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**AE SERIES**  
**GPS MASTER CLOCK SYSTEMS**

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**AE SERIES GPS MASTER CLOCK SYSTEMS**  
**REV 09/18/00**

**DESCRIPTION**

AE Series GPS Master Clock Systems are synchronized by the Global Positioning System (GPS), which is a system of satellites deployed by the U.S. Department of Defense. Although this system was intended initially for military applications, it is now available in a commercial version for use in navigation and time reference applications. Universal Coordinated Time (UTC) and date are provided along with the extensive navigational data by the GPS satellites. The AE Series GPS Master Clock Systems use this information along with other user programmed information such as time zone and Daylight Savings Time (DST) information to provide accurate, local time, date, and Julian Date for any size clock system. See the ATS GPS Master Clock brochure for more information.

A typical AE Series GPS Master Clock System consists of a GPS-427A GPS Antenna/Receiver, an AE2412R-427A or AE26R-427A GPS Master Clock, and any quantity of AEXX-354 and/or CC2000 Series Digital System Clocks. Other clocks and displays such as Time Zone Clocks, Time & Date Displays, and Julian Clock Displays can also be included. System components are available for controlling other brands of analog and digital clocks, for ringing bells, and for controlling other equipment.

The AE2412R-427A or AE26R-427A GPS Master Clocks have built-in controls for setting the time (12 or 24 Hour format), the time zone offset and the DST data. Once programmed and connected to the GPS-427A GPS Antenna/Receiver, the master clock will display accurate, local time and provide an RS232 serial output for use by AEXX-354 and/or CC2000 Series System Clocks.

There are two GPS Master Clock models. The AE2412R-427A and AE26R-427A. Both can be either rack mounted or shelf mounted depending on the application. For more details see the pictures in the Installation Section of this manual.

This manual covers both models, and will use the term's "master clock", or "GPS Master" to simplify the manual.

Most systems are Factory Configured to your specifications. For your specific system configuration, refer to the drawings and/or addenda at the back of this manual.

Also, for other installed options, refer to the drawings and addenda provided for the specific option.

This product is intended for use on systems requiring accurate time of day synchronized with UTC. Interference, fading or satellite failure could affect the accuracy of this system.

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**SPECIFICATIONS**

- Time Reference:** Universal Coordinated Time, also known as Greenwich Mean Time (UTC/GMT) is provided by the GPS-427A Antenna / Receiver System and the Global Positioning System satellites (GPS). The GPS Master acquires time and date from the GPS-427A Antenna/Receiver once each minute as the GPS-427A passes through the 30th second. Time corrections such as "leap seconds" and "leap years" are provided by the GPS system's atomic clock. For specifications on the GPS-427A refer to drawing at the back of this manual.
- GPS Lock:** The AE2412R-427A and AE26R-427A GPS Master Clocks reads the data from the GPS-427A Antenna/Receiver constantly at a 2400 Baud rate. They look for the \$GPRMC, NMEA sentence which includes UTC time and date and the receiver status. When 2 or more satellites are received, as indicated by the receiver's status, the decimal point on the 6th digit (seconds) will be lighted at the next 30<sup>th</sup> second update. This could take up to 15 minutes the first time the system is powered on. The decimal point will pulse off during time updates from the GPS-427A, once each minute as it passes through the 30th second.
- Accuracy:** Within 500 msec of UTC + time zone offset when GPS LOCK is lighted. Uses a 0.005% crystal time base when not locked on to the GPS.
- Controls:** Built-in controls are provided for manually setting the time in 12 or 24 hour format, the time zone offset from UTC, the day of the week and whether or not to apply DST.
- RS232 Output:** Time, Day, Date, Julian Date, and DST information is provided via the RS232 Output. This output is provided in the AEXX-354 format (354 Output) for use by AEXX-354 and/or CC2000 Series System Clocks and Displays. This output signal is active each minute when the GPS master clock rolls over from XX:XX:59 to XX:XX:00. Therefore, all remote displays connected to this output will be updated once each minute at the 00<sup>th</sup> second. Local time is sent with address 15, local date is sent with address 13 and the local day of the week and Julian day is sent with address 12. Addresses on the AEXX-354 remote displays can be set to display time, date, day of the week or Julian day. AEXX-354 remote displays can also be set to accept or reject the DST information. CC2000 Series System Clocks will only read address 0 data (All Call) or address 15 data (local time of day). This RS232 output signal can drive up to 50 remote AEXX-354 and/or CC2000 Series Digital System Clocks or Displays distances of up to 2000 feet. For additional remote displays, or for longer distances, one or more AE455-DR6 RS232 drivers can be added to the system.
- Power:** AE2412R-427A and AE26R-427A GPS Master Clocks require 120 VAC, 60 Hz. (less than 6 watts). Optional power includes 50 HZ, 12 VAC, 12 to 15 VDC and 220 VAC.

