named "C:\Windows\System___488.vxd". (For example, "…\vpci488.vxd".)
6. Click on the *Change Driver* button.
7. Select the model that you are updating. Click *OK*.

   **Note:** DO NOT select the *Have Disk...* button.
8. Windows will return you to the *Driver* tab. Click *OK*. The hardware drivers will now be updated from the Driver Disk.
9. Windows will prompt you if you wish to restart the system. Select *Yes*. Otherwise the hardware will continue to use the outdated drivers until the next time the system is restarted.

# Configuring Other Hardware Settings

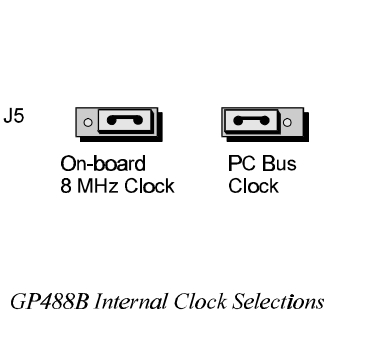
### Configuring the GP488B Interface Wait State




*GP488B Wait State Configurations*

The GP488B is fast enough to be compatible with virtually every PC/XT/AT-compatible computer on the market. Even if the computer is very fast, the processor is normally slowed to 8 MHz or below when accessing the I/O channel. If the I/O channel runs faster than 8 MHz, it may be faster than the GP488B board. If you suspect this is a problem, the computer can be made to wait for the GP488B by enabling wait states. Increasing the number of wait states slows down access to the GP488B board, but the overall performance degradation is usually only a few percent.

### Configuring the GP488B Interface Internal Clock




*GP488B Internal Clock Selections*

The IEEE 488 bus interface circuitry requires a master clock. This clock is normally connected to an on-board 8 MHz clock oscillator. However, some compatible IEEE 488 interface boards connect this clock to the PC's own clock signal. Using the PC clock to drive the IEEE 488 bus clock is not recommended because the PC clock frequency depends on the model of computer. A standard PC has a 4.77 MHz clock, while an AT might have a 6 MHz or 8 MHz clock. Other manufacturers' computers may have almost any frequency clock. If you are using a software package designed for an interface board (that derived its clock from the PC clock) and you need to do the same to use GP488B with that particular software, the clock source can be changed. However, the clock frequency must never be greater than 8 MHz, and clock frequency must be correctly entered in the Driver488 software.

*Notes*

# Personal488/MM (with GP488B/MM) 7

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## *Introduction*

### The Package

The Personal488/MM, including the IEEE 488 interface board and the Driver488 software, is carefully inspected, both mechanically and electrically, before shipment. When you receive the product, unpack all items carefully from the shipping carton and check for any obvious signs of physical damage that may have occurred during shipment. Report any such damage to the shipping agent immediately. Remember to retain all shipping materials in the event shipment back to the factory becomes necessary.

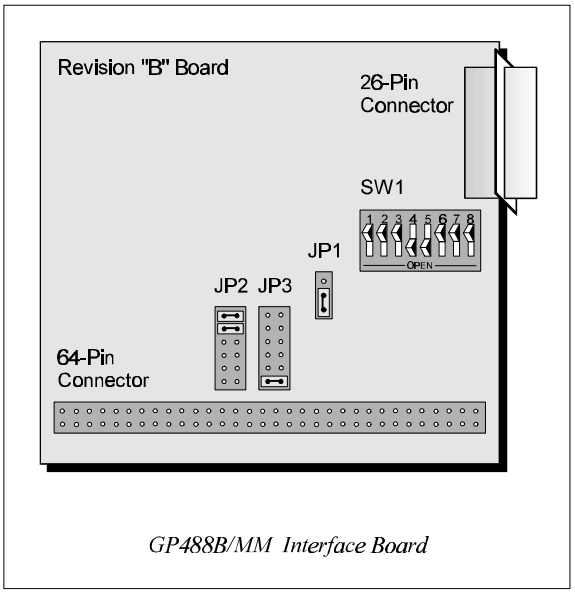
The Personal488/MM (with GP488B/MM) package includes:

- GP488B/MM IEEE 488 Bus Interface PC/104 Board
- Driver488 Software Disks for Windows 95 or Windows NT (Driver488/W95 or Driver488/WNT)
- *Personal488 User s Manual for Windows 95 and Windows NT*

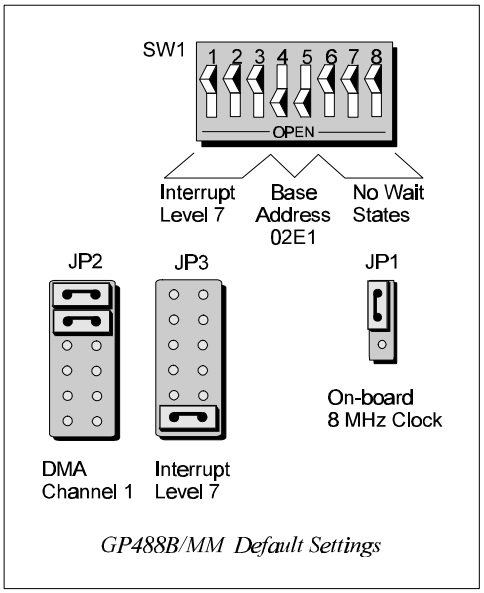
### GP488B/MM Specifications

**Note:** (1) GP488B/MM is only compatible with the Ampro PC/104. (2) Only GP488B/MM Revision B is discussed in this manual. (3) Microswitches 6, 7, and 8 on switch SW1 do not have a function on this board. (4) These specifications are subject to change without notice.

**IEEE 488 Controller Device:** IOT7210
**Maximum Transfer Rate:** 8-bit DMA: 330 Kbyte/s (reads and writes)
**Connector:** 26-pin header ribbon cable to IEEE 488 standard connector
**Power:** 650 mA @ 5 V from PC
**Environment:** 0 to 70°C; 0 to 95% RH, non-condensing
**DMA:** 8-bit DMA on channels 0, 1, 2., and 3 (jumper selectable)
**Interrupts:** IRQ 2, 3, 4, 5, 6, or 7
**IEEE 488 Base I/O Addresses:** **`&H02E1`**, **`&H22E1`**, **`&H42E1`**, or **`&H62E1`**




*GP488B/MM Interface Board*




*GP488B/MM Default Settings*

## Configuring the New Hardware

The following text will guide you through the setup of your IEEE 488 controller interface. It includes instructions on how to verify the resource settings of ports in your system, and how to properly configure the switches/jumpers on your interface board.

To avoid a configuration conflict, you must first verify which I/O addresses, IRQs, and DMAs are being used by existing ports in your system, prior to configuring and installing the IEEE 488 controller interface.

### Step 1: Verifying/Recording the Current System Settings

The Windows *Control Panel* enables you to easily determine and configure the I/O addresses, IRQ setting, and DMA settings in your system for proper operation. Perform the following steps to verify your system settings.

1. Open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Under the line "Ports (COM & LPT)", look for a list of used ports. For each port, highlight the port and click on the *Properties* button.
2. Properties already being used in the system are displayed under the *Resources* tab. Values NOT listed are available.
   - For each listed port, record which Input/Output (I/O) address, if any, is being used.
   - For each listed port, record which Interrupt Request (IRQ) value, if any, is being used.
   - For each listed port, record which Direct Memory Access (DMA) value, if any, is being used.
3. Exit Windows and turn the system OFF.

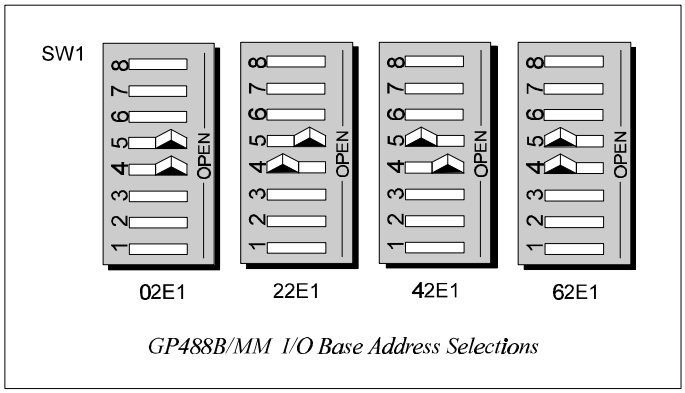
**Note:** (1) GP488B/MM is only compatible with the Ampro PC/104. (2) Only GP488B/MM Revision B is discussed in this manual. (3) Microswitches 6, 7, and 8 on switch SW1 do not have a function on this board.

There is only one revision level of the GP488B/MM board which is currently supported by 32-bit Driver488 software, Revision B. Consequently, only GP488B/MM Revision B is discussed in this manual.

The I/O base address, IRQ, and DMA settings are switch/jumper selectable via the following locations on the GP488B/MM interface board: One 8-microswitch DIP switch labelled SW1, two 12-pin headers labelled JP2 and JP3, and one 3-pin header labelled JP1. The DIP switch settings, and the arrangement of the jumpers on the headers set the hardware configuration.

For the next steps, make sure that the I/O address, IRQ, and DMA, set on the interface board are different from any existing ports in your system. A conflict results when two I/O addresses, IRQs, or DMAs are the same. (As the exception, additional GP488B interfaces may share the same IRQ and DMA values.) If there is a conflict, perform the following steps to select new switch/jumper settings.

### *Step 2: Configuring the GP488B/MM Interface I/O Base Address*




*GP488B/MM I/O Base Address Selections*

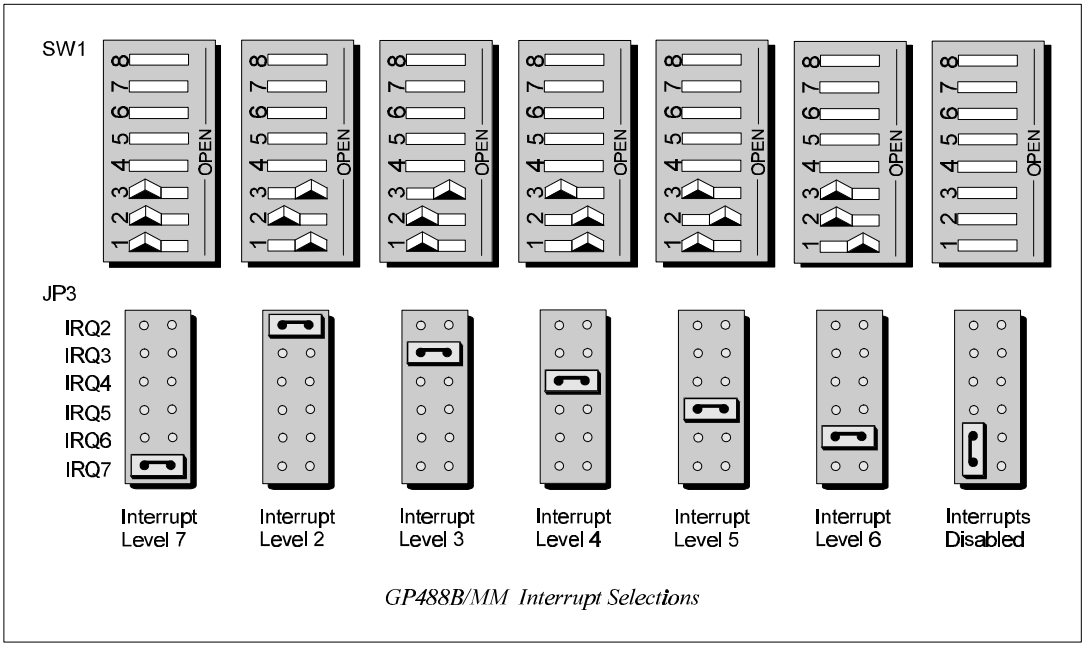
1. The factory default I/O base address is **02E1**. If this creates a conflict, reset SW1 microswitches 4 and 5 according to the figure and following table. The register addresses will be automatically relocated at fixed offsets from the base address.
2. If reset, record the new Input/Output (I/O) address being used.

| Selected I/O Base Address | | | | Register | |
|---|---|---|---|---|---|
| **02E1** | **22E1** | **42E1** | **62E1** | | |
| **Automatic Offset Addresses** | | | | **Read Register** | **Write Register** |
| **02E1** | **22E1** | **42E1** | **62E1** | Data In | Data Out |
| **06E1** | **26E1** | **46E1** | **66E1** | Interrupt Status 1 | Interrupt Mask 1 |
| **0AE1** | **2AE1** | **4AE1** | **6AE1** | Interrupt Status | Interrupt Mask 2 |
| **0EE1** | **2EE1** | **4EE1** | **6EE1** | Serial Poll Status | Serial Poll Mode |
| **12E1** | **32E1** | **52E1** | **72E1** | Address Status | Address Mode |
| **16E1** | **36E1** | **56E1** | **76E1** | CMD Pass Through | Auxiliary Mode |
| **1AE1** | **3AE1** | **5AE1** | **7AE1** | Address 0 | Address 0/1 |
| **1EE1** | **3EE1** | **5EE1** | **7EE1** | Address 1 | End of String |

The I/O base address sets the addresses used by the computer to communicate with the IEEE 488 interface hardware on the board. The address is normally specified in hexadecimal and can be **02E1**, **22E1**, **42E1**, or **62E1**. The registers of the IOT7210 IEEE 488 controller chip and other auxiliary registers are then located at fixed offsets from the base address.

Most versions of Driver488 are capable of managing as many as four IEEE 488 interfaces. To do so, the board configurations must be arranged to avoid conflict among themselves. No two boards may have the same I/O address; but they may, and usually should, have the same DMA channel and interrupt level.

### *Step 3: Configuring the GP488B/MM Interface Interrupt (IRQ)*

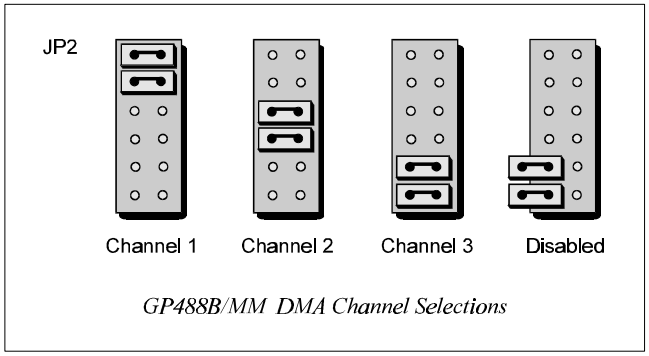



*GP488B/MM Interrupt Selections*

1. The factory default Interrupt (IRQ) is 7. If this creates a conflict, reset SW1 microswitches 1, 2, and 3, and jumper JP3 according to the figure. The switch and jumper settings must both indicate the same interrupt level for correct operation with interrupts.
2. If reset, record the new Interrupt (IRQ) being used.

The GP488B/MM Revision B interface board may be set to interrupt the PC on the occurrence of certain hardware conditions. The level of the interrupt generated is set by JP3. The GP488B/MM interface board adheres to the "AT-style" interrupt sharing conventions. When an interrupt occurs, the interrupting device must be reset by writing to I/O address **`02FX`**, where X is the interrupt level (from 0 to 7). This interrupt response level is set by switches 1, 2, and 3 of SW1 which must be set to correspond to the JP3 interrupt level setting.

### *Step 4: Configuring the GP488B/MM Interface DMA Channel*




*GP488B/MM DMA Channel Selections*

1. The factory default DMA channel is 1. If this creates a conflict, reset jumper JP2 according to the figure.
2. If reset, record the new DMA channel being used.

Direct Memory Access (DMA) is a high-speed method of transferring data from or to a peripheral, such as a digitizing oscilloscope, to or from the PC's memory. The factory default selection is DMA Channel 1. Notice that jumper JP2 is used to select the DMA channel.

Check your computer documentation to ensure the selected DMA channel is not being used by another device. The GP488B/MM board has circuitry which allows for more than one GP488B/MM board to share the same channel. Most computers use DMA Channel 2 for floppy disk drives, making that channel unavailable.

## Installing the New Hardware & Hardware Drivers

Unlike typical IEEE 488 interface boards which are installed into expansion slots inside the PC's system unit, the GP488B/MM Mini-Module interface board is installed into the Ampro PC/104 board by using its "stack-through" connector.

For technical assistance, see chapter *Troubleshooting* on page 119 in this manual, or the troubleshooting section in your PC's manual. If you are still not sure of the problem, contact the dealer or manufacturer of your interface board or PC.

### Step 1: Installing the GP488B/MM Interface Board onto the PC/104 Board

1. Turn OFF the power to your computer and any other connected peripheral devices. Follow the precautions for static electricity discharge.
   - Touch a large grounded metal surface to discharge any static electricity build up in your body.
   - Avoid any contact with internal parts. Handle cards only by their edges.
   - Disconnect the AC power before removing the cover.
2. Unplug all power cords and cables that may interfere from the back of the computer.
3. Remove your computer's cover by removing its mounting screws with a screwdriver. Slide the cover OFF. If necessary, refer to your PC's manual.
4. Locate the bus expansion connector on the Ampro PC/104 board. This connector is a 64-socket header consisting of two rows of 32 sockets. Then locate the "stack-through" bus expansion connector on your GP488B/MM. This connector has a similar 64-socket header on the front with 64 pins extending from the back of the header.
5. Lining up the screw and/or spacer locations, insert the 64-pin connector of the GP488B/MM carefully into the 64-socket header on the Ampro PC/104 board.
6. With the board firmly in place, secure the GP488B/MM using the appropriate screws and/or spacers.
7. Replace the computer's cover and screws. Then reconnect all power cords and cables to the back of the computer. If available, connect your external data acquisition instrument to the IEEE 488 port connector on the interface.
8. Turn on your PC.

At this point, the hardware installation is complete. Continue to *Step 2*.

### Step 2: Detecting the GP488B/MM Interface Board in "Add New Hardware"

1. After installing the IEEE 488 controller interface, turn on your computer. Windows will detect the new hardware and prompt for a Manufacturer's Disk.
2. Insert the disk labeled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive. Click *OK*.
3. The hardware will now be recognized by Windows; the "Add New Hardware Wizard" will assign the available I/O base address, IRQ (Interrupt), and DMA channel, which were configured earlier. (Additional GP488B/MM interfaces may use the same IRQ and DMA values.)

   Continue as prompted to load the interface driver, but DO NOT restart Windows. Select No to NOT shut down and go directly to the *Device Manager* to verify the presence of the new hardware device.

At this point, the hardware detection is complete. Continue to *Step 3*.

### *Step 3: Verifying the GP488B/MM Interface Installation & Driver488 Software Settings*

1. To confirm proper installation, open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers" and below it, verify the presence of the new hardware device.
2. During Driver488 installation, a new *Control Panel* applet titled "IEEE 488" was installed under the *Control Panel* with default settings selected.

   To verify or configure the Driver488 software settings for your IEEE 488 interface(s) and IEEE 488 external device(s), see chapter *Driver488/W95 & Driver488/WNT* on page 41.

   - When the I/O base address, IRQ (Interrupt), and DMA channel settings match the jumpered board, select OK and restart Windows below.
   - If any of these settings do not match, manually reset each value. When all of the settings are correct, select OK and restart Windows below.
3. Restart Windows and once again verify the hardware installation and Driver488 configuration in *Device Manager*.