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- Battery Backup:** A self-charging NICAD battery backup system is provided for maintaining time during power outages for up to four hours. The GPS reference and the LED displays are off line during backup. In addition the GPS-427A Antenna / Receiver has a backup system of its own that keeps time and data for up to six months. The AEXX-354 remote clocks and displays have a NICAD battery backup system. The CC2000 Series System Clocks have a capacitive backup system
- Wiring:** The AE2412R-427A and AE26R-427A GPS Master Clocks have clearly labeled, terminal blocks on the back panel for all external wiring. See the system block diagrams and wiring diagrams at the back of this manual for more details.
- Digits:** Six digits, only. The AE26R-427A has six 2.3-Inch High, Seven Segment Digits. The AE2412R-427A has four 2.3-Inch High, Seven Segment Digits for the Hours and Minutes, and two One-Inch High, Seven Segment Digits for the Seconds. For additional digit specifications, see the drawings at the back of this manual.
- Enclosures:** The enclosures of both GPS Master Clocks are made of black anodized aluminum with .118" thick red acrylic lens. The rack mount ears are removable for shelf mounted applications. For the size, see the drawings at the back of this manual.
- For all remote system clocks and displays, refer to the specific manuals supplied with those units.
- Options:** When options are ordered, supplemental information is provided with addenda and additional drawings.

***For all other options refer to the drawings at the back of this manual for additional specifications.***

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**INSTALLATION**

Most systems are Factory Configured and are supplied with a Factory Configuration Addendum.

**MOUNTING THE AE2412R-427A or AE26R-427A GPS MASTER CLOCKS**

The AE2412R-427A and AE26R-427A Master Clocks are intended for mounting in a standard 19" equipment rack. The AE2412R-427A requires 5.25 inches of rack height (3U) and the AE26R-427A requires 3.5 inches of rack height (2U). For shelf mounting the rack mount ears can be removed. See the drawings at the back of this manual for more details.