At this point, the hardware and driver verification is complete. Continue to *Step 4*.

### *Step 4: Installing the GP488B Interface Software Support Files*

1. Insert the disk titled "IEEE 488 Software Installation Disk, 1 of 2" into the floppy disk drive.
2. To install, you can do one of the following:
   - Select *Run* from the *Start Menu*, type in **`A:\SETUP.EXE`**, then click *OK*.
   - Go to *My Computer* or *Windows Explorer*, double-click on the *Floppy Drive* icon, then double-click on the *Setup* icon.
   - Or go to the *Control Panel* from the *Start > Settings* menu, double-click on the *Add/Remove Programs* icon, then click the *Install* button.
3. The Installation program will step you through various options on installing these software support files.

   **Note:** These files are NOT required to get the hardware to work properly, but it is recommended if any software development is desired or Help files are needed.
4. Any or all of the installed software support files may be removed by going to the *Control Panel* from the *Start > Settings* menu, double-clicking on the *Add/Remove Programs* icon, then selecting "Personal IEEE 488 v 2.0", and clicking the *Add/Remove* button.

At this point, the installation of software support files is complete.

# Updating the Existing Hardware Drivers

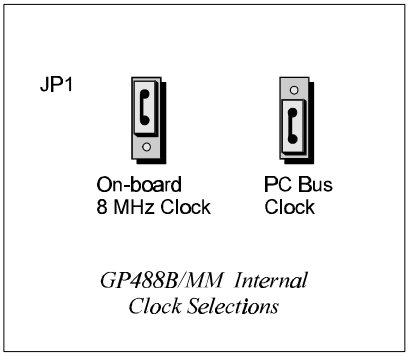
### Updating the GP488B/MM Interface Hardware Drivers

1. Insert the disk titled "Driver488 Driver Disk, 1 of 1" into the floppy disk drive.
2. Open the *Control Panel* window from the *Start > Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Look for a device type named "IEEE488.2 Controllers".
3. Highlight the device you want to update under "IEEE488.2 Controllers".
4. Click on the *Properties* button. Click on the *Driver* tab.
5. Highlight the driver file named "C:\Windows\System___488.vxd". (For example, "…\vpci488.vxd".)
6. Click on the *Change Driver* button.
7. Select the model that you are updating. Click *OK*.

   **Note:** DO NOT select the *Have Disk...* button.
8. Windows will return you to the *Driver* tab. Click *OK*. The hardware drivers will now be updated from the Driver Disk.
9. Windows will prompt you if you wish to restart the system. Select *Yes*. Otherwise the hardware will continue to use the outdated drivers until the next time the system is restarted.

# Configuring Other Hardware Settings

### Configuring the GP488B/MM Interface Internal Clock




*GP488B/MM Internal Clock Selections*

The IEEE 488 bus interface circuitry requires a master clock. This clock is normally connected to an on-board 8 MHz clock oscillator. However, some compatible IEEE 488 interface boards connect this clock to the PC's own clock signal. Using the PC clock to drive the IEEE 488 bus clock is not recommended because the PC clock frequency depends on the model of computer. A standard PC has a 4.77 MHz clock, while an AT might have a 6 MHz or 8 MHz clock. Other manufacturers' computers may have almost any frequency clock. If you are using a software package designed for an interface board (that derived its clock from the PC clock) and you need to do the same to use GP488B/MM with that particular software, the clock source can be changed. However, the clock frequency must never be greater than 8 MHz, and clock frequency must be correctly entered in the Driver488 software.

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# *Introduction*

## Differences from 16-Bit Driver488 Software

The following list provides the general differences between 32-bit Driver488 software (for Windows 95 and Windows NT), and 16-bit Driver488 software (for Windows 3.X). With the 32-bit driver:

- There is no RS-232 serial support.
- The function **`Hello`** now returns two lines of ID: One for the Dynamic Link Library (DLL) and one for the device driver.
- The library function prototypes have changed to reflect standard Windows types.
- The **`include`** file has been renamed to: **`IOTIEEE.H`**

The following outline provides the specific differences in API command functions, between 32-bit Driver488 software, and 16-bit Driver488 software. With the 32-bit driver:

### *Obsolete Functions*

The parameters that these functions set are now set by a provided Windows Control Panel configuration utility:

- **`ClockFrequency`**
- **`DmaChannel`**
- **`IntLevel`**
- **`IOAddress`**
- **`LightPen`**
- **`SysController`**

### *New Functions*

These are functions not previously supported:

- **`MakeNewDevice`**
- **`OnEventVDM`** (Console mode applications)
- **`TermQuery`**
- **`TimeOutQuery`**

### *Enhanced Functions*

These are updated functions:

- **`ControlLine`**
- **`Hello`**
- **`KeepDevice`**

## Programming Support

Driver488/W95 and Driver488/WNT both provide language interfaces for Microsoft C, Visual Basic, Borland C++, and Borland Delphi. These 32-bit drivers make IEEE events in your C or C++ applications conform to Windows' standard event handling scheme, passing IEEE events such as bus errors and SRQs to Windows as standard messages. This assures consistent handling of IEEE and user events.

When building your programs with Microsoft C to use the IEEE 488 interface, be sure to "include" the **`IOTIEEE.H`** file in your source and be sure to link the **`IOTSLPIB.LIB`** export library with your program.

## 16-Bit Driver488/W95 Compatibility Layer

Unlike Driver488/WNT, Driver488/W95 supports backward compatibility for applications written in the 16-bit environment of the Driver488/W31 (formerly named Driver488/WIN) product. Support is provided through a Dynamic Link Library, **`DRVR488.DLL`**, and various language-specific header files which will allow the recompilation of 16-bit applications.

### *Differences from 16-Bit Driver488 Software*

Although Driver488/W95 supports asynchronous **`Enter`** and **`Output`** operations, its 16-bit *compatibility layer* for Windows 3.X *does not* support asynchronous **`Enter`** and **`Output`** operations. The asynchronous flag is ignored and the **`Enter`** or **`Output`** operation is treated as a synchronous operation.

The **`OnEvent`** feature is *not supported* by the Windows 3.X compatibility layer. A call to **`OnEvent`** will return an error and the error value will be set to an obsolete value.

Existing 16-bit programs will run with Driver488/W95 without any re-compilation or re-linking. Since the compatibility layer DLL has the same name as the Windows 3.X driver DLL, existing programs written for Driver488/W31 (or Driver488/WIN) will automatically link to the compatibility layer and through it, link to Driver488/W95.

To use the 16-bit compatibility, the **`DRVR488.DLL`** must be copied into your system directory or to the location of a previously installed 16-bit **`DRVR488.DLL`** for Windows 3.X.

## Configuration Utility

The *configuration utility* is accessed from the Windows Control Panel. This utility allows you to configure Driver488/W95 or Driver488/WNT, as well as any user-specified IEEE 488 External Devices.

### *Interfaces*

The minimum requirement for configuring your system is to make certain that your IEEE 488.2 interface board is selected under *Device Type*. The default settings in all of the other fields match those of the interface as shipped from the factory. If you are unsure of a setting, it is recommended that you leave it as it is.

### *External Devices*

Each external device requires a handle or "call" to communicate with Driver488. An external device handle is a means of maintaining a record of its three configurable items:

- IEEE 488 bus address
- IEEE 488 bus terminators
- Time out period.

Any communication with the external device uses these three items. All external devices have either a default value or a user-supplied value for the different fields. All of the fields can be changed by Driver488 commands during program execution.

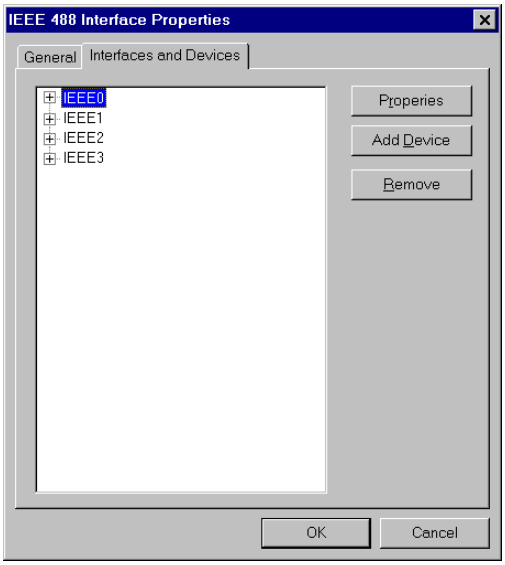
# Configuring the Driver488 Software Settings

**Note:** The following configuration information is software oriented. It is assumed that you have already successfully performed the necessary hardware and hardware driver installations, as provided in the appropriate hardware chapter of this manual.

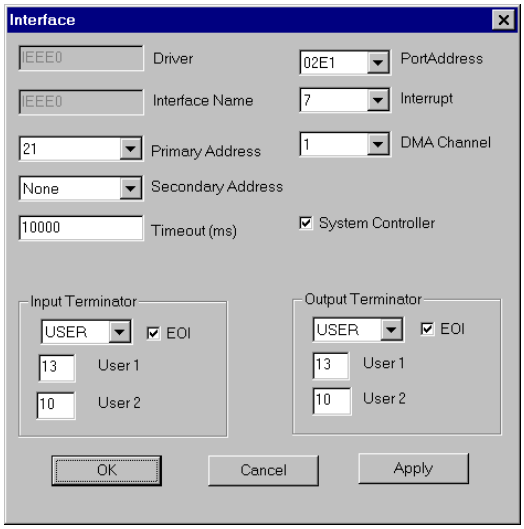
### Step 1: Opening the Configuration Utility

1. Open the Windows *Control Panel* from the *Start > Settings* menu.
2. Double-click on the *IEEE 488 Driver* icon. The *IEEE 488 Interface Properties* dialog box will appear.
3. Select the *Interfaces and Devices* tab to display a list of the four available IEEE 488 interfaces: **`IEEE0`**, **`IEEE1`**, **`IEEE2`**, and **`IEEE3`**.
4. At this point, you have the option of configuring an interface or configuring an external device.

### Step 2: Configuring the IEEE 488 Interface




*IEEE 488 Interface Properties Dialog Box*
*Interfaces and Devices Tab*




*Interface Dialog Box*

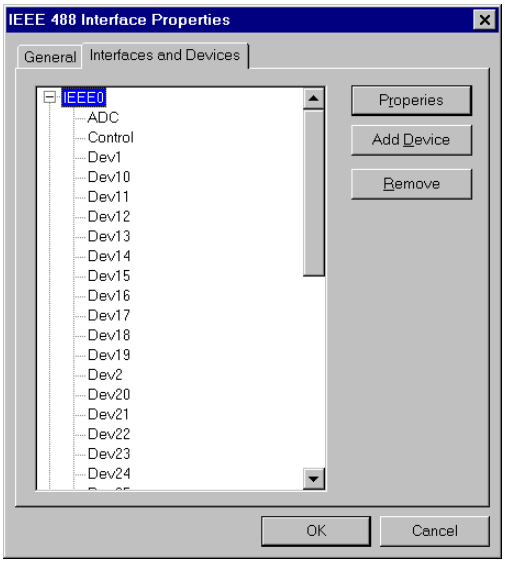
1. From the *Interfaces and Devices* tab of the *IEEE 488 Interface Properties* dialog box, click on the appropriate interface name to highlight the interface to be configured.
2. Select the *Properties* button. The *Interface* dialog box will appear.
3. Fill in the appropriate configuration parameters.
   - ***Driver:*** This field is automatically assigned. It shows the interface that has been chosen for configuration.
   - ***Interface Name:*** This field is a descriptive instrument name which is automatically assigned by the driver. It is a duplication of the driver interface.
   - ***Primary Address:*** This field is the setting for the IEEE bus address of the board. It will be checked against all the instruments on the bus for conflicts. It must be a valid IEEE bus address between **`0`** and **`30`**. The Secondary Address field is not supported.
   - ***Timeout (ms):*** The time out period is the amount of time that data transfers wait before assuming that the device does not transfer data. If the time out period elapses while waiting to transfer data, an error signal occurs. This field is the default timeout for any bus request or action, measured in milliseconds. If no timeout is desired, the value may be set to zero.
   - ***Port Address:*** This field is the I/O base address.

- ***Interrupt:*** This field is the hardware interrupt level (IRQ*). IRQ is not an option; it is a requirement.* Valid settings for the interrupt levels of specific boards, are provided in the chart.
- ***DMA:*** A DMA channel can be specified for use. If DMA is to be used, select a channel as per the hardware setting. If no DMA is to be used, select NONE. Valid settings for the DMA channels of specific boards, are provided in the chart.

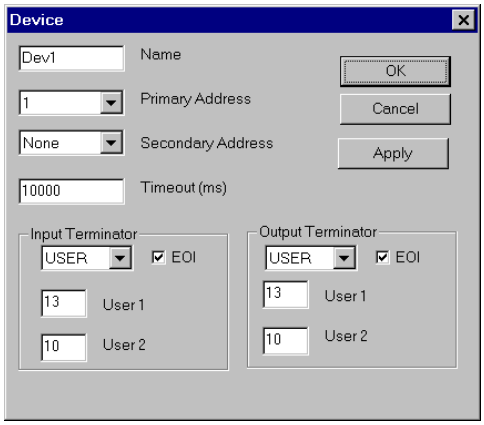
| Board | Interrupt Levels | DMA Channels |
|---|---|---|
| GP488B | levels 2-7 | 1, 2, 3 or none |
| GP488B/MM | levels 2-7 | 1, 2, 3 or none |
| AT488 | levels 3-7, 9-12, or 14-15 | 1, 2, 3, 5, 6, 7 or none |

- ***System Controller (Check Box):*** The IEEE 488 interface board is configured as a System Controller or Peripheral by clicking on the System Controller toggle check box. The interface board is configured as a System Controller if a "check mark" is present in the check box. The System Controller has ultimate control of the IEEE 488 bus and therefore has the ability of asserting the Interface Clear (**IFC**) and Remote Enable (**REN**) signals. Each IEEE 488 bus can have only one System Controller. If the board is configured as a Peripheral, it can obtain control of the IEEE 488 bus from the Active Controller. Once control status is achieved, the peripheral board may take control of the bus and carry out its assignments. Upon completion of its tasks, control will be relinquished to the System Controller or another computer.
- ***Input & Output Terminators (Bus Termination):*** The IEEE488 bus terminators specify the characters and/or EOI signal that is to be appended to data that is sent to the external device, or mark the end of data that is received from the external device.

### *Step 3: Configuring the IEEE 488 External Device*




*IEEE 488 Interface Properties Dialog Box*
*Interfaces and Devices Tab*




*Device Dialog Box*

1. From the *Interfaces and Devices* tab of the *IEEE 488 Interface Properties* dialog box, click on the "+" node symbol located just to the left of the desired interface. A list of external devices associated with that interface will display.
2. At this point, you have the option of using one of the provided device names (such as **Dev1**) or creating a new one.
   - To use one of the provided device names, click to highlight the desired external device, and select the *Properties* button. The *Device* dialog box will appear.
   - Otherwise, to create a new user-specified device name, click on the *Add Device* button. A *Device* dialog box will appear much like the one shown above. The only difference is that all of the configuration fields are blank and must be user-specified. Provide a *Name* for the external device.
3. Fill in the appropriate configuration parameters.
   - ***Name:*** This field specifies the type of device represented by the IEEE device name selected. External Device names are user-defined names which are used to convey the configuration information about each device from the initialization file to the application program. External device names consist of 1 to 32 characters, and the first character must be a letter. The remaining characters may be letters, numbers, or underscores ("_"). External device names are case insensitive; upper and lower case letters are equivalent. **ADC** is the same device as **adc**. Each external device must have a name to identify its configuration. The name can then be used to obtain a handle to that device which will be used by all of the Driver488 commands.
   - ***Primary & Secondary Addresses*:** These fields specify the IEEE 488 bus primary and secondary addresses of the external device. They will be checked against all the instruments on the bus for conflicts. The IEEE488 bus primary address ranges from **0** to **30**, and the optional secondary address ranges from **0** to **31**.
   - ***Timeout (ms):*** The time out period is the amount of time that data transfers wait before assuming that the device does not transfer data. If the time out period elapses while waiting to transfer data, an error signal occurs. This field is the default timeout for any bus request or action, measured in milliseconds. If no timeout is desired, the value may be set to zero.
   - ***Input & Output Terminators*:** The IEEE 488 bus terminators specify the characters and/or **EOI** signal that is to be appended to data that is sent to the external device, or mark the end of data that is received from the external device.

   Because secondary addresses and bus terminators are specified by each handle, it may be useful to have several different external devices defined for a single IEEE 488 bus device. For example, separate device handles would be used to communicate with different secondary addresses within a device. Also, different device handles might be used for communication of command and status strings (terminated by carriage return **CR**, line feed **LF**), and for communication of binary data (terminated by **EOI**).

*Notes*

# API Command Reference 9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## *Introduction*

This chapter contains the API command reference for Driver488/W95 and Driver488/WNT, *using the C language*. The following 67 commands are presented in alphabetical order for ease of use.

# Abort

| | |
|---|---|
| **Syntax** | **INT WINAPI Abort(DevHandleT devHandle);** |
| | **devHandle** refers to either an IEEE 488 hardware interface or an external device. If **devHandle** refers to an external device, the **Abort** command will act on the hardware interface to which the external device is attached. |
| **Returns** | **-1** if error |
| **Mode** | **SC** or ***SC•CA** |
| **Bus States** | **IFC, *IFC** (if **SC**) |
| | **ATN•MTA** (if ***SC•CA**) |
| **Example** | **errorflag = Abort(ieee);** |
| **See Also** | **MyTalkAddr, Talk, UnTalk** |

As the System Controller (**SC**), whether Driver488 is the Active Controller or not, the **Abort** command causes the Interface Clear (**IFC**) bus management line to be asserted for at least 500 microseconds. By asserting **IFC**, Driver488 regains control of the bus even if one of the devices has locked it up during a data transfer. Asserting **IFC** also makes Driver488 the Active Controller. If a Non System Controller was the Active Controller, it is forced to relinquish control to Driver488. **Abort** forces all IEEE 488 device interfaces into a quiescent state.

If Driver488 is a Non System Controller in the Active Controller state (***SC•CA**), it asserts Attention (**ATN**), which stops any bus transactions, and then sends its My Talk Address (**MTA**) to "Untalk" any other Talkers on the bus. It does not (and cannot) assert **IFC**.

# Arm

| | |
|---|---|
| **Syntax** | **INT WINAPI Arm(DevHandleT devHandle, ArmCondT condition);** |
| | **devHandle** refers to either an IEEE 488 hardware interface or an external device. If **devHandle** refers to an external device, the **Arm** command acts on the hardware interface to which the external device is attached. |
| | **condition** is one of the following: **acError**, **acSRQ**, **acPeripheral**, **acController**, **acTrigger**, **acClear**, **acTalk**, **acListen**, **acIdle**, **acByteIn**, **acByteOut**, or **acChange**. |
| **Returns** | **-1** if **DevHandleT** is an illegal device or interface |
| | otherwise, the current state of the event trigger flag |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **errorflag = Arm(ieee, acSRQ\|acTrigger\|acChange);** |
| **See Also** | **Disarm, OnEvent** |

The **Arm** command allows Driver488 to signal to the user-specified function when one or more of the specified conditions occurs. **Arm** sets a flag for each implementation of the conditions which are user-indicated. **Arm** conditions may be combined using the bitwise **OR** operator.

The following **Arm** conditions are supported:

| Condition | Description |
|---|---|
| **acSRQ** | The Service Request bus line is asserted. |
| **acPeripheral** | An addressed status change has occurred and the interface is a Peripheral. |
| **acController** | An addressed status change has occurred and the interface is an Active Controller. |
| **acTrigger** | The interface has received a device **Trigger** command. |
| **acClear** | The interface has received a device **Clear** command. |
| **acTalk** | An addressed status change has occurred and the interface is a Talker. |
| **acListen** | An addressed status change has occurred and the interface is a Listener. |
| **acIdle** | An addressed status change has occurred and the interface is neither Talker nor Listener. |
| **acByteIn** | The interface has received a data byte. |
| **acByteOut** | The interface has been configured to output a data byte. |
| **acError** | A Driver488 error has occurred. |
| **acChange** | The interface has changed its addressed status. Its Controller/Peripheral or Talker/Listener/Idle states of the interface have changed. |

# AutoRemote

| | |
|---|---|
| **Syntax** | **INT WINAPI AutoRemote(DevHandleT devHandle, BOOL flag);** |
| | **devHandle** refers to either an IEEE 488 hardware interface or an external device. If **devHandle** refers to an external device, the **AutoRemote** command acts on the hardware interface to which the external device is attached. |
| | **flag** may be either **OFF** or **ON** |
| **Returns** | **-1** if **DevHandleT** is an illegal device or interface |
| | otherwise, the previous state is returned |
| **Mode** | **SC** |
| **Bus States** | None |
| **Example** | **errorcode = AutoRemote(ieee,ON);** |
| **See Also** | **Local, Remote, EnterX, OutputX** |

The **AutoRemote** command enables or disables the automatic assertion of the Remote Enable (**REN**) line by **Output**. When **AutoRemote** is enabled, **Output** automatically asserts **REN** before transferring any data. When **AutoRemote** is disabled, there is no change to the **REN** line. **AutoRemote** is on by default.

# Buffered

| Driver488/W95 only | |
|---|---|
| **Syntax** | **LONG WINAPI Buffered(DevHandleT devHandle);** |
| | **devHandle** refers to either an IEEE 488 hardware interface or an external device. If **devHandle** refers to an external device, the **Buffered** command acts on the hardware interface to which the external device is attached. |
| **Returns** | **-1** if error |
| | otherwise long integer from **0** to **1,048,575($2^{20}$-1)** |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **result = Buffered(ieee);**<br>**printf("%ld bytes were received.",result);** |
| **See Also** | **EnterX, OutputX** |

The **Buffered** command returns the number of characters transferred by the latest **Enter**, **Output**, **SendData**, or **SendEoi** command. If an asynchronous transfer is in progress, the result is the number of characters that have been transferred at the moment the command is issued. This command is most often used after a **count**ed **Enter**, **EnterN**, **EnterNMore**, etc., to determine if the full number of characters was received, or if the transfer terminated upon detection of **term**. It is also used to find out how many characters have currently been sent during an asynchronous DMA transfer.

# BusAddress

| | |
|---|---|
| **Syntax** | **`INT WINAPI BusAddress (DevHandleT devHandle, BYTE primary, BYTE secondary);`** |
| | **`devHandle`** refers to either an IEEE 488 hardware interface or an external device. |
| | **`primary`** is the IEEE 488 bus primary address of the specified device. |
| | **`secondary`** is the IEEE 488 bus secondary address of the specified device. If the specified device is an IEEE 488 hardware interface, this value must be **`-1`** since there are no secondary addresses for the IEEE 488 hardware interface. For no secondary address, a **`-1`** must be specified. |
| **Returns** | **`-1`** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **`errorcode = BusAddress(dmm,14,0);`** |
| **See Also** | **`MakeDevice`** |

The **`BusAddress`** command sets the IEEE 488 bus address of the IEEE 488 hardware interface or an external device. Every IEEE 488 bus device has an address that must be unique within any single IEEE 488 bus system. The default IEEE 488 bus address for Driver488 is **`21`**, but this may be changed if it conflicts with some other device.

# CheckListener

| | |
|---|---|
| **Syntax** | **INT WINAPI CheckListener(DevHandleT devHandle, BYTE primary, BYTE secondary);** |
| | **devHandle** refers to either an IEEE 488 hardware interface or an external device. If **devHandle** refers to an external device, the **CheckListener** command acts on the hardware interface to which the external device is attached. |
| | **primary** is the primary bus address to check for a Listener (**00** to **30**) |
| | **secondary** is the secondary bus address to check for a Listener (**00** to **31**). For no secondary address, a **-1** must be specified |
| **Returns** | **-1** if error |
| | otherwise it returns a **1** if a listener was found at the specified address, or a **0** if a listener was not found at the specified address. |
| **Mode** | **CA** |
| **Bus States** | **ATN•UNL, LAG,** (check for **NDAC** asserted) |
| **Example** | **result = CheckListener(ieee,15,4);**<br>**if (result == 1)**<br>**{**<br>**printf("Device found at specified address.\n");**<br>**}**<br>**if (result == 0)**<br>**{**<br>**printf("Device not found at specified address.\n");**<br>**}** |
| **See Also** | **FindListener, BusAddress** |

The **CheckListener** command checks for the existence of a device on the IEEE 488 bus at the specified address.

# Clear

| | |
|---|---|
| **Syntax** | **INT WINAPI Clear(DevHandleT devHandle);** |
| | **devHandle** refers to either an IEEE 488 hardware interface or an external device. If **devHandle** refers to a hardware interface, then a Device Clear (**DCL**) is sent. If **devHandle** refers to an external device, a Selected Device Clear (**SDC**) is sent. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN•DCL** (all devices) |
| | **ATN•UNL, MTA, LAG, SDC** (selected device) |
| **Examples** | **errorcode = Clear(ieee);** Sends the Device Clear (**DCL**) command to the IEEE interface board. |
| | **errorcode = Clear(wave);** Sends the Selected Device Clear (**SDC**) command to the WAVE device. |
| | **errorcode = Clear(dmm);** Sends the Selected Device Clear (**SDC**) command to the DMM device. |
| **See Also** | **Reset, ClearList** |

The **Clear** command causes the Device Clear (**DCL**) bus command to be issued to an interface or a Selected Device Clear (**SDC**) command to be issued to an external device. IEEE 488 bus devices that receive a Device Clear or Selected Device Clear command normally reset to their power-on state.

# ClearList

| | |
|---|---|
| **Syntax** | **INT WINAPI ClearList(DevHandlePT dhList);** |
| | **dhList** is a pointer to a list of device handles that refer to external devices. If a hardware interface is in the list, **DCL** is sent instead of **SDC**. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN•DCL** (all devices) |
| | **ATN•UNL, MTA, LAG, SDC** (selected device) |
| **Example** | `deviceList[0] = wave;`<br>`deviceList[1] = scope;`<br>`deviceList[2] = dmm;`<br>**`deviceList[3] = NODEVICE;`**<br>`errorcode = ClearList(deviceList);`<br>Sends the Selected Device Clear (**SDC**) command to a list of devices. |
| **See Also** | **Clear, Reset** |

The **ClearList** command causes the Selected Device Clear (**SDC**) command to be issued to a list of external devices. IEEE 488 bus devices that receive a Selected Device Clear command normally reset to their power-on state.

# Close

| | |
|---|---|
| **Syntax** | **INT WINAPI Close(DevHandleT devHandle);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | Completion of any pending I/O activities |
| **Example** | **errorcode = Close(wave);** |
| **See Also** | **OpenName, MakeDevice, Wait** |

The **Close** command waits for I/O to complete, flushes any buffers associated with the device that is being closed, and then invalidates the handle associated with the device.

# ControlLine

| | |
|---|---|
| **Syntax** | **INT WINAPI ControlLine(DevHandleT devHandle);** |
| | **ControlLine** returns a bit mapped number. |
| | **devHandle** refers to the I/O adapter. If **devHandle** refers to an external device, the **ControlLine** command acts on the hardware interface to which the external device is attached. |
| **Response** | **-1** if error |
| | otherwise, a bit map of the current state of the IEEE 488 interface. Under 32-bit Driver488 software, serial interfaces are no longer supported. |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **result = ControlLine(ieee);**<br>**printf("The response is %X\n",result);** |
| **See Also** | **TimeOut** |

The **ControlLine** command may be used only on IEEE 488 devices. Under 32-bit Driver488 software, serial interfaces are no longer supported. This command returns the status of the IEEE 488 bus control lines as an 8-bit unsigned value (bits 2 and 1 are reserved for future use), as shown below:

| Bit 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 |
|---|---|---|---|---|---|---|---|
| EOI | SRQ | NRFD | NDAC | DAV | ATN | 0 | 0 |

# DigArm

| AT488pnp and PCI488 only | |
|---|---|
| **Syntax** | **INT WINAPI DigArm(DevHandleT devHandle, BOOL bArm);** |
| | **devHandle** refers to an interface handle. |
| | **bArm** refers to a value that arms or disarms event generation. **TRUE** = Arm, **FALSE** = Disarm. |
| **Returns** | **-1** if neither nibble is set for input, or other error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **DigArm(devHandle, TRUE);** Arms digital input event generation. |
| **See Also** | **DigArmSetup, DigSetup, OnDigEvent, OnDigEventVDM** |

The **DigArm** command arms or disarms the event-generation due to a digital I/O port match condition. The caller should configure the digital I/O port, the event-callback mechanism, and the match condition prior to arming the event generation. The following code snippet illustrates this sequence:

```
DigSetup(devHandle, FALSE, FALSE);    // Configure both nibbles for input.
OnDigEventVDM(devHandle, MyFunc, 0);  // On event, call function MyFunc.
DigArmSetup(devHandle, 0x0A5);        // Trigger when inputs equals 0xA5.
DigArm(devHandle, TRUE);              // Enable event generation.
```

Event generation is automatically disarmed when an event is triggered. The event generation configuration, however, remains intact, so event generation can be re-armed just by calling **DigArm**. The other steps shown in the above code snippet do not need to be repeated unless the event configuration is to be changed.

Event generation may be disarmed (**bArm = FALSE**) at any time.

**Note:** This function does not configure the digital I/O port for input. The caller must use **DigSetup** to configure the port for input before performing arming event generation. If neither nibble is configured for input the function returns **-1** and sets the error code to **IOT_BAD_VALUE2**.

**Note:** Event generation may be re-armed from within the event handler to provide continuous detection of match condition events. However, this is not guaranteed to catch every event if the digital input values are rapidly changing.

**Note:** Any digital I/O port bits configured for output are treated as "don't care" bits for the purposes of event generation. In other words, it is valid to arm an event when only one nibble of the port is configured for input. In this case, the other nibble is ignored when detecting the match condition.

# DigArmSetup

| AT488pnp and PCI488 only | |
|---|---|
| **Syntax** | **INT WINAPI DigArmSetup(DevHandleT devHandle, BYTE byMatchValue);** |
| | **devHandle** refers to an interface handle. |
| | **byMatchValue** refers to a value that is compared against the digital I/O inputs |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **DigArmSetup(devHandle, 0xA5);** Sets the match value to **0xA5**. |
| **See Also** | **DigArm, DigSetup** |

The **DigArmSetup** command sets the match condition value. This value will be compared against the digital I/O port inputs to detect when an event occurs. The event must be armed (via **DigArm**) for event notification to take place.

The comparison operation depends on the current digital port configuration. If both nibbles are configured for input, then the match value is compared to the entire byte value of the digital port. If only one of the nibbles is configured for input, then the value is compared against just that nibble. If no nibbles are configured for input, then the match value is ignored. The **DigArm** function will not allow event generation to be armed unless at least one of the nibbles is configured for input.

# DigRead

| AT488pnp and PCI488 only | |
|---|---|
| **Syntax** | **INT WINAPI DigRead(DevHandleT devHandle);** |
| | **devHandle** refers to an interface handle. |
| **Returns** | **-1** if no part of the port is configured for input, or other error |
| | otherwise, integer between **0** and **255** if the entire digital I/O port is configured for input; or integer between **0** and **15** if only one nibble (either low or high) is configured for input |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **int i = DigRead(devHandle);** Returns the current value of the digital I/O port per the current configuration. |
| **See Also** | **DigSetup, DigWrite** |

The **DigRead** command reads the current value of the digital IO port per the input/output configuration of the port. If the entire port is configured for input, a value between **0** and **255** is returned. If either the upper or lower nibble is configured for input, and the other for output, a value between **0** and **15** is returned.

**Note:** This function does not configure the digital I/O port for input. The caller must use **DigSetup** to configure the port for input before performing any reads. If neither nibble is configured for input the function returns **-1** and sets the error code to **IOT_BAD_VALUE2**.

# DigSetup

| AT488pnp and PCI488 only | | |
|---|---|---|
| **Syntax** | **INT WINAPI DigSetup(DevHandleT devHandle, BOOL bLowOut, BOOL bHighOut);** | |
| | **devHandle** refers to an interface handle. | |
| | **bLowOut** refers to the lower nibble setup. **TRUE** = output, **FALSE** = input. | |
| | **bHighOut** refers to the upper nibble setup. **TRUE** = output, **FALSE** = input. | |
| **Returns** | **-1** if error | |
| **Mode** | Any | |
| **Bus States** | None | |
| **Examples** | **DigSetup(devHandle, TRUE , TRUE);** | All 8 bits output. |
| | **DigSetup(devHandle, FALSE, TRUE);** | Lower 4 bits input, upper 4 output. |
| | **DigSetup(devHandle, TRUE , FALSE);** | Lower 4 bits output, upper 4 input. |
| | **DigSetup(devHandle, FALSE, FALSE);** | All 8 bits input. |
| **See Also** | **DigRead, DigWrite** | |

The **DigSetup** command configures the digital I/O port for input and output on a per-nibble basis. Each of the two nibbles can be set for input or output. All combinations are supported. Once **DigSetup** is called, the configuration of the digital I/O port does not change until the next call to **DigSetup**. The port may be read and written many times without affecting the port setup.

**Note:** The digital I/O port must be configured every time the driver is opened. The configuration is not stored between sessions.

# DigWrite

| AT488pnp and PCI488 only | |
|---|---|
| **Syntax** | **INT WINAPI DigWrite(DevHandleT devHandle, BYTE byDigData);** |
| | **devHandle** refers to an interface handle. |
| | **byDigData** refers to a value to write to the digital output port, where the integer range is between **0** and **255** if the entire digital I/O port is configured for output, or between **0** and **15** if only one nibble (either low or high) is configured for output. |
| **Returns** | **-1** if no part of the digital I/O port is configured for output. |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **DigRead(devHandle, 0x0A);** Writes the given value to the digital I/O port per the current configuration. |
| **See Also** | **DigSetup, DigRead** |

The **DigWrite** command writes the given value to the digital I/O port per the input/output configuration of the port. If the entire port is configured for output, then the data value with a range from **0** to **255** is written to the port. If either the upper or lower nibble is configured for input, and the other for output, then the data value is truncated to the range from **0** to **15** and it is written to the appropriate nibble per the current configuration.

**Note:** This function does not configure the digital I/O port for output. The caller must use **DigSetup** to configure the port before performing any reads or writes. If neither nibble is configured for output the function returns **-1** and sets the error code to **IOT_BAD_VALUE2**.

**Note:** Outputs do not persist after an interface is closed. At that time, all digital I/O lines are configured for input.

# Disarm

| | |
|---|---|
| **Syntax** | **INT WINAPI Disarm(DevHandleT devHandle, ArmCondT condition);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. If **devHandle** refers to an external device, then the **Disarm** command acts on the hardware interface to which the external device is attached. |
| | **condition** specifies which of the conditions are no longer to be monitored. If condition is **0**, then all conditions are **Disarm**ed. |
| **Returns** | **-1** if error |
| | otherwise, the current bit map of the event condition mask. |
| **Mode** | Any |
| **Bus States** | None |
| **Examples** | **errorcode=Disarm(ieee,acTalk\|acListen\|acChange);** |
| | **errorcode=Disarm(ieee,0);** |
| **See Also** | **Arm, OnEvent** |

The **Disarm** command prevents Driver488 from invoking an event handler and interrupting the PC, even when the specified condition occurs. Your program can still check for the condition by using the **Status** command. If the **Disarm** command is invoked without specifying any conditions, then all conditions are disabled. The **Arm** command may be used to re-enable interrupt detection.

# EnterX

| | |
|---|---|
| **Syntax** | **LONG WINAPI EnterX(DevHandleT devHandle, LPBYTE data,DWORD count,BOOL forceAddr,TermT*term,BOOL async,LPDWORD compStat);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. |
| | **data** is a pointer to the buffer into which the data is read. |
| | **count** is the number of characters to read. |
| | **forceAddr** is used to specify whether the addressing control bytes are to be issued for each **EnterX** command. |
| | **term** is a pointer to a terminator structure that is used to set up the input terminators. If **term** is set to **0**, the default terminator is used. |
| | **async** is a flag that allows asynchronous data transfer. Note that this asynchronous flag is ignored in Driver488/WNT. |
| | **compStat** is a pointer to an integer containing completion status information. |
| **Returns** | **-1** if error |
| | otherwise, the actual count of bytes transferred. The memory buffer pointed to by the data parameter is filled in with the information read from the device. Note that the actual count does not include terminating characters if term characters are specified by the term in function. In addition, term characters are not returned but are discarded. |
| **Mode** | **CA** |
| **Bus States** | With interface handle: ***ATN, data** |
| | With external device handle: **ATN•UNL, MLA, TAG, *ATN, data** |
| **Example** | **term.EOI = TRUE;**<br>**term.nChar = 1;**<br>**term.EightBits = TRUE;**<br>**term.termChar[0] = '\r';**<br>**bytecount=EnterX(timer,data,1024,0,&term,1,&stat);** |
| **See Also** | **OutputX, Term, Buffered** |

**Note:** The asynchronous flag **async** is ignored in Driver488/WNT.

The **EnterX** command reads data from the I/O adapter. If an external device is specified, then Driver488 is addressed to Listen, and that device is addressed to Talk. If an interface is specified, then Driver488 must already be configured to receive data and the external device must be configured to Talk, either as a result of an immediately preceding **EnterX** command or as a result of one of the **Send** commands. **EnterX** terminates reception on either the specified count of bytes transferred, or the specified or default terminator being detected. Terminator characters, if any, are stripped from the received data before the **EnterX** command returns to the calling application.

The **forceAddr** flag is used to specify whether the addressing control bytes are to be issued for each **EnterX** command. If the device handle refers to an I/O adapter, then **forceAddr** has no effect and command bytes are not sent. For an external device, if **forceAddr** is **TRUE** then Driver488 always sends the **UNL**, **MLA**, and **TAG** command bytes. If **forceAddr** is **FALSE**, then Driver488 compares the current device with the previous device that used that interface adapter board for an **EnterX** command. If they are the same, then no command bytes are sent. If they are different, then **EnterX** acts as if the **forceAddr** flag were **TRUE** and sends the command bytes. The **forceAddr** flag is usually set **TRUE** for the first transfer of data from a device, and then set **FALSE** for additional transfers from the same block of data from that device.

### *Additional Enter Functions*

Driver488 provides additional **Enter** routines that are short-form versions of the **EnterX** function. The following **Enter** functions are already defined in your header file.

# Enter

| Syntax | **LONG WINAPI Enter(DevHandleT devHandle, LPBYTE data)** |
|---|---|
| Remarks | **Enter** is equivalent to the following call to **EnterX**:<br>**EnterX(devHandle,data,sizeof(data),1,0L,0,0L);** |

The **Enter** function passes the device handle and a pointer to the data buffer to the **EnterX** function. It determines the size of the data buffer that you provided, and passes that value as the **count** parameter. It specifies **forceAddr** is **TRUE**, causing Driver488 to re-address the device. The default terminators are chosen by specifying a **0** as the **term** parameter. Asynchronous transfer is turned off by sending **0** for the **async** parameter, and the completion status value is ignored by sending **0** for the **compStat** parameter.

# EnterN

| Syntax | **LONG WINAPI EnterN(DevHandleT devHandle,LPBYTE data,int count)** |
|---|---|
| Remarks | **EnterN** is equivalent to the following call to **EnterX**:<br>**EnterX(devHandle,data,count,1,0L,0,0L);** |

The **EnterN** function passes the device handle, the pointer to the data buffer, and the size of the data buffer to the **EnterX** function. It specifies **forceAddr** is **TRUE**, causing Driver488 to re-address the device. The default terminators are chosen by specifying a **0** pointer as the **term** parameter. Asynchronous transfer is turned off by sending **0** for the **async** parameter, and the completion status value is ignored by sending **0** for the **compStat** parameter.

# EnterMore

| Syntax | **LONG WINAPI EnterMore(DevHandleT devHandle,LPBYTE data)** |
|---|---|
| Remarks | **EnterMore** is equivalent to the following call to **EnterX**:<br>**EnterX(devHandle,data,sizeof(data),0,0L,0,0L);** |

The **EnterMore** function passes the device handle and the pointer to the data buffer to the **EnterX** function. It determines the size of the data buffer that you provided, and passes that value as the **count** parameter. It specifies **forceAddr** is **FALSE**, therefore Driver488 does not address the device if it is the same device as previously used. The default terminators are chosen by specifying a **0** as the **term** parameter. Asynchronous transfer is turned off by sending **0** for the **async** parameter, and the completion status value is ignored by sending **0** for the **compStat** parameter.

# EnterNMore

| Syntax | **LONG WINAPI EnterNMore(DevHandleT devHandle,LPBYTE data,int count);** |
|---|---|
| Remarks | **EnterNMore** is equivalent to the following call to **EnterX**:<br>**EnterX(devHandle,data,count,0,0L,0,0L);** |

The **EnterNMore** function passes the device handle, the pointer to the data buffer, and the size of the data buffer to the **EnterX** function. It specifies **forceAddr** is **FALSE**; therefore, Driver488 does not address the device if it is the same device as previously used. The default terminators are chosen by specifying a **0** as the **term** parameter. Asynchronous transfer is turned off by sending **0** for the **async** parameter, and the completion status value is ignored by sending **0** for the **compStat** parameter.

# Error

| | |
|---|---|
| **Syntax** | **INT WINAPI Error(DevHandleT devHandle, BOOL display);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. |
| | **display** indicates whether the error message display should be **ON** or **OFF**. |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **errorcode = Error(ieee, OFF);** |
| **See Also** | **OnEvent, GetError, GetErrorList, Status** |

The **Error** command enables or disables automatic on-screen display of Driver488 error messages. Specifying **ON** enables the error message display, while specifying **OFF** disables the error message display. **Error ON** is the default condition.

# FindListeners

| | |
|---|---|
| **Syntax** | **INT WINAPI FindListeners(DevHandleT devHandle, BYTE primary, LPWORD listener, DWORD limit);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. If **devHandle** refers to an external device, then the **FindListeners** command acts on the hardware interface to which the external device is attached. |
| | **primary** is the primary IEEE 488 bus address to check. |
| | **listener** is a pointer to a list that contains all Listeners found on the specified interface board. You must allocate enough memory to accommodate all of the possible Listeners up to the limit that he specified. |
| | **limit** is the maximum number of Listeners to be entered into the Listener list. |
| **Returns** | **-1** if error |
| | otherwise, the number of Listeners found on the interface |
| **Mode** | Any |
| **Bus States** | **ATN•MTA, UNL, LAG** |
| **Example** | **WORD listeners[5];**<br>**errorcode = FindListeners(ieee,10,listeners,5);** |
| **See Also** | **CheckListener, BusAddress, Status** |

The **FindListeners** command finds all of the devices configured to Listen at the specified primary address on the IEEE 488 bus. The command first identifies the primary address to check and returns the number of Listeners found and their addresses. Then, it fills the user-supplied array with the addresses of the Listeners found. The number of Listeners found is the value returned by the function. The returned values include the secondary address in the upper byte, and the primary address in the lower byte. If there is no secondary address, then the upper byte is set to **255**; hence, a device with only a primary address of **16** and no secondary address is represented as **0xFF10** or **-240** decimal.

# Finish

| Driver488/W95 only | |
|---|---|
| **Syntax** | **INT WINAPI Finish(DevHandleT devHandle);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. If **devHandle** refers to an external device, the **Finish** command acts on the hardware interface to which the external device is attached. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN** |
| **Example** | **errorcode = Finish(ieee);** |
| **See Also** | **Resume, PassControl** |

The **Finish** command asserts Attention (**ATN**) and releases any pending holdoffs after a **Resume** function is called with the monitor flag set.

# GetError

| | |
|---|---|
| **Syntax** | **ErrorCodeT WINAPI GetError(DevHandleT devHandle, LPSTR errText);** |
| | **devHandle** refers to either the IEEE 488 interface or the external device that has the associated error. |
| | **errText** is the string that will contain the error message. If **errText** is non-null, the string must contain at least 247 bytes. |
| **Returns** | **-1** if error |
| | otherwise, it returns the error code number associated with the error for the specified device. |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **errnum = GetError(ieee,errText);**<br>**printf("Error number:%d;%s \n"errnum,errText);** |
| **See Also** | **Error, GetErrorList, Status** |

The **GetError** command is user-called after another function returns an error indication. The device handle sent to the function that returned the error indication is sent to **GetError** as its **devHandle** parameter. **GetError** finds the error associated with that device and returns the error code associated with that error. If a non-null error text pointer is passed, **GetError** also fills in up to 247 bytes in the string. The application must ensure that sufficient space is available.

# GetErrorList

| | |
|---|---|
| **Syntax** | **ErrorCodeT WINAPI GetErrorList(DevHandlePT dhList, LPSTR errText, DevHandlePT errHandle);** |
| | **dhList** is a pointer to a list of external devices that was returned from a function, due to an error associated with one of the external devices in the list. |
| | **errText** is the text string that contains the error message. You must ensure that the string length is at least 247 bytes. |
| | **errHandle** is a pointer to the device handle that caused the error. |
| **Returns** | **-1** if error |
| | otherwise, it returns the error number associated with the given list of devices. |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **char errText[329];<br>int errHandle;<br>int errnum;<br>result = ClearList(list);<br>if (result == -1) {<br>errnum=GetErrorList(list,errText,&errHandle);<br>printf("Error %d;%s,at handle %d\n", errnum, errText,<br>errHandle);<br>}** |
| **See Also** | **Error, GetError, Status** |

The **GetErrorList** command is user-called, after another function identifying a list of device handles, returns an error indication. The device handle list sent to the function that returned the error indication, is sent to **GetErrorList**. **GetErrorList** finds the device which returned the error indication, returning the handle through **errHandle**, and returns the error code associated with that error. If a non-null error text pointer is passed, **GetError** also fills in up to 247 bytes in the string. The application must ensure that sufficient space is available.

# Hello

| | |
|---|---|
| **Syntax** | **INT WINAPI Hello(DevHandleT devHandle, LPSTR message);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. If **devHandle** refers to an external device, the **Hello** command acts on the hardware interface to which the external device is attached. |
| | **message** is a character pointer that contains the returned message. |
| **Returns** | **-1** if error |
| | otherwise, the version of the Dynamic Link Library (DLL) and the version of the device driver. The returned byte count will never exceed 247 bytes. |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **char message[247];**<br>**result = Hello(ieee,message);**<br>**printf("%s\n",message);** |
| **See Also** | **Status, OpenName, GetError** |

The **Hello** command is used to verify communication with Driver488, and to read the software revision number. If a non-null string pointer is passed, **Hello** fills in up to 247 bytes in the string. The application must ensure that sufficient space is available. When the command is sent, Driver488 returns a string similar to the following:

**Driver488 Revision X.X (C)199X ...**

where **X** is the appropriate revision or year number.

# KeepDevice

| | |
|---|---|
| **Syntax** | **INT WINAPI KeepDevice(DevHandleT devHandle);** |
| | **devHandle** refers to an external device. |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **errorcode = KeepDevice(scope);** |
| **See Also** | **MakeDevice, MakeNewDevice, RemoveDevice, OpenName** |

**Note:** **KeepDevice** will update an existing device or will create a new device in the Registry. This update feature is new and useful. For example, if you wish to change the bus address of the device and make it a permanent change.

The **KeepDevice** command changes the indicated temporary Driver488 device to a permanent device, visible to all applications. Permanent Driver488 devices are not removed when Driver488 is closed. Driver488 devices are created by **MakeDevice** and are initially temporary. Unless **KeepDevice** is used, all temporary Driver488 devices are forgotten when Driver488 is closed. The only way to remove the permanent device once it has been made permanent by the **KeepDevice** command, is to use the **RemoveDevice** command.

# Listen

| | |
|---|---|
| **Syntax** | **INT WINAPI Listen(DevHandleT devHandle, BYTE pri, BYTE sec);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. If **devHandle** refers to an external device, the **Listen** command acts on the associated interface. |
| | **pri** and **sec** specify the primary and secondary addresses of the device which is to be addressed to listen. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN, LAG** |
| **Example** | **errorcode = Listen (ieee, 12, -1);** |
| **See Also** | **Talk, SendCmd, SendData, SendEoi, FindListener** |

The **Listen** command addresses an external device to Listen.

# Local

| | |
|---|---|
| **Syntax** | **INT WINAPI Local(DevHandleT devHandle);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. |
| **Returns** | **-1** if error |
| **Mode** | **SC** |
| **Bus States** | ***REN** |
| **Examples** | **errorcode = Local(ieee);** To unassert the Remote Enable (**REN**) line, the IEEE 488 interface is specified. |
| | **errorcode = Local(wave);** To send the Go To Local (**GTL**) command, an external device is specified. |
| **See Also** | **LocalList, Remote, AutoRemote** |

In the System Controller mode, the **Local** command issued to an interface device, causes Driver488 to unassert the Remote Enable (**REN**) line. This causes devices on the bus to return to manual operation. A **Local** command addressed to an external device, places the device in the local mode via the Go To Local (**GTL**) bus command.

# LocalList

| | |
|---|---|
| **Syntax** | **INT WINAPI LocalList(DevHandlePT dhList);** |
| | **dhList** refers to a pointer to a list of external devices. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN•UNL, MTA, LAG,GTL** |
| **Example** | **deviceList[0] = wave;**<br>**deviceList[1] = timer;**<br>**deviceList[2] = dmm;**<br>**deviceList[3] = NODEVICE;**<br>**errorcode = LocalList(deviceList);**<br>Sends the Go To Local (**GTO**) bus command to a list of external devices. |
| **See Also** | **Local, Remote, RemoteList, AutoRemote** |

In the System Controller mode, the **LocalList** command issued to an interface device, causes Driver488 to unassert the Remote Enable (**REN**) line. This causes devices on the bus to return to manual operation. A **LocalList** command addressed to an external device, places the device in the local mode via the Go To Local (**GTL**) bus command.

# Lol

| | |
|---|---|
| **Syntax** | **INT WINAPI Lol(DevHandleT devHandle);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. If **devHandle** refers to an external device, the **Lol** command acts on the hardware interface to which the external device is attached. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN•LLO** |
| **Example** | **errorcode = Lol(ieee);** |
| **See Also** | **Local, LocalList, Remote, RemoteList** |

The **Lol** command causes Driver488 to issue an IEEE 488 LocalLockout (**LLO**) bus command. Bus devices that support this command are thereby inhibited from being controlled manually from their front panels.

# MakeDevice

| | |
|---|---|
| **Syntax** | **INT WINAPI MakeDevice(DevHandleT devHandle, LPSTR name);** |
| | **devHandle** refers to an existing external device. |
| | **name** is the device name of the device that is to be made and takes the configuration of the device given by **devHandle**. |
| **Returns** | **-1** if error |
| | otherwise, the **DevHandleT** of the new device. Note that the new device is an exact copy (except for the name) of the specified device as it currently sets in memory and not in the Registry. |
| **Mode** | Any |
| **Bus State** | None |
| **Example** | **dmm = MakeDevice(scope,"DMM");** Create a device named **DMM**, attached to the same I/O adapter as **scope** and set its IEEE 488 bus address to 16.<br>**BusAddress(dmm,16,-1);** |
| **See Also** | **MakeNewDevice, KeepDevice, RemoveDevice, OpenName, Close** |

The **MakeDevice** command creates a new temporary Driver488 device that is an identical copy of an already existing Driver488 external device. The new device is attached to the same I/O adapter of the existing device and has the same bus address, terminators, timeouts, and other characteristics. The newly created device is temporary and is removed when Driver488 is closed. **KeepDevice** may be used to make the device permanent. To change the default values assigned to the device, it is necessary to call the appropriate configuration functions such as **BusAddress**, **IOAddress**, and **TimeOut**.

# MakeNewDevice

| | |
|---|---|
| **Syntax** | **DevHandleT WINAPI MakeNewDevice(LPSTR iName, LPSTR aName,BYTE primary,BYTE secondary,TermPT In,TermPT Out,DWORD tOut);** |
| | **devHandle** refers to the new external device. |
| | **iName** is the user name of the interface on which the device is to be created. |
| | **aName** is the user name of the device. |
| | **primary** and **secondary** are the secondary and primary bus addresses to be specified. For no secondary address, a **-1** must be specified. |
| | **In** and **Out** are pointers to terminator structures specified to set up the respective input and output terminators of the device. |
| | **tOut** is the timeout parameter to be specified. |
| **Returns** | **-1** if error |
| | otherwise, the **DevHandleT** of the new device, based on the parameters specified. |
| **Mode** | Any |
| **Bus State** | None |
| **Example** | **DevHandleT anotherDevice;**<br>**anotherDevice =**<br>**MakeNewDevice("IEEE0", "Scope",13,-1,NULL, NULL,10000);**<br>Specifies parameters for: Pointer to the interface, pointer to the device name, **primary** and **secondary** addresses, pointers to the term **In** and **Out** structures, and timeout in milliseconds. |
| **See Also** | **MakeDevice, KeepDevice, RemoveDevice, OpenName, Close** |

This is a new function in Driver488/W95 and in Driver488/WNT. This function is similar to the **MakeDevice** function except that **MakeNewDevice** will create a new device based on the parameters specified, instead of simply cloning an existing device.

The **MakeNewDevice** command does not save the parameters of the newly created device in the system registry. To keep the device, it is necessary to call the **KeepDevice** function.

**Note:** The **MakeNewDevice** command will only create, not save, a new device. Interface descriptions are created and maintained by the configuration utility and the IEEE 488 configuration applet in the Windows Control Panel.

# MyListenAddr

| | |
|---|---|
| **Syntax** | **INT WINAPI MyListenAddr (DevHandleT devHandle);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an external device, the **MyListenAddr** command acts on the associated interface. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN, MLA** |
| **Example** | **errorcode = MyListenAddr (ieee);** |
| **See Also** | **MyTalkAddr, Talk, Listen, SendCmd** |

The **MyListenAddr** command addresses the interface to Listen.

# MyTalkAddr

| | |
|---|---|
| **Syntax** | **INT WINAPI MyTalkAddr (DevHandleT devHandle);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an external device, the **MyTalkAddr** command acts on the associated interface. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN, MTA** |
| **Example** | **errorcode = MyTalkAddr (ieee);** |
| **See Also** | **MyListenAddr, Listen, SendCmd** |

The **MyTalkAddr** command addresses the interface to Talk.

# OnDigEvent

| AT488pnp and PCI488 only | |
|---|---|
| **Syntax** | **`INT WINAPI OnDigEvent(DevHandleT devHandle, HWND hwnd, OpaqueP lParam);`** |
| | **`devHandle`** refers to an interface handle. |
| | **`hwnd`** is the window handle to receive event notification. |
| | **`lParam`** value will be passed in the notification message. |
| **Returns** | **`-1`** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **`OnDigEvent(devHandle, TRUE, 0x10L);`** Sets the event notification to be via a window message to the specified window handle. The value **`0x10`** will be passed with the message. |
| **See Also** | **`DigArm, OnDigEventVDM, OnEvent`** |

The **`OnDigEvent`** command sets the handle of a window to receive a notification message when a digital match event is triggered. This function uses the same mechanism as the **`OnEvent`** command. For details, see the description of **`OnEvent`**.

**Note:** This function sets the event generation mechanism to be a window notification message, replacing any previously defined event notification mechanism. Only one event notification mechanism can be used at one time.

# OnDigEventVDM

| AT488pnp and PCI488 only | |
|---|---|
| **Syntax** | **`INT WINAPI OnDigEventVDM(DevHandleT devHandle, DigEventFuncT func, OpaqueP lParam);`** |
| | **`devHandle`** refers to an interface handle. |
| | **`func`** is a user-defined function to be called when the digital match event is triggered. |
| | **`lParam`** value will be passed in the notification message. |
| **Returns** | **`-1`** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **`OnDigEventVDM(devHandle, MyFunc, 0x10L);`** Sets the event notification to be via a function call to the specified callback function. The value **`0x10`** will be passed to the function. |
| **See Also** | **`DigArm, OnDigEventVDM, OnEventVDM`** |

The **`OnDigEventVDM`** command sets the address of a "C"-style (**`__stdcall`**) function to be called when a digital match event occurs. This function uses a similar mechanism as the **`OnEventVDM`** command. The prototype of the callback function for **`OnDigEventVDM`** is:

```
void DigEventFunc( DevHandleT devHandle, LPARAM lParam )
```

The **`lParam`** value which is passed to **`OnDigEventVDM`** is passed on to the callback function when the event occurs. For details, see the description of **`OnEventVDM`**.

**Note:** This function sets the event generation mechanism to be a callback function, replacing any previously defined event notification mechanism. Only one event notification mechanism can be used at one time.

# OnEvent

| | |
|---|---|
| **Syntax** | **INT WINAPI OnEvent(DevHandleT devHandle, HWND hWnd, OpaqueP lParam);** |
| | **devHandle** refers to either an interface or an external device. |
| | **hWnd** is the window handle to receive the event notification. |
| | **lParam** value will be passed in the notification message. |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **ieee = OpenName ("ieee");**<br>**OnEvent (ieee, hWnd, (OpaqueP) 12345678L);**<br>**Arm (ieee, acSRQ \| acError);**<br>**break;** |
| **See Also** | **OnEventVDM, Arm, Disarm** |

The **OnEvent** command causes the event handling mechanism to issue a message upon occurrence of an **Arm**ed event. The message will have a type of **WM_IEEE488EVENT**, whose value is retrieved via:

```
RegisterWindowMessage ((LPSTR) "WM_IEEE488EVENT");
```

The associated **wParam** is an event mask indicating which **Arm**ed event(s) caused the notification, and the **lParam** is the value passed to **OnEvent**. Note that although there is a macro for **WM_IEEE488EVENT** in the header file for each language, this macro resolves to a function call and therefore cannot be used as a case label. The preferred implementation is to include a default case in the message handling case statement and directly compare the message ID with **WM_IEEE488EVENT**. The following is a full example of a program using the **OnEvent** function:

```
LONG FAR WINAPI export
WndProc(HWND hWnd, unsigned iMessage, WORD wParam, LONG lParam);
{
HANDLE
ieee;
switch (iMessage)
      {
      case WM_CREATE:
            ieee = OpenName ("ieee");
            OnEvent (ieee, hWnd, (OpaqueP) 12345678L);
            Arm (ieee, acSRQ | acError);
            break;
      default:
            if (iMessage == WM_IEEE488EVENT) {
                  char buff [80];
                  wsprintf (buff, "Condition = %04X,
                  Param = %081X",wParam, lParam);
                  MessageBox (hWnd, (LPSTR) buff,
                  (LPSTR) "Event Noted", MB OK);
                  return TRUE;
            }
      }
}
```

# OnEventVDM

| | |
|---|---|
| **Syntax** | **INT WINAPI OnEventVDM(DevHandleT devHandle, EventFuncT func);** |
| | **devHandle** refers to either an interface or an external device. |
| | **func** is a user-specified interrupt-handler function that is to perform some user-defined function, when one of the **Arm**ed conditions occur. |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **Arm(ieee0, acSRQ);** Arms **SRQ** detection and sets up **SRQ** function handler<br>**OnEventVDM(ieee0, srqHandler);** |
| **See Also** | **OnEvent, Arm, Disarm** |

This function is new in Driver488/W95 and in Driver488/WNT. The **OnEventVDM** (**VDM** refers to Virtual DOS Machine) allows a call back to a user-specified function in a console mode application. The following is a full example of a console mode program using the **OnEventVDM** function:

```
#include <windows.h>
#include <stdio.h>
#include "iotieee.h"

// For debugging
#define qsk(v,x) (v=x, printf(#x "returned %d/n", v))

void
srqHandler(DevHandlerT devHandle, UINT mask)
{
      LONG xfered;
      printf("\007\n\nEVENT-FUNCTION on %d mask 0x%04x\n",
      devHandle, mask);
      qsk(xfered, Spoll(devHandle));
      printf("\n\n");
}

void
main(void)
{
      LONG result, xfered;
      int ioStatus, x;
      DevHandleT ieee0, wave14, wave16;
      TermT myTerm;
      UCHAR buffer[500];

      printf("\n\nSRQTEST program PID %d\n",GetCurrentProcessId ());
      qsk(ieee0, OpenName("ieee0"));
      qsk(wave14, OpenName("Wave14"));
      qsk(wave16, OpenName("Wave16"));
      qsk(result, Abort(wave14));
      qsk(result, Abort(wave16));
      qsk(x, Hello(ieee0, buffer));
      printf("\n%s\n\n", buffer);
      myTerm.EOI = 1;
      myTerm.nChar = 0;
      myTerm.termChar[0] = '\r';
      myTerm.termChar[1] = '\n';

      // Arm SRQ detection and set up SRQ function handler
      qsk(x, Arm(ieee0, acSRQ));
      qsk(x, OnEventVDM(ieee0, srqHandler));

      // Tell the Wave to assert SRQ in 3 seconds
      qsk(xfered,Output(wave16,"t3000x",6L,1,0,&myTerm,0,&ioStatus));
      printf("Completion code: 0x%04x\n", ioStatus);
```

```
        // Normally, your program would be off doing other work, for
        // this example we will just hold here for a short time.
        For(result = 0; result 30000; result++) {
               printf("Result is %06d\r", result);
        }
        printf("\n\n");

        qsk(xfered, Spoll(wave16));
        qsk(x, Close(wave14));
        qsk(x, Close(wave16));
        qsk(x, Close(ieee0));
}
```

# OpenName

| | |
|---|---|
| **Syntax** | **DevHandleT WINAPI OpenName(LPSTR name);** |
| | **name** is the name of an interface or external device. |
| **Returns** | **-1** if error |
| | otherwise, the device handle associated with the given name |
| **Mode** | Any |
| **Bus State** | None |
| **Examples** | **dmm = OpenName("DMM");** Opens the external device **DMM** |
| | **dmm = OpenName("IEEE:DMM");** Specifies the interface to which the external device is connected |
| **See Also** | **MakeDevice, Close** |

The **OpenName** command opens the specified interface or external device and returns a device handle for use in accessing that device.

# OutputX

| | |
|---|---|
| **Syntax** | **LONG WINAPI OutputX(DevHandleT devHandle, LPBYTE data, DWORD count, BOOL last, BOOL forceAddr, TermT *terminator, BOOL async, LPDWORD compStat);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an external device, the **OutputX** command acts on the hardware interface to which the external device is attached. |
| | **data** is a string of bytes to send. |
| | **count** is the number of bytes to send. |
| | **last** is a flag that forces the device output terminator to be sent with the data. |
| | **forceAddr** is used to specify whether the addressing control bytes are to be issued for each **OutputX** command. |
| | **terminator** is a pointer to a terminator structure that is used to set up the input terminators. If **terminator** is set to **0**, the default terminator is used. |
| | **async** is a flag that allows asynchronous data transfer. Note that this asynchronous flag is ignored in Driver488/WNT. |
| | **compStat** is a pointer to an integer containing completion status information. |
| **Returns** | **-1** if error |
| | otherwise, the number of characters transferred |
| **Mode** | **CA** |
| **Bus States** | With interface handle: **REN (if SC and AutoRemote), *ATN, ATN** |
| | With external device handle: **REN (if SC and AutoRemote), ATN•MTA, UNL, LAG, *ATN, ATN** |
| **Example** | **term.EOI = TRUE;**<br>**term.nChar = 1;**<br>**term.EightBits = TRUE;**<br>**term.termChar[0] = '\r';**<br>**data = "U0X";**<br>**count = strlen(data);**<br>**bytecnt=Output(timer,data,count,1,0,&term,0,&stat);** |
| **See Also** | **EnterX, Term, TimeOut, Buffered** |

**Note:** The asynchronous flag **async** is ignored in Driver488/WNT.

The **OutputX** command sends data to an interface or external device. The Remote Enable (**REN**) line is first asserted if Driver488 is the System Controller and **AutoRemote** is enabled. Then, if a device address (with optional secondary address) is specified, Driver488 is addressed to Talk and the specified device is addressed to Listen. If no address is specified, then Driver488 must already be configured to send data, either as a result of a preceding **OutputX** command, or as the result of a **Send** command. Terminators are automatically appended to the output data as specified.

The **forceAddr** flag is used to specify whether the addressing control bytes are to be issued for each **OutputX** command. If the device handle refers to an interface, **forceAddr** has no effect and command bytes are not sent. If the device handle refers to an external device and **forceAddr** is **TRUE**, Driver488 addresses the interface to Talk and the external device to Listen. If **forceAddr** is **FALSE**, Driver488 compares the current device with the most recently addressed device on that interface. If the addressing information is the same, no command bytes are sent. If they are different, **OutputX** acts as if the **forceAddr** flag were **TRUE** and sends the addressing information.

The **terminator** is a pointer to a terminator structure that is used to set up the input terminators. This pointer may be a null pointer, requesting use of the default terminators for the device, or it may point to a terminator structure requesting no terminators. The **async** is a flag that allows asynchronous data transfer. If this flag is **TRUE**, the **OutputX** command returns to the caller as soon as the data transfer is underway. **FALSE** indicates that the **OutputX** command should not return until the transfer is complete. The **compStat** is a pointer to an integer containing completion status information. A null pointer indicates that completion status is not requested. In the case of an asynchronous transfer, this pointer must remain valid until the transfer is complete.

### *Additional Output Functions*

Driver488 provides additional **Output** functions that are short-form versions of the **OutputX** function. The following **Output** functions are already defined in your header file.

## Output

| Syntax | **LONG WINAPI Output(DevHandleT devHandle,LPBYTE data);** |
|---|---|
| Remarks | **Output** is equivalent to the following call to **OutputX**:<br>**OutputX(devHandle,data,strlen(data),1,1,0L,0,0L);** |

The **Output** function passes the device handle and a pointer to the data buffer to the **OutputX** function. It determines the size of the data buffer that you provided, and passes that value as the **count** parameter. It specifies that the **forceAddr** flag is set **TRUE**, which causes Driver488 to address the device if an external device is specified. The default terminators are chosen by specifying a **0** pointer as the **terminator** parameter. Synchronous transmission is specified by sending **0** for the **async** parameter, and the completion status value is ignored by sending a **0** for the **compStat** pointer.

## OutputN

| Syntax | **LONG WINAPI OutputN(DevHandleT devHandle,LPBYTE data,DWORD count);** |
|---|---|
| Remarks | **OutputN** is equivalent to the following call to **OutputX**:<br>**OutputX(devHandle,data,count,0,1,0L,0,0L);** |

The **OutputN** function passes the device handle and a pointer to the data buffer to the **OutputX** function. It specifies that the **forceAddr** flag is set **TRUE**, which causes Driver488 to address the device if an external device is specified. The default terminators are chosen by specifying a **0** pointer as the **terminator** parameter. Synchronous transmission is specified by sending **0** for the **async** parameter, and the completion status value is ignored by sending a **0** for the **compStat** pointer.

## OutputMore

| Syntax | **LONG WINAPI OutputMore(DevHandleT devHandle, LPBYTE data);** |
|---|---|
| Remarks | **OutputMore** is equivalent to the following call to **OutputX**:<br>**OutputX(devHandle,data,strlen(data),1,0,0L,0,0L);** |

The **OutputMore** function passes the device handle and a pointer to the data buffer to the **OutputX** function. It determines the size of the data buffer that you provided, and passes that value as the **count** parameter. It specifies that the **forceAddr** flag is set **FALSE**, so Driver488 does not re-address the device if it is the same device as that previously used. The default terminators are chosen by specifying a **0** pointer as the **terminator** parameter. Synchronous transmission is specified by sending **0** for the **async** parameter, and the completion status value is ignored by sending a **0** pointer for the **compStat** pointer.

## OutputNMore

| Syntax | **LONG WINAPI OutputNMore (DevHandleT devHandle, LPBYTE data, DWORD count);** |
|---|---|
| Remarks | **OutputNMore** is equivalent to the following call to **OutputX**:<br>**OutputX(devHandle,data,0,0,0L,0,0L);** |

The **OutputNMore** function passes the device handle and a pointer to the data buffer to the **OutputX** function. It specifies that the **forceAddr** flag is set **FALSE**, so Driver488 does not re-address the device if it is the same device as that previously used. The default terminators are chosen by specifying a **0** pointer as the **terminator** parameter. Synchronous transmission is specified by sending **0** for the **async** parameter, and the completion status value is ignored by sending a **0** pointer for the **compStat** pointer.

# PassControl

| | |
|---|---|
| **Syntax** | **INT WINAPI PassControl(DevHandleT devHandle);** |
| | **devHandle** refers to an external device to which control is passed. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN•UNL, MLA, TAG, UNL, TCT, *ATN** |
| **Example** | **errorcode = PassControl(scope);** |
| **See Also** | **Abort, Reset, SendCmd** |

The **PassControl** command allows Driver488 to give control to another controller on the bus. After passing control, Driver488 enters the Peripheral mode. If Driver488 was the System Controller, then it remains the System Controller, but it is no longer the Active Controller. The Controller now has command of the bus until it passes control to another device or back to Driver488. The System Controller can regain control of the bus at any time by issuing an **Abort** command.

# PPoll

| | |
|---|---|
| **Syntax** | **INT WINAPI PPoll(DevHandleT devHandle);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an external device, then the **PPoll** command acts on the hardware interface to which the external device is attached. |
| **Returns** | **-1** if error |
| | otherwise, a number in the range 0 to 255 |
| **Mode** | **CA** |
| **Bus States** | **ATN•EOI, *EOI** |
| **Example** | **errorcode = PPoll(ieee);** |
| **See Also** | **PPollConfig, PPollUnconfig, PPollDisable, SPoll** |

The **PPoll** (Parallel Poll) command is used to request status information from many bus devices simultaneously. If a device requires service then it responds to a Parallel Poll by asserting one of the eight IEEE 488 bus data lines (**DIO1** through **DIO8**, with **DIO1** being the least significant). In this manner, up to eight devices may simultaneously be polled by the controller. More than one device can share any particular **DIO** line. In this case, it is necessary to perform further Serial Polling (**SPoll**) to determine which device actually requires service.

Parallel Polling is often used upon detection of a Service Request (**SRQ**), though it may also be performed periodically by the controller. In either case, **PPoll** responds with a number from **0** to **255** corresponding to the eight binary **DIO** lines. Not every device supports Parallel Polling. Refer to the manufacturer's documentation for each bus device to determine if **PPoll** capabilities are supported.

# PPollConfig

| | |
|---|---|
| **Syntax** | **INT WINAPI PPollConfig(DevHandleT devHandle,BYTE ppresponse);** |
| | **devHandle** refers to either an interface or an external device to configure for the Parallel Poll. |
| | **ppresponse** is the decimal equivalent of the four binary bits **S**, **P2**, **P1**, and **P0** where **S** is the Sense bit, and **P2**, **P1**, and **P0** assign the **DIO** bus data line used for the response. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN•UNL, MTA, LAG, PPC** |
| **Example** | **errorcode = PPollConfig (dmm,0x0D);** Configure device **DMM** to assert **DIO6** when it desires service (**ist** = 1) and it is Parallel Polled (0x0D = &H0D = 1101 binary; **S**=1, **P2**=1, **P1**=0, **P0**=1; 101 binary = 5 decimal = **DIO6**). |
| **See Also** | **PPoll, PPollUnconfig, PPollDisable** |

The **PPollConfig** command configures the Parallel Poll response of a specified bus device. Not all devices support Parallel Polling and, among those that do, not all support the software control of their Parallel Poll response. Some devices are configured by internal switches.

The Parallel Poll response is set by a four-bit binary number response: **S**, **P2**, **P1**, and **P0**. The most significant bit of response is the *Sense* (**S**) bit. The Sense bit is used to determine when the device will assert its Parallel Poll response. Each bus device has an internal individual status (**ist**). The Parallel Poll response is asserted when this **ist** equals the Sense bit value **S**. The **ist** is normally a logic **1** when the device requires attention, so the **S** bit should normally also be a logic **1**. If the **S** bit is **0**, then the device asserts its Parallel Poll response when its **ist** is a logic **0**. That is, it does not require attention. However, the meaning of **ist** can vary between devices, so refer to your IEEE 488 bus device documentation. The remaining 3 bits of response: **P2**, **P1**, and **P0**, specify which **DIO** bus data line is asserted by the device in response to a Parallel Poll. These bits form a binary number with a decimal value from **0** through **7**, specifying data lines **DIO1** through **DIO8**, respectively.

# PPollDisable

| | |
|---|---|
| **Syntax** | **INT WINAPI PPollDisable(DevHandleT devHandle);** |
| | **devHandle** is either an interface or an external device that is to have its Parallel Poll response disabled. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN•UNL, MTA, LAG, PPC, PPD** |
| **Example** | **errorcode = PPollDisable(dmm);** Disables Parallel Poll of device **DMM**. |
| **See Also** | **PPoll, PPollConfig, PPollUnconfig** |

The **PPollDisable** command disables the Parallel Poll response of a selected bus device.

# PPollDisableList

| | |
|---|---|
| **Syntax** | **INT WINAPI PPollDisableList(DevHandlePT dhList);** |
| | **dhList** is a pointer to a list of external devices that are to have their Parallel Poll response disabled. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN•UNL, MTA, LAG, PPC, PPD** |
| **Example** | **deviceList[0] = wave;**<br>**deviceList[1] = timer;**<br>**deviceList[2] = dmm;**<br>**deviceList[3] = NODEVICE;**<br>**errorcode = PPollDisableList(deviceList);** |
| **See Also** | **PPoll, PPollConfig, PPollUnconfig** |

The **PPollDisableList** command disables the Parallel Poll response of selected bus devices.

# PPollUnconfig

| | |
|---|---|
| **Syntax** | **INT WINAPI PPollUnconfig(DevHandleT devHandle);** |
| | **devHandle** refers to a hardware interface. If **devHandle** refers to an external device, then the **PPollUnconfig** command acts on the hardware interface to which the external device is attached. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN•PPU** |
| **Example** | **errorcode = PPollUnconfig(ieee);** |
| **See Also** | **PPoll, PPollConfig, PPollDisable** |

The **PPollUnconfig** command disables the Parallel Poll response of all bus devices.

# Remote

| | |
|---|---|
| **Syntax** | **INT WINAPI Remote(DevHandleT devHandle);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an interface, then the Remote Enable (**REN**) line is asserted. If **devHandle** refers to an external device, then that device is addressed to Listen and placed into the **Remote** state. |
| **Returns** | **-1** if error |
| **Mode** | **SC** |
| **Bus States** | With interface: **REN** |
| | With external device: **REN, ATN•UNL, MTA, LAG** |
| **Examples** | **errorcode = Remote(ieee);** Asserts the **REN** bus line |
| | **errorcode = Remote(scope);** Asserts the **REN** bus line and addresses the **scope** device specified to Listen, to place it in the **Remote** state |
| **See Also** | **Local, LocalList, RemoteList** |

The **Remote** command asserts the Remote Enable (**REN**) bus management line. If an external device is specified, then **Remote** will also address that device to Listen, placing it in the **Remote** state.

# RemoteList

| | |
|---|---|
| **Syntax** | **INT WINAPI RemoteList(DevHandlePT dhList);** |
| | **dhList** is a pointer to a list of devices. |
| **Returns** | **-1** if error |
| **Mode** | **SC•CA** |
| **Bus States** | **REN, ATN•UNL, MTA, LAG** |
| **Example** | **deviceList[0] = wave;**<br>**deviceList[1] = timer;**<br>**deviceList[2] = dmm;**<br>**deviceList[3] = NODEVICE;**<br>**errorcode = RemoteList(deviceList);**<br>Asserts the **REN** bus line and addresses a list of specified devices to Listen, to place these specified devices in the **Remote** state. |
| **See Also** | **Remote, Local, LocalList** |

The **RemoteList** command asserts the Remote Enable (**REN**) bus management line. If external devices are specified, then **RemoteList** will also address those devices to Listen, placing them in the **Remote** state.

# RemoveDevice

| | |
|---|---|
| **Syntax** | **`INT WINAPI RemoveDevice(DevHandleT devHandle);`** |
| | **`devHandle`** specifies an interface or an external device to remove. |
| **Returns** | **`-1`** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **`errorcode = RemoveDevice(dmm);`** |
| **See Also** | **`MakeDevice, KeepDevice`** |

The **`RemoveDevice`** command removes the specific temporary or permanent Driver488 device that was created with either the **`MakeDevice`** command or the startup configuration. This command also removes a device that was made permanent through a **`KeepDevice`** command.

# Request

| | |
|---|---|
| **Syntax** | **INT WINAPI Request(DevHandleT devHandle, BYTE spstatus);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an external device, the **Request** command acts on the hardware interface to which the external device is attached. |
| | **spstatus** is the Service Request status in the range **0** to **255**. |
| **Returns** | **-1** if error |
| **Mode** | ***CA** |
| **Bus States** | **SRQ** (if **rsv** is set) |
| | ***SRQ** (if **rsv** is not set) |
| **Examples** | **errorcode = Request(ieee,0);** Clears **SRQ** and Serial Poll Response. |
| | **errorcode = Request(ieee,64+2+4);** Generates an **SRQ** (decimal 64) with **DIO2** (decimal 2) and **DIO3** (decimal 4) set in the Serial Poll Response. |
| **See Also** | **Status, ControlLine** |

In Peripheral mode, Driver488 is able to request service from the Active Controller by asserting the Service Request (**SRQ**) bus signal. The **Request** command sets or clears the Serial Poll status (including Service Request) of Driver488. **Request** takes a numeric argument in the decimal range **0** to **255** (hex range **&H0** to **&HFF**) that is used to set the Serial Poll status. When Driver488 is Serial Polled by the Controller, it returns this byte on the **DIO** data lines.

The data lines are numbered **DIO8** through **DIO1**. **DIO8** is the most significant line and corresponds to a decimal value of **128** (hex **&H80**). **DIO7** is the next most significant line and corresponds to a decimal value of **64** (hex **&H40**). **DIO7** has a special meaning: It is the *Request for Service* (**rsv**) bit. If **rsv** is set, then Driver488 asserts the Service Request (**SRQ**) bus signal. If **DIO7** is clear (a logic **0**), then Driver488 does not assert SRQ. When Driver488 is Serial Polled, all eight bits of the Serial Poll status are returned to the Controller. The **rsv** bit is cleared when Driver488 is Serial Polled by the Controller. This causes Driver488 to stop asserting **SRQ**.

# Reset

| | |
|---|---|
| **Syntax** | **INT WINAPI Reset(DevHandleT devHandle);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an external device, the **Reset** command acts on the hardware interface to which the external device is attached. |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **errorcode=Reset(ieee);** |
| **See Also** | **Abort, Term, TimeOut** |

The **Reset** command provides a warm start of the interface. It is equivalent to issuing the following command process, including clearing all error conditions:

1. **Stop.**
2. **Disarm.**
3. Reset hardware (resets to Peripheral if not System Controller).
4. **Abort** (if System Controller).
5. **Error ON.**
6. **Local.**
7. **Request 0** (if Peripheral).
8. Clear **Change**, **Trigger**, and **Clear** status.
9. Reset I/O adapter settings to installed values (**BusAddress**, **TimeOut**, **IntLevel** and **DmaChannel**).

# Resume

| Driver488/W95 only | | |
|---|---|---|
| **Syntax** | **INT WINAPI Resume(DevHandleT devHandle, BOOL monitor);** | |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an external device, then the **Resume** command acts on the hardware interface to which the external device is attached. | |
| | **monitor** is a flag that when it is **ON**, Driver488 monitors the data. | |
| **Returns** | **-1** if error | |
| **Mode** | **CA** | |
| **Bus States** | ***ATN** | |
| **Examples** | **errorcode = Resume(ieee,OFF);** | Do not go into monitoring mode. |
| | **errorcode = Resume(ieee,ON);**<br>**errorcode = Finish(ieee);** | Go into monitoring mode. |
| **See Also** | **Finish** | |

The **Resume** command unasserts the Attention (**ATN**) bus signal. Attention is normally kept asserted by Driver488, but it must be unasserted to allow transfers to take place between two peripheral devices. In this case, Driver488 sends the appropriate Talk and Listen addresses, and then must unassert Attention with the **Resume** command.

If **monitor** is specified, Driver488 monitors the handshaking process but does not participate in it. Driver488 takes control synchronously when the last terminator or **EOI** is encountered. At that point, the transfer of data stops. The **Finish** command must be called to assert Attention and release any pending holdoffs to be ready for the next action.

# SendCmd

| | |
|---|---|
| **Syntax** | **INT WINAPI SendCmd(DevHandleT devHandle, LPBYTE commands, DWORD len);** |
| | **devHandle** refers to an interface handle. |
| | **commands** points to a string of command bytes to be sent. |
| | **len** is the length of the command string. |
| **Response** | None |
| **Mode** | **CA** |
| **Bus States** | User-defined |
| **Example** | **char command[] = "U?0";**<br>**errorcode = SendCmd(ieee, &command, sizeof command);** |
| **See Also** | **SendData, SendEoi** |

The **SendCmd** command sends a specified string of bytes with Attention (**ATN**) asserted, causing the data to be interpreted as IEEE 488 command bytes.

# SendData

| | |
|---|---|
| **Syntax** | **INT WINAPI SendData(DevHandleT devHandle, LPBYTE data, DWORD len);** |
| | **devHandle** refers to an interface handle. |
| | **data** points to a string of data bytes to be sent. |
| | **len** is the length of the data string. |
| **Response** | None |
| **Mode** | Any |
| **Bus States** | User-defined |
| **Example** | **char data[] = "W0X";**<br>**errorcode = SendData(ieee, data, strlen (data));** |
| **See Also** | **SendCmd, SendEoi** |

The **SendData** command provides byte-by-byte control of data transfers and gives greater flexibility than the other commands. This command can specify exactly which operations Driver488 executes.

# SendEoi

| | |
|---|---|
| **Syntax** | **INT WINAPI SendEoi(DevHandleT devHandle, LPBYTE data, DWORD len);** |
| | **devHandle** refers to an interface handle. |
| | **data** points to a string of data bytes to be sent. |
| | **len** is the length of the data string. |
| **Response** | None |
| **Mode** | Any |
| **Bus States** | User-defined |
| **Example** | **char data[] = "W0X";**<br>**errorcode = SendEoi(ieee, data, strlen (data));** |
| **See Also** | **SendCmd, SendData** |

The **SendEoi** command provides byte-by-byte control of data transfers and gives greater flexibility than the other commands. This command can specify exactly which operations Driver488 executes. Driver488 asserts **EOI** during the transfer of the final byte.

# SPoll

| | |
|---|---|
| **Syntax** | **INT WINAPI SPoll(DevHandleT devHandle);** |
| | **devHandle** refers to either an interface or a specific external device. |
| **Returns** | **-1** if error |
| | otherwise, **0** or **64** (hardware interface) in the range **0** to **255** (external device) |
| **Mode** | Any |
| **Bus States** | **ATN•UNL, MLA, UNT, TAG, SPE, *ATN, ATN•SPD, UNT** |
| **Examples** | **errorcode = SPoll(ieee);** Returns the internal **SRQ** status |
| | **errorcode = SPoll(dmm);** Returns the Serial Poll response of the specified device |
| **See Also** | **SPollList, PPoll** |

In Active Controller mode, the **SPoll** (Serial Poll) command performs a Serial Poll of the bus device specified and responds with a number from **0** to **255** representing the decimal equivalent of the eight-bit device response. If **rsv** (**DIO7**, decimal value **64**) is set, then that device is signaling that it requires service. The meanings of the other bits are device-specific.

Serial Polls are normally performed in response to assertion of the Service Request (**SRQ**) bus signal by some bus device. In Active Controller mode, with the interface device specified, the **SPoll** command returns the internal **SRQ** status. If the internal **SRQ** status is set, it usually indicates that the **SRQ** line is asserted. Driver488 then returns a **64**. If it is not set, indicating that **SRQ** is not asserted, then Driver488 returns a **0**. With an external device specified, **SPoll** returns the Serial Poll status of the specified external device.

In Peripheral mode, the **SPoll** command is issued only to the interface, and returns the Serial Poll status. If **rsv** (**DIO7**, decimal value **64**) is set, then Driver488 has not been Serial Polled since the issuing last **Request** command. The **rsv** is reset whenever Driver488 is Serial Polled by the Controller.

# SPollList

| | |
|---|---|
| **Syntax** | **INT WINAPI SPollList(DevHandlePT dhList, LPBYTE result, BYTE flag);** |
| | **dhList** is a pointer to a list of external devices. |
| | **result** is an array that is filled in with the Serial Poll results of the corresponding external devices. |
| | **flag** refers to either **ALL**, **WHILE_SRQ**, or **UNTIL_RSV**. |
| **Returns** | **-1** if error |
| **Mode** | ***CA** |
| **Bus States** | **ATN•UNL, MLA, TAG, SPE, *ATN, ATN•SPD, UNT** |
| **Example** | **deviceList[0] = wave;**<br>**deviceList[1] = timer;**<br>**deviceList[2] = dmm;**<br>**deviceList[3] = NODEVICE;**<br>**result = SPollList(deviceList, resultList, ALL);**<br>Returns the Serial Poll response for a list of device handles. |
| **See Also** | **SPoll, PPoll** |

In Active Controller mode, the **SPollList** (Serial Poll) command performs a Serial Poll of the bus devices specified and responds with a number from **0** to **255** (representing the decimal equivalent of the eight-bit device response) for each device on the list. If **rsv** (**DIO7**, decimal value **64**) is set, then that device is signaling that it requires service. The meanings of the other bits are device-specific.

Serial Polls are normally performed in response to assertion of the Service Request (**SRQ**) bus signal by some bus device. In Active Controller mode with the interface device specified, the **SPollList** command returns the internal **SRQ** status for each device. If the internal **SRQ** status is set, it usually indicates that the **SRQ** line is asserted. Driver488 then returns a **64**. If it is not set, indicating that **SRQ** is not asserted, then Driver488 returns a **0**. With an external device specified, **SPollList** returns the Serial Poll status of the specified external device.

In Peripheral mode, the **SPollList** command is issued only to the interface and returns the Serial Poll status. If **rsv** (**DIO7**, decimal value **64**) is set, then Driver488 has not been Serial Polled since the last **Request** command was issued. The **rsv** is reset whenever Driver488 is Serial Polled by the Controller.

The **untilflag** refers to either **ALL**, **WHILE_SRQ**, or **UNTIL_RSV**. If **ALL** is chosen, all the devices are Serial Polled and their results placed into the result array. If **untilflag** is **WHILE_SRQ**, Driver488 Serial Polls the devices until the **SRQ** bus signal becomes unasserted, and the results are put into the result array. If **untilflag** is **UNTIL_RSV**, Driver488 Serial Polls the devices until the first device whose **rsv** bit is set, is found and the results are put into the result array.

# Status

| | |
|---|---|
| **Syntax** | **INT WINAPI Status(DevHandleT devHandle, IeeeStatusPT result);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. If **devHandle** refers to an external device, **Status** acts on the hardware interface to which the external device is attached. |
| | **result** is a pointer to a **Status** structure. |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **result = Status(ieee,&StatusResult);**<br>**if (statusResult.transfer == TRUE) {**<br>**printf("We have a transfer in progress\n");**<br>**} else {**<br>**printf("There is no transfer in progress\n");**<br>**}** |
| **See Also** | **GetError, SPoll** |

The **Status** command returns various items detailing the current state of Driver488. They are returned in a data structure, based on the following table:

| Status Item | Flag | Values and Description |
|---|---|---|
| **Controller Active** | **.CA** | **TRUE**: Active Controller, **FALSE**: Not CA. |
| **System Controller** | **.SC** | **TRUE**: System Controller, **FALSE**: Not SC. |
| **Primary Bus Address** | **.Primaddr** | **0** to **30**: Two-digit decimal number. |
| **Secondary Bus Address** | **.Secaddr** | **0** to **31**: Two-digit decimal number, or **-1** if no address. |
| **Address Change** | **.addrChange** | **TRUE**: Address change has occured, **FALSE**: Not so. |
| **Talker** | **.talker** | **TRUE**: Talker, **FALSE**: Not Talker. |
| **Listener** | **.listener** | **TRUE**: Listener, **FALSE**: Not Listener. |
| **ByteIn** | **.bytein** | **TRUE**: Byte in, ready to read, **FALSE**: Not so. |
| **ByteOut** | **.byteout** | **TRUE**: Byte out, ready to output, **FALSE**: Not so. |
| **Service Request** | **.SRQ** | **TRUE**: SRQ is asserted, **FALSE**: SRQ is not asserted. |
| **Triggered** | **.triggered** | **TRUE**: Trigger command received, **FALSE**: Not so. |
| **Cleared** | **.cleared** | **TRUE**: Clear command received, **FALSE**: Not so. |
| **Transfer in Progress** | **.transfer** | **TRUE**: Transfer in progress, **FALSE**: Not so. |

These **Status** items are more-fully described in the following paragraphs:

- The *Controller Active* flag (**.CA**) is true if Driver488 is the Active Controller. If Driver488 is not the System Controller, then it is initially a Peripheral and it becomes a controller when Driver488 receives control from the Active Controller.
- The *System Controller* flag (**.SC**) is true if Driver488 is the System Controller. The System Controller mode may be configured during installation or by using the SysController command.
- The *Primary Bus Address* (**.Primaddr**) is the IEEE 488 bus device primary address assigned to Driver488 or the specified device. This will be an integer from **0** to **30**. The *Secondary Bus Address* (**.Secaddr**) is the IEEE 488 bus device secondary address assigned to the specified device. This will be either **-1** to indicate no secondary address, or an integer from **0** to **31**. Note that the interface device can never have a secondary address.
- The *Address Change* indicator (**.addrChange**) is set whenever Driver488 become a Talker, Listener, or the Active Controller, or when it becomes no longer a Talker, Listener, or the Active Controller. It is reset when **Status** is read. The *Talker* (**.talker**) and *Listener* (**.listener**) flags reflect the current Talker/Listener state of Driver488. As a Peripheral, Driver488 can check this status to see if it has been addressed to Talk or addressed to Listen by the Active Controller. In this way, the desired direction of data transfer can be determined.

- The *ByteIn* (**.byteIn**) indicator is set when the I/O adapter has received a byte that can be read by an **Enter** command. The *ByteOut* (**.byteOut**) indicator is set when the I/O adapter is ready to output data. The *Service Request* field (**.SRQ**), as an active controller, reflects the IEEE 488 bus **SRQ** line signal. As a peripheral, this status reflects the **rsv** bit that can be set by the **Request** command and is cleared when the Driver488 is Serial Polled. For more details, refer to the **SPoll** command in this chapter.
- The *Triggered* (**.triggered**) and *Cleared* (**.cleared**) indicators are set when, as a Peripheral, Driver488 is triggered or cleared. These two indicators are cleared when **Status** is read. The Triggered and Cleared indicators are not updated while asynchronous transfers are in progress. The *Transfer in Progress* (**.transfer**) indicator signifies an asynchronous transfer in progress.

# Stop

| Driver488/W95 only | |
|---|---|
| **Syntax** | **`INT WINAPI Stop(DevHandleT devHandle);`** |
| | **`devHandle`** refers to either an interface or an external device. If **`devHandle`** refers to an external device, the **`Stop`** command acts on the hardware interface to which the external device is attached. |
| **Returns** | **`-1`** if error |
| **Mode** | Any |
| **Bus States** | **`ATN`** (Controller) |
| | None (Peripheral) |
| **Example** | **`errorcode = Stop(ieee);`** |
| **See Also** | **`EnterX, OutputX, Buffered`** |

The **`Stop`** command halts any asynchronous transfer that may be in progress. If the transfer has completed already, then **`Stop`** has no effect. The actual number of characters transferred is available from the **`Buffered`** command.

# Talk

| | |
|---|---|
| **Syntax** | **INT WINAPI Talk(DevHandleT devHandle, BYTE pri, BYTE sec);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an external device, the **Talk** command acts on the associated interface. |
| | **pri** and **sec** specify the primary and secondary addresses of the device which is to be addressed to Talk. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN, TAG** |
| **Example** | **errorcode = Talk (ieee, 12, -1);** |
| **See Also** | **Listen, SendCmd** |

The **Talk** command addresses an external device to Talk.

# Term

| | |
|---|---|
| **Syntax** | **INT WINAPI Term(DevHandleT devHandle, TermT *terminator, DWORD TermType);** |
| | **devHandle** refers to either an interface or an external device. |
| | **terminator** is a pointer to the terminator structure. |
| | **TermType** can be either **TERMIN**, **TERMOUT**, or **TERMIN+TERMOUT**, specifying whether input, output, or both are being set. |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **term.EOI = TRUE;**<br>**term.nChar = 1;**<br>**term.EightBits = TRUE;**<br>**term.termChar[0] = 13;**<br>**errorcode = Term(ieee,&term,TERMIN);** |
| **See Also** | **TermQuery, EnterX, OutputX, Status** |

The **Term** command sets the end-of-line (**EOL**) terminators for input from, and output to, I/O adapter devices. These terminators are sent at the end of output data and expected at the end of input data, in the manner of **CR LF** as used with printer data.

During output, **Term** appends the bus output terminator to the data before sending it to the I/O adapter device. Conversely, when Driver488 receives the bus input terminator, it recognizes the end of a transfer and returns the data to the calling application. The terminators never appear in the data transferred to or from the calling application. The default terminators for both input and output are set by the startup configuration and are normally **CR LF EOI**, which is appropriate for most bus devices.

End-Or-Identify (**EOI**) has a different meaning when it is specified for input than when it is specified for output. During input, **EOI** specifies that input is terminated on detection of the **EOI** bus signal, regardless of which characters have been received. During output, **EOI** specifies that the **EOI** bus signal is to be asserted during the last byte transferred.

# TermQuery

| | |
|---|---|
| **Syntax** | **`INT TermQuery(DevHandleT devHandle, TermT *terminator, INT TermType);`** |
| | **`devHandle`** refers to either an interface or an external device. |
| | **`terminator`** is a pointer to the terminator structure. |
| | **`TermType`** can be either **`TERMIN`**, **`TERMOUT`**, or **`TERMIN+TERMOUT`**, specifying whether input, output, or both are being set. |
| **Returns** | **`-1`** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | None provided. |
| **See Also** | **`Term, EnterX, OutputX, Status`** |

This is a new function in Driver488/W95. The **`TermQuery`** function queries the terminators setting. Terminators are defined by the **`TermT`** structure.

# TimeOut

| | |
|---|---|
| **Syntax** | **INT WINAPI TimeOut(DevHandleT devHandle, DWORD millisec);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. |
| | **millisec** is a numeric value given in milliseconds. |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | **errorcode = TimeOut(ieee,100);** Sets the timeout value to 100 msec. |
| **See Also** | **TimeOutQuery, Reset** |

The **TimeOut** command sets the number of milliseconds that Driver488 waits for a transfer before declaring a time out error. Driver488 checks for timeout errors on every byte it transfers, except in the case of asynchronous transfers. While the first byte of an asynchronous transfer is checked for time out, subsequent bytes are not. Your program must check for timely completion of an asynchronous transfer.

Time out checking may be suppressed by specifying a time out value of zero seconds, which specifies an infinite timeout. The default time out is specified in the startup configuration, normally **10** seconds. The time out interval may be specified to the nearest **0.001** seconds (1 millisecond). However, due to the limitations of the computer, the actual interval is always a multiple of **55** milliseconds and there is an uncertainty of **55** msec in the actual interval. Time out intervals from **1** to **110** milliseconds are rounded to **110** milliseconds. Larger intervals are rounded to the nearest multiple of **55** msec (e.g. **165**, **220**, **275** msec, etc.).

# TimeOutQuery

| | |
|---|---|
| **Syntax** | **`INT WINAPI TimeOutQuery(DevHandleT devHandle,DWORD millisec);`** |
| | **`devHandle`** refers to either an IEEE 488 interface or an external device. |
| | **`millisec`** is a numeric value given in milliseconds. |
| **Returns** | **`-1`** if error |
| **Mode** | Any |
| **Bus States** | None |
| **Example** | None provided. |
| **See Also** | **`TimeOut, Reset`** |

This is a new function in Driver488/W95. The **`TimeOutQuery`** function queries the time out setting, given in milliseconds.

# Trigger

| | |
|---|---|
| **Syntax** | **INT WINAPI Trigger(DevHandleT devHandle);** |
| | **devHandle** refers to either an IEEE 488 interface or an external device. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | With interface handle: **ATN•GET** |
| | With external device handle: **ATN•UNL, MTA, LAG, GET** |
| **Examples** | **errorcode = Trigger(ieee);** Issues a Group Execute Trigger (**GET**) bus command to those devices that are already in the Listen state as the result of a previous **Output** or **Send** command |
| | **errorcode = Trigger(dmm);** Issues a Group Execute Trigger (**GET**) bus command to the device specified |
| **See Also** | **TriggerList, Status, SendCmd** |

The **Trigger** command issues a Group Execute Trigger (**GET**) bus command to the specified device. If no interface devices are specified, then the **GET** only affects those devices that are already in the Listen state as a result of a previous **Output** or **Send** command.

# TriggerList

| | |
|---|---|
| **Syntax** | **INT WINAPI TriggerList(DevHandlePT dhList);** |
| | **dhList** is a pointer to a list of external devices. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN•UNL, MTA, LAG, GET** |
| **Example** | **deviceList[0] = wave;**<br>**deviceList[1] = timer;**<br>**deviceList[2] = dmm;**<br>**deviceList[3] = NODEVICE;**<br>**errorcode = TriggerList(deviceList);**<br>Issues a Group Execute Trigger (**GET**) bus command to a list of specified devices. |
| **See Also** | **Trigger, SendCmd, Status** |

The **TriggerList** command issues a Group Execute Trigger (**GET**) bus command to the specified devices. If no interface devices are specified, then the **GET** affects those devices that are already in the Listen state as a result of a previous **Output** or **Send** command.

# UnListen

| | |
|---|---|
| **Syntax** | **INT WINAPI UnListen (DevHandleT devHandle);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an external device, the **UnListen** command acts on the associated interface. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN, UNL** |
| **Example** | **errorcode = UnListen (ieee);** |
| **See Also** | **Listen, UnTalk, SendCmd, Status** |

The **UnListen** command unaddresses an external device that was addressed to Listen.

# UnTalk

| | |
|---|---|
| **Syntax** | **INT WINAPI UnTalk (DevHandleT devHandle);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** refers to an external device, the **UnTalk** command acts on the associated interface. |
| **Returns** | **-1** if error |
| **Mode** | **CA** |
| **Bus States** | **ATN, UNT** |
| **Example** | **errorcode = UnTalk (ieee);** |
| **See Also** | **Talk, UnListen, SendCmd, Status** |

The **UnTalk** command unaddresses an external device that was addressed to Talk.

# Wait

| Driver488/W95 only | |
|---|---|
| **Syntax** | **INT WINAPI Wait(DevHandleT devHandle);** |
| | **devHandle** refers to either an interface or an external device. If **devHandle** is an external device, the **Wait** command acts on the hardware interface to which the external device is attached. |
| **Returns** | **-1** if error |
| **Mode** | Any |
| **Bus States** | Determined by previous **Enter** or **Output** command |
| **Example** | **errorcode = Wait(ieee);** |
| **See Also** | **EnterX, OutputX, Buffered, Status** |

The **Wait** command causes Driver488 to wait until any asynchronous transfer has completed before returning to your program. It can be used to guarantee that the data has actually been received before beginning to process it, or that it has been sent before overwriting the buffer. It is especially useful with the **Enter** command, when a terminator has been specified. In that case, the amount that is actually received is unknown, and so your program must check with Driver488 to determine when the transfer is done. Time out checking, if enabled, is performed while **Wait**ing.

# Troubleshooting 10

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*Hardware-Software Conflicts 120*
*Checking Hardware & Software Settings 120*

## Radio Interference Problems

Personal488 hardware systems generate, use and can radiate radio frequency energy, and if not installed and not used correctly, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, you the user are encouraged to try to correct the interference by one or more of the following measures:

- ***Antenna Adjustment:*** Reorient or relocate the receiving antenna.
- ***Spatial Separation:*** Increase the separation between the equipment and receiver.
- ***Circuit Separation:*** Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.

Otherwise, consult the dealer of an experienced radio/television technician for help.

## IEEE 488 Bus Errors

- ***Connections:*** Check to make sure that all of the that IEEE 488 bus cables are securely fastened to their respective terminals, and that the IEEE 488 Standard has been met.
- ***Primary Addresses:*** Check to make sure that all of the IEEE 488 bus primary addresses each has a unique value between **`0`** and **`30`**. No two interface boards or external devices should have the same primary address within any single IEEE 488 bus system. The default IEEE 488 bus primary address is **`21`**, but this may be changed if it conflicts with some other device.
- ***Timeouts:*** Check to make sure that the time out period is preferred over setting IEEE 488 bus terminators. If the time out period elapses while waiting to transfer data or while waiting for unspecified terminators, a time out error occurs.
- ***Bus Terminators:*** Check to make sure that the IEEE 488 bus terminators sent by the device and the IEEE 488 bus terminators expected by the software driver, match up. Typically, these terminators are carriage return (**`CR`**) and line feed (**`LF`**), followed by an End-Or-Identify (**`EOI`**).

For more information on the configuration of Driver488 software settings for IEEE 488 interfaces and external devices, see chapter *Driver488/W95 & Driver488/WNT* on page 41.

**Note:** If you make any changes to the configuration parameters – such as the Primary Address, Timeout, and Bus Terminator – you must restart the device driver for the changes to take effect. For Driver488/W95, close all applications using the interface board and restart your programs. For Driver488/WNT, you can use the following commands to restart your device driver: **`net stop drvr488`** and **`net start drvr488`**.

## Hardware-Software Conflicts

**Note:** If your Personal488 package includes a plug-and-play interface – such as the Personal488/PCI (with PCI488), Personal488/ATpnp (with AT488pnp), or Personal488/CARD (with CARD488) packages – disregard the list below.

- ***I/O Base Address:*** Check to make sure that the I/O base address selected through the configuration utility of Driver488, matches the interrupt setting configured through the appropriate DIP switch on your IEEE 488 interface.
- ***Interrupt Setting:*** Check to make sure that the interrupt setting selected through the configuration utility of Driver488, matches the interrupt setting configured through the appropriate jumper(s) and DIP switch(es) on your IEEE 488 interface.
- ***Direct Memory Access (DMA) Setting:*** Check to make sure that the DMA setting selected through the configuration utility of Driver488, matches the DMA setting configured through the appropriate jumper(s) on your IEEE 488 interface.

## Checking Hardware & Software Settings

### Checking the Interface Board Settings

**Note:** If your Personal488 package includes a plug-and-play interface – such as the Personal488/PCI (with PCI488), Personal488/ATpnp (with AT488pnp), or Personal488/CARD (with CARD488) packages – disregard the list below.

Remove the interface board from the computer, and refer to the appropriate Personal488 chapter in this manual, which corresponds to your Personal488 package.

### Checking the Driver488/W95 Software Settings

1. Open the *Control Panel* window from the *Start* > *Settings* menu, click on the *System* icon, and select the *Device Manager* tab. Under the line "Ports (COM & LPT)", look for a list of used ports. For each port, highlight the port and click on the *Properties* button.
2. Properties already being used in the system are displayed under the *Resources* tab. Values NOT listed are available.

For more information on the configuration of Driver488 software settings for IEEE 488 interfaces and external devices, see chapter *Driver488/W95 & Driver488/WNT* on page 41.

### Checking the Driver488/WNT Software Settings

1. From the console mode, or DOS prompt, execute the program **`WINMSD.EXE`**.
2. When the *Windows NT Diagnostic* dialog box appears, you can check the settings from the available tab displays.

For more information on the configuration of Driver488 software settings for IEEE 488 interfaces and external devices, see chapter *Driver488/W95 & Driver488/WNT* on page 41.

# Appendix A


***IEEE 488 Bus & Serial Bus 121***
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## *IEEE 488 Bus & Serial Bus Lines*

| Bus State | Bus Line | Data Transfer (DIO) Lines | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| **Bus Management Lines** | | | | | | | | | |
| **IFC** | Interface Clear | | | | | | | | |
| **REN** | Remote Enable | | | | | | | | |
| **IEEE 488 Interface: Bus Management Lines** | | | | | | | | | |
| **ATN** | Attention ($04) | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| **EOI** | End-Or-Identify ($80) | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **SRQ** | Service Request ($40) | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **IEEE 488 Interface: Handshake Lines** | | | | | | | | | |
| **DAV** | Data Valid ($08) | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| **NDAC** | Not Data Accepted ($10) | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **NRFD** | Not Ready For Data ($20) | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **Serial Interface: Bus Management Lines** | | | | | | | | | |
| **DTR** | Data Terminal Ready ($02) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **RI** | Ring Indicator ($10) | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **RTS** | Request To Send ($01) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Serial Interface: Handshake Lines** | | | | | | | | | |
| **CTS** | Clear To Send ($04) | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| **DCD** | Data Carrier Detect ($08) | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| **DSR** | Data Set Ready ($20) | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **Hexadecimal & Decimal Values** | | | | | | | | | |
| | Hexadecimal Value | $80 | $40 | $20 | $10 | $08 | $04 | $02 | $01 |
| | Decimal Value | 128 | 064 | 032 | 016 | 008 | 004 | 002 | 001 |

# *IEEE 488 Bus Commands*

| Bus State | IEEE 488 Bus Command (ATN is asserted 1 ) | Data Transfer (DIO) Lines 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|
| **DCL** | Device Clear | **0** | **0** | **0** | **1** | **0** | **1** | **0** | **0** |
| **GET** | Group Execute Trigger ($08) | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** |
| **GTL** | Go To Local ($01) | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** |
| **LAG** | Listen Address Group ($20-3F) | **0** | **0** | **1** | **a** | **d** | **d** | **r** | **n** |
| **LLO** | Local Lock Out ($11) | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **1** |
| **MLA** | My Listen Address | **0** | **0** | **1** | **a** | **d** | **d** | **r** | **n** |
| **MTA** | My Talk Address | **0** | **1** | **0** | **a** | **d** | **d** | **r** | **n** |
| **PPC** | Parallel Poll Config | **0** | **1** | **1** | **0** | **S** | **P2** | **P1** | **P0** |
| **PPD** | Parallel Poll Disable ($07) | **0** | **0** | **0** | **0** | **0** | **1** | **1** | **1** |
| **PPU** | Parallel Poll Unconfig ($15) | **0** | **0** | **0** | **1** | **0** | **1** | **0** | **1** |
| **SCG** | Second. Cmd. Group ($60-7F) | **0** | **1** | **1** | **c** | **o** | **m** | **m** | **d** |
| **SDC** | Selected Device Clear ($04) | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** |
| **SPD** | Serial Poll Disable ($19) | **0** | **0** | **0** | **1** | **1** | **0** | **0** | **1** |
| **SPE** | Serial Poll Enable ($18) | **0** | **0** | **0** | **1** | **1** | **0** | **0** | **0** |
| **TAG** | Talker Address Group ($40-5F) | **0** | **1** | **0** | **a** | **d** | **d** | **r** | **n** |
| **TCT** | Take Control ($09) | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **1** |
| **UNL** | Unlisten ($3F) | **0** | **0** | **1** | **1** | **1** | **1** | **1** | **1** |
| **UNT** | Untalk ($5F) | **0** | **1** | **0** | **1** | **1** | **1** | **1** | **1** |
| **Hexadecimal & Decimal Values** | | | | | | | | | |
| | Hexadecimal Value | $80 | $40 | $20 | $10 | $08 | $04 | $02 | $01 |
| | Decimal Value | 128 | 064 | 032 | 016 | 008 | 004 | 002 | 001 |

# *ASCII Codes*

## ASCII Code Summary

### *Decimal Values 00 to 63 ACG, UCG & LAG*

**Box Items**

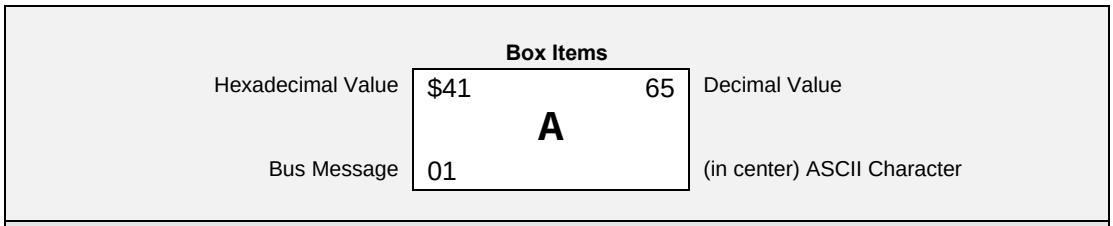
Hexadecimal Value — $41 — 65 — Decimal Value

**A**

Bus Message — 01 — (in center) ASCII Character

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Addressed Command Group (ACG)** | | | | | | | |
| $00 00 **NUL** | $01 01 **SOH** GTL | $02 02 **STX** | $03 03 **ETX** | $04 04 **EOT** SDC | $05 05 **ENQ** | $06 06 **ACK** | $07 07 **BEL** PPD |
| $08 08 **BS** GET | $09 09 **HT** TCT | $0A 10 **LF** | $0B 11 **VT** | $0C 12 **FF** | $0D 13 **CR** | $0E 14 **SO** | $0F 15 **SI** |
| **Universal Command Group (UCG)** | | | | | | | |
| $10 16 **DLE** | $11 17 **DC1** LLO | $12 18 **DC2** | $13 19 **DC3** | $14 20 **DC4** DCL | $15 21 **NAK** PPU | $16 22 **SYN** | $17 23 **ETB** |
| $18 24 **CAN** SPE | $19 25 **EM** SPD | $1A 26 **SUB** | $1B 27 **ESC** | $1C 28 **FS** | $1D 29 **GS** | $1E 30 **RS** | $1F 31 **US** |
| **Listen Address Group (LAG)** | | | | | | | |
| $20 32 **SP** 00 | $21 33 **!** 01 | $22 34 **"** 02 | $23 35 **#** 03 | $24 36 **$** 04 | $25 37 **%** 05 | $26 38 **&** 06 | $27 39 **'** 07 |
| $28 40 **(** 08 | $29 41 **)** 09 | $2A 42 ***** 10 | $2B 43 **+** 11 | $2C 44 **,** 12 | $2D 45 **-** 13 | $2E 46 **.** 14 | $2F 47 **/** 15 |
| $30 48 **0** 16 | $31 49 **1** 17 | $32 50 **2** 18 | $33 51 **3** 19 | $34 52 **4** 20 | $35 53 **5** 21 | $36 54 **6** 22 | $37 55 **7** 23 |
| $38 56 **8** 24 | $39 57 **9** 25 | $3A 58 **:** 26 | $3B 59 **;** 27 | $3C 60 **<** 28 | $3D 61 **=** 29 | $3E 62 **>** 30 | $3F 63 **?** UNL |

### *Decimal Values 64 to 127  TAG & SCG*




| Talk Address Group (TAG) | | | | | | | |
|---|---|---|---|---|---|---|---|
| $40 64 @ 00 | $41 65 A 01 | $42 66 B 02 | $43 67 C 03 | $44 68 D 04 | $45 69 E 05 | $46 70 F 06 | $47 71 G 07 |
| $48 72 H 08 | $49 73 I 09 | $4A 74 J 10 | $4B 75 K 11 | $4C 76 L 12 | $4D 77 M 13 | $4E 78 N 14 | $4F 79 O 15 |
| $50 80 P 16 | $51 81 Q 17 | $52 82 R 18 | $53 83 S 19 | $54 84 T 20 | $55 85 U 21 | $56 86 V 22 | $57 87 W 23 |
| $58 88 X 24 | $59 89 Y 25 | $5A 90 Z 26 | $5B 91 [ 27 | $5C 92 \ 28 | $5D 93 ] 29 | $5E 94 ^ 30 | $5F 95 _ UNT |
| **Secondary Command Group (SCG)** | | | | | | | |
| $60 96 ‘ 00 | $61 97 a 01 | $62 98 b 02 | $63 99 c 03 | $64 100 d 04 | $65 101 e 05 | $66 102 f 06 | $67 103 g 07 |
| $68 104 h 08 | $69 105 i 09 | $6A 106 j 10 | $6B 107 k 11 | $6C 108 l 12 | $6D 109 m 13 | $6E 110 n 14 | $6F 111 o 15 |
| $70 112 p 16 | $71 113 q 17 | $72 114 r 18 | $73 115 s 19 | $74 116 t 20 | $75 117 u 21 | $76 118 v 22 | $77 119 w 23 |
| $78 120 x 24 | $79 121 y 25 | $7A 122 z 26 | $7B 123 { 27 | $7C 124 \| 28 | $7D 125 } 29 | $7E 126 ~ 30 | $7F 127 DEL 31 |

## ASCII Code Details

### *Decimal Values 00 to 31  ACG & UCG Characteristics*

| ASCII Control Codes (Decimal 00 to 31) | | | | |
|---|---|---|---|---|
| **Dec Value** | **Hex Value ($)** | **Character & Abbreviation** | **Name** | **Bus Message** |
| **Addressed Command Group (ACG)** | | | | |
| **00** | **$00** | **None / NUL** | Null | None |
| **01** | **$01** | **^A / SOH** | Start of Header | Go To Local (**GTL**) |
| **02** | **$02** | **^B / STX** | Start of Text | None |
| **03** | **$03** | **^C / ETX** | End of Text | None |
| **04** | **$04** | **^D / EOT** | End of Transmission | Selected Device Clear (**SDC**) |
| **05** | **$05** | **^E / ENQ** | Inquiry | None |
| **06** | **$06** | **^F / ACK** | Acknowledgement | None |
| **07** | **$07** | **^G / BEL** | Bell | Parallel Poll Disable (**PPD**) |
| **08** | **$08** | **^H / BS** | Backspace | Group Execute Trigger (**GET**) |
| **09** | **$09** | **^I / HT** | Horizontal Tab | Take Control (**TCT**) |
| **10** | **$0A** | **^J / LF** | Line Feed | None |
| **11** | **$0B** | **^K / VT** | Vertical Tab | None |
| **12** | **$0C** | **^L / FF** | Form Feed | None |
| **13** | **$0D** | **^M / CR** | Carriage Return | None |
| **14** | **$0E** | **^N / SO** | Shift Out | None |
| **15** | **$0F** | **^O / SI** | Shift In | None |
| **Universal Command Group (UCG)** | | | | |
| **16** | **$10** | **^P / DLE** | Data Link Escape | None |
| **17** | **$11** | **^Q / DC1** | Device Control 1 | Local Lockout (**LLO**) |
| **18** | **$12** | **^R / DC2** | Device Control 2 | None |
| **19** | **$13** | **^S / DC3** | Device Control 3 | None |
| **20** | **$14** | **^T / DC4** | Device Control 4 | Device Clear (**DCL**) |
| **21** | **$15** | **^U / NAK** | Negative Acknowledgement | Parallel Poll Unconfig (**PPU**) |
| **22** | **$16** | **^V / SYN** | Synchronous Idle | None |
| **23** | **$17** | **^W / ETB** | End of Transmission Block | None |
| **24** | **$18** | **^X / CAN** | Cancel | Serial Poll Enable (**SPE**) |
| **25** | **$19** | **^Y / EM** | End of Medium | Serial Poll Disable (**SPD**) |
| **26** | **$1A** | **^Z / SUB** | Substitute | None |
| **27** | **$1B** | **^[ / ESC** | Escape | None |
| **28** | **$1C** | **^\ / FS** | File Separator | None |
| **29** | **$1D** | **^] / GS** | Group Separator | None |
| **30** | **$1E** | **^^ / RS** | Record Separator | None |
| **31** | **$1F** | **^_ / US** | Unit Separator | None |

**Note:** (1) ASCII control codes are sometimes used to "formalize" a communications session between communication devices. (2) **DC1, DC2, DC3, DC4, FS, GS, RS,** and **US** all have user-defined meanings, and may vary in use between sessions or devices. (3) **DC4** is often used as a general "stop transmission character." (4) Codes used to control cursor position may be used to control print devices, and move the print head accordingly. However, not all devices support the full set of positioning codes.

### *Decimal Values 00 to 31 ACG & UCG Descriptions*

| ASCII Control Codes (00 to 31) | | |
|---|---|---|
| **Dec** | **Name** | **Description** |
| **Addressed Command Group (ACG)** | | |
| **00** | Null (**NUL**) | Space filler character. Used in output timing for some device drivers. |
| **01** | Start of Header (**SOH**) | Marks beginning of message header. |
| **02** | Start of Text (**STX**) | Marks beginning of data block (text). |
| **03** | End of Text (**ETX**) | Marks end of data block (text). |
| **04** | End of Transmission (**EOT**) | Marks end of transmission session. |
| **05** | Inquiry (**ENQ**) | Request for identification or information. |
| **06** | Acknowledgement (**ACK**) | "Yes" answer to questions or "ready for next transmission." Used in asynchronous protocols for timing. |
| **07** | Bell (**BEL**) | Rings bell or audible alarm on terminal. |
| **08** | Backspace (**BS**) | Moves cursor position back one character. |
| **09** | Horizontal Tab (**HT**) | Moves cursor position to next tab stop on line. |
| **10** | Line Feed (**LF**) | Moves cursor position down one line. |
| **11** | Vertical Tab (**VT**) | Moves cursor position down to next "tab line." |
| **12** | Form Feed (**FF**) | Moves cursor position to top of next page. |
| **13** | Carriage Return (**CR**) | Moves cursor to left margin. |
| **14** | Shift Out (**SO**) | Next characters do not follow ASCII definitions. |
| **15** | Shift In (**SI**) | Next characters revert to ASCII meaning. |
| **Universal Command Group (UCG)** | | |
| **16** | Data Link Escape (**DLE**) | Used to control transmissions using "escape sequences." |
| **17** | Device Control 1 (**DC1**) | Not defined. Normally used for ON controls. |
| **18** | Device Control 2 (**DC2**) | Usually user-defined. |
| **19** | Device Control 3 (**DC3**) | Not defined. Normally used for OFF controls. |
| **20** | Device Control 4 (**DC4**) | Usually user-defined. |
| **21** | Negative Acknowledgement (**NAK**) | "No" answer to questions or "errors found, re-transmit." Used in asynchronous protocols for timing. |
| **22** | Synchronous Idle (**SYN**) | Sent by asynchronous devices when idle to insure sync. |
| **23** | End of Transmission Block (**ETB**) | Marks block boundaries in transmission. |
| **24** | Cancel (**CAN**) | Indicates previous transmission should be disregarded. |
| **25** | End of Medium (**EM**) | Marks end of physical media, as in paper tape. |
| **26** | Substitute (**SUB**) | Used to replace a character known to be wrong. |
| **27** | Escape (**ESC**) | Marks beginning of an Escape control sequence. |
| **28** | File Separator (**FS**) | Marker for major portion of transmission. |
| **29** | Group Separator (**GS**) | Marker for submajor portion of transmission. |
| **30** | Record Separator (**RS**) | Marker for minor portion of transmission. |
| **31** | Unit Separator (**US**) | Marker for most minor portion of transmission. |

**Note:** (1) ASCII control codes are sometimes used to "formalize" a communications session between communication devices. (2) **DC1, DC2, DC3, DC4, FS, GS, RS,** and **US** all have user-defined meanings, and may vary in use between sessions or devices. (3) **DC4** is often used as a general "stop transmission character." (4) Codes used to control cursor position may be used to control print devices, and move the print head accordingly. However, not all devices support the full set of positioning codes.

### *Decimal Values 32 to 63 LAG*

| ASCII Character Set (Decimal 32 to 63) | | | | |
|---|---|---|---|---|
| **Dec** | **Hex** | **Character** | **Name** | **Bus Message** |
| **Listen Address Group (LAG)** | | | | |
| **32** | **$20** | **<space>** | Space | Bus address 00 |
| **33** | **$21** | **!** | Exclamation Point | Bus address 01 |
| **34** | **$22** | **“** | Quotation Mark | Bus address 02 |
| **35** | **$23** | **#** | Number Sign | Bus address 03 |
| **36** | **$24** | **$** | Dollar Sign | Bus address 04 |
| **37** | **$25** | **%** | Percent Sign | Bus address 05 |
| **38** | **$26** | **&** | Ampersand | Bus address 06 |
| **39** | **$27** | **‘** | Apostrophe | Bus address 07 |
| **40** | **$28** | **(** | Opening Parenthesis | Bus address 08 |
| **41** | **$29** | **)** | Closing Parenthesis | Bus address 09 |
| **42** | **$2A** | ***** | Asterisk | Bus address 10 |
| **43** | **$2B** | **+** | Plus Sign | Bus address 11 |
| **44** | **$2C** | **,** | Comma | Bus address 12 |
| **45** | **$2D** | **-** | Hyphen or Minus Sign | Bus address 13 |
| **46** | **$2E** | **.** | Period | Bus address 14 |
| **47** | **$2F** | **/** | Slash | Bus address 15 |
| **Listen Address Group (LAG)** | | | | |
| **48** | **$30** | **0** | Zero | Bus address 16 |
| **49** | **$31** | **1** | One | Bus address 17 |
| **50** | **$32** | **2** | Two | Bus address 18 |
| **51** | **$33** | **3** | Three | Bus address 19 |
| **52** | **$34** | **4** | Four | Bus address 20 |
| **53** | **$35** | **5** | Five | Bus address 21 |
| **54** | **$36** | **6** | Six | Bus address 22 |
| **55** | **$37** | **7** | Seven | Bus address 23 |
| **56** | **$38** | **8** | Eight | Bus address 24 |
| **57** | **$39** | **9** | Nine | Bus address 25 |
| **58** | **$3A** | **:** | Colon | Bus address 26 |
| **59** | **$3B** | **;** | Semicolon | Bus address 27 |
| **60** | **$3C** | **<** | Less Than Sign | Bus address 28 |
| **61** | **$3D** | **=** | Equal Sign | Bus address 29 |
| **62** | **$3E** | **>** | Greater Than Sign | Bus address 30 |
| **63** | **$3F** | **?** | Question Mark | Unlisten (**UNL**) |

### *Decimal Values 64 to 95 TAG*

| ASCII Character Set (Decimal 64 to 95) | | | | |
|---|---|---|---|---|
| **Dec** | **Hex** | **Character** | **Name** | **Bus Message** |
| **Talk Address Group (TAG)** | | | | |
| **64** | **$40** | **@** | At Sign | Bus address 00 |
| **65** | **$41** | **A** | Capital A | Bus address 01 |
| **66** | **$42** | **B** | Capital B | Bus address 02 |
| **67** | **$43** | **C** | Capital C | Bus address 03 |
| **68** | **$44** | **D** | Capital D | Bus address 04 |
| **69** | **$45** | **E** | Capital E | Bus address 05 |
| **70** | **$46** | **F** | Capital F | Bus address 06 |
| **71** | **$47** | **G** | Capital G | Bus address 07 |
| **72** | **$48** | **H** | Capital H | Bus address 08 |
| **73** | **$49** | **I** | Capital I | Bus address 09 |
| **74** | **$4A** | **J** | Capital J | Bus address 10 |
| **75** | **$4B** | **K** | Capital K | Bus address 11 |
| **76** | **$4C** | **L** | Capital L | Bus address 12 |
| **77** | **$4D** | **M** | Capital M | Bus address 13 |
| **78** | **$4E** | **N** | Capital N | Bus address 14 |
| **79** | **$4F** | **O** | Capital O | Bus address 15 |
| **Talk Address Group (TAG)** | | | | |
| **80** | **$50** | **P** | Capital P | Bus address 16 |
| **81** | **$51** | **Q** | Capital Q | Bus address 17 |
| **82** | **$52** | **R** | Capital R | Bus address 18 |
| **83** | **$53** | **S** | Capital S | Bus address 19 |
| **84** | **$54** | **T** | Capital T | Bus address 20 |
| **85** | **$55** | **U** | Capital U | Bus address 21 |
| **86** | **$56** | **V** | Capital V | Bus address 22 |
| **87** | **$57** | **W** | Capital W | Bus address 23 |
| **88** | **$58** | **X** | Capital X | Bus address 24 |
| **89** | **$59** | **Y** | Capital Y | Bus address 25 |
| **90** | **$5A** | **Z** | Capital Z | Bus address 26 |
| **91** | **$5B** | **[** | Opening Bracket | Bus address 27 |
| **92** | **$5C** | **** | Backward Slash | Bus address 28 |
| **93** | **$5D** | **]** | Closing Bracket | Bus address 29 |
| **94** | **$5E** | **^** | Caret | Bus address 30 |
| **95** | **$5F** | **_** | Underscore | Untalk (**UNT**) |

### *Decimal Values 96 to 127 SCG*

| ASCII Character Set (96 to 127) | | | | |
|---|---|---|---|---|
| **Dec** | **Hex** | **Character** | **Name** | **Bus Message** |
| **Secondary Command Group (SCG)** | | | | |
| **96** | **$60** | **`** | Grave | Command 00 |
| **97** | **$61** | **a** | Lowercase A | Command 01 |
| **98** | **$62** | **b** | Lowercase B | Command 02 |
| **99** | **$63** | **c** | Lowercase C | Command 03 |
| **100** | **$64** | **d** | Lowercase D | Command 04 |
| **101** | **$65** | **e** | Lowercase E | Command 05 |
| **102** | **$66** | **f** | Lowercase F | Command 06 |
| **103** | **$67** | **g** | Lowercase G | Command 07 |
| **104** | **$68** | **h** | Lowercase H | Command 08 |
| **105** | **$69** | **I** | Lowercase I | Command 09 |
| **106** | **$6A** | **j** | Lowercase J | Command 10 |
| **107** | **$6B** | **k** | Lowercase K | Command 11 |
| **108** | **$6C** | **l** | Lowercase L | Command 12 |
| **109** | **$6D** | **m** | Lowercase M | Command 13 |
| **110** | **$6E** | **n** | Lowercase N | Command 14 |
| **111** | **$6F** | **o** | Lowercase O | Command 15 |
| **Secondary Command Group (SCG)** | | | | |
| **112** | **$70** | **p** | Lowercase P | Command 16 |
| **113** | **$71** | **q** | Lowercase Q | Command 17 |
| **114** | **$72** | **r** | Lowercase R | Command 18 |
| **115** | **$73** | **s** | Lowercase S | Command 19 |
| **116** | **$74** | **t** | Lowercase T | Command 20 |
| **117** | **$75** | **u** | Lowercase U | Command 21 |
| **118** | **$76** | **v** | Lowercase V | Command 22 |
| **119** | **$77** | **w** | Lowercase W | Command 23 |
| **120** | **$78** | **x** | Lowercase X | Command 24 |
| **121** | **$79** | **y** | Lowercase Y | Command 25 |
| **122** | **$7A** | **z** | Lowercase Z | Command 26 |
| **123** | **$7B** | **{** | Opening Brace | Command 27 |
| **124** | **$7C** | **\|** | Vertical Line | Command 28 |
| **125** | **$7D** | **}** | Closing Brace | Command 29 |
| **126** | **$7E** | **~** | Tilde | Command 30 |
| **127** | **$7F** | **DEL** | Delete | Command 31 |

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*Notes*

# Abbreviations

| | | | |
|---|---|---|---|
| • | (bullet symbol) “and” (e.g. ***SC•CA**) | **FCC** | Federal Communications Commission |
| * | (asterisk symbol) “unasserted” (e.g. ***SC**) | **FF** | Form Feed (ASCII Code) |
| ***CA** | Not Controller Active mode | **FS** | File Separator (ASCII Code) |
| ***SC** | Not System Controller mode | **GET** | Group Execute Trigger bus command |
| **A/D** | Analog-to-Digital | **GPIB** | General Purpose Interface Bus |
| **ACG** | Addressed Command Group | **GS** | Group Separator (ASCII Code) |
| **ACK** | Acknowledgement (ASCII Code) | **GTL** | Go To Local bus command |
| **ADC** | Analog-to-Digital Converter | **GUI** | Graphical User Interface |
| **API** | Application Program Interface | **H/W** | Hardware |
| **ASCII** | American Standard Code for Info. Interchange | **HT** | Horizontal Tab (ASCII Code) |
| **ATN** | Attention line | **IDDC** | Invalid Device Dependent Command |
| **BEL** | Bell (ASCII Code) | **IDDCO** | Invalid Device Dependent Command Option |
| **BS** | Backspace (ASCII Code) | **IEEE** | Institute of Electrical & Electronic Engineers |
| **CA** | Controller Active mode | **IFC** | Interface Clear line |
| **CAN** | Cancel (ASCII Code) | **IOCTL** | Input/Output Control |
| **CCL** | Character Command Language | **ISA** | Industry Standard Architecture bus |
| **CJC** | Cold Junction Compensation | **ISR** | Interrupt Service Routine |
| **CMD** | Bus Command interpretation | **ist** | Bus Device Individual Status |
| **CR** | Carriage Return (ASCII Code) | **LAG** | Listen Address Group bus command |
| **CSR** | Calibration Status Register | **LED** | Light-Emitting Diode |
| **CTS** | Clear To Send line | **LF** | Line Feed (ASCII Code) |
| **DAV** | Data Valid line | **LLO** | Local Lock Out bus command |
| **DC1** | Device Control 1 (ASCII Code) | **LSB** | Least Significant Bit |
| **DC2** | Device Control 2 (ASCII Code) | **MAV** | Message Available bit |
| **DC3** | Device Control 3 (ASCII Code) | **MLA** | My Listen Address |
| **DC4** | Device Control 4 (ASCII Code) | **MSB** | Most Significant Bit |
| **DCD** | Data Carrier Detect line | **MSS** | Master Summary Status bit |
| **DCL** | Device Clear bus command | **MTA** | My Talk Address |
| **DDE** | Dynamic Data Exchange | **N/U** | Not Used |
| **DEL** | Delete (ASCII Code) | **NAK** | Negative Acknowledgement (ASCII Code) |
| **DIO** | Data Transfer (I/O) line | **NDAC** | Not Data Accepted line |
| **DLE** | Data Link Escape (ASCII Code) | **NRFD** | Not Ready For Data line |
| **DLL** | Dynamic Link Library | **NUL** | Null (ASCII Code) |
| **DMA** | Direct Memory Access | **NV-RAM** | Non-Volatile RAM |
| **DMM** | Digital Multimeter | **PCI** | Peripheral Component Interconnect bus |
| **DSR** | Data Set Ready line | **PPC** | Parallel Poll Configure bus command |
| **DTR** | Data Terminal Ready line | **PPD** | Parallel Poll Disable bus command |
| **EEPROM** | Electronically Erasable Programmable ROM | **PPU** | Parallel Poll Unconfig bus command |
| **EM** | End of Medium (ASCII Code) | **RAM** | Random-Access Memory |
| **ENQ** | Inquiry (ASCII Code) | **REN** | Remote Enable line |
| **EOI** | End-Or-Identify line | **RI** | Ring Indicator line |
| **EOL** | End-Of-Line terminator | **RMS** | Root Mean Square |
| **EOT** | End of Transmission (ASCII Code) | **ROM** | Read-Only Memory |
| **EPROM** | Erasable Programmable ROM | **RQS** | Request for Service bit |
| **ESB** | Event Status Register bit | **RS** | Record Separator (ASCII Code) |
| **ESC** | Error Source Register | **RS-** | Revised Standard (e.g. RS-232, RS-422) |
| **ESC** | Escape (ASCII Code) | **rsv** | Request for Service bit |
| **ESE** | Event Status Enable Register | **RTD** | Resistance Temperature Device |
| **ESR** | Event Status Register | **RTS** | Request To Send line |
| **ETB** | End of Transmission Block (ASCII Code) | **SC** | System Controller mode |
| **ETX** | End of Text (ASCII Code) | **SCG** | Secondary Command Group |

| | | | |
|---|---|---|---|
| **SCPI** | Standard Cmds. for Programmable Instruments | **SUB** | Substitute (ASCII Code) |
| **SCSI** | Small Computer System Interface bus | **SYN** | Synchronous Idle (ASCII Code) |
| **SDC** | Selected Device Clear bus command | **T/C** | Thermocouple |
| **SI** | Shift In (ASCII Code) | **TAG** | Talk Address Group bus command |
| **SO** | Shift Out (ASCII Code) | **TCT** | Take Control bus command |
| **SOH** | Start of Header (ASCII Code) | **TTL** | Transistor-Transistor Logic |
| **SPD** | Serial Poll Disable bus command | **UCG** | Universal Command Group |
| **SPE** | Serial Poll Enable bus command | **UNL** | Unlisten bus command |
| **SRE** | Service Request Enable Register | **UNT** | Untalk bus command |
| **SRQ** | Service Request line | **US** | Unit Separator (ASCII Code) |
| **STB** | Status Byte Register | **VDM** | Virtual DOS Machine |
| **STX** | Start of Text (ASCII Code) | **VT** | Vertical Tab (ASCII Code) |

*Notes*

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