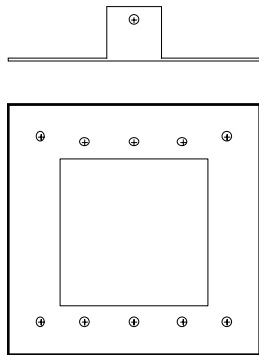
**AE2412R-427**



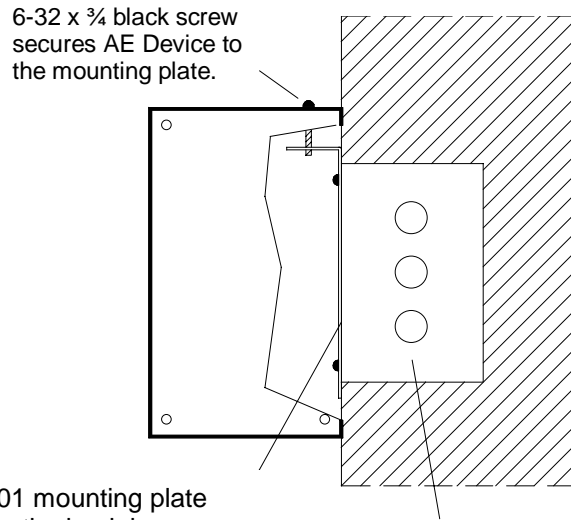
**AE26R-427**

**MOUNTING SYSTEM CLOCKS AND DISPLAYS**

The AEXX-354 and CC2000 Series System Clocks and Displays can be mounted in a variety of ways. Things to consider for mounting include ambient light, viewing area, ambient temperature, dirt or dust. Most models are supplied with one or more 1210-0101 mounting brackets for wall mounting to a single or double gang box. See the detail below. For other mounting options, such as ceiling mounts or double-sided mounts, refer to the specific drawings.



**1210-0101  
mounting plate detail**



**1210-0101 mounting plate  
fastens to the back box.**

**Single or double gang box  
(supplied by others)  
Must be securely mounted**

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**WIRING:**

There are many wiring configurations for the GPS Master Clock Systems, depending on the functions used and the options installed.

Most AE Series, GPS Master Clocks have the rack mount enclosure, such as the AE22412R-427A and the AE26R-427A. A power cord is provided for the 120 VAC powered units. For other power options, wiring addenda is provided. A clearly labeled terminal block is provided for all signal wiring such as for the GPS-427A and RS232 Output connections on the rack mount units. An additional terminal block (TB2) is installed when needed.



For the remote clocks and displays, clearly labeled pigtail leads wires are provided for the power at the back panel of the unit. Additional pigtail leads are provided for the RS232 signal connection. For more detail, refer to the specific manuals provided with the remote clocks and displays, or the addendum sheets provided for specific Factory Configuration. Also, see the wiring diagrams for more detail at the back of this manual.

**POWER**

All standard rack mount versions will have a six-foot power cord for the 120 VAC, 60 HZ power. Standard wall mount versions have pigtail lead wires for the 120 VAC, 60 HZ power. For any other power options refer to the wiring diagrams or power wiring labels. The GPS-427A is powered from the AEXX-427A Master clock. Each AEXX-354 and/or CC2000 Series Remote Clock will also require power. Refer to the specific manual supplied for that product.

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**GPS-427A ANTENNA / RECEIVER**

**MOUNTING**

The GPS-427A Antenna / Receiver System is housed in a weatherproof enclosure, intended for mounting outdoors. It requires an unobstructed view of a 120-degree portion of the sky. If possible the antenna should be mounted vertically on the roof of a building, however height is not important. It should be protected from lightning or possible falling objects. Avoid mounting close to high power transmitting equipment or antennae. See the drawings at the back of this manual for more details.

**WIRING**

The GPS-427A Antenna/Receiver has clearly labeled terminal blocks. Simply wire from the GPS427A terminals to the terminals on the GPS master clock.

Since the GPS-427A is providing a data output, and is powered by 12 VDC, standard three conductor 22 gage, data cable can be used. The GPS-427A can be located at a distance up to 100 feet from the master clock. If you are connecting to an AE2412R-427A or an AE26R-427A GPS Master Clock, clearly labeled terminal blocks are provided on the back panel for connecting the GPS-427A.

GPS-427A

AEXX-427A GPS Master Clock

Connect	"TXD1" terminal	to	"DATA" terminal
Connect	"GND" terminal	to	"COM" terminal
Connect	"+12VDC" terminal	to	"12V+" terminal



See the drawings at the back of this manual for more details.

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**RS232 SIGNAL TO THE REMOTE CLOCKS AND DISPLAYS (354 OUTPUT)**

Clearly labeled terminal blocks are provided at the back panel of the GPS Master Clock for connecting up to 50 AEXX-354 or CC2000 Series Remote Displays. Connect the "RCV" and "COM" signals from the AEXX-427A GPS Master Clock in parallel to the "RCV" and "COM" wires of all AEXX-354 and CC2000 Series Remote Displays.

See the drawings at the back of this manual for more details.

**NMEA RECEIVED SENTENCES**

The NMEA received sentences from the GPS-427A Antenna /Receiver are available for use by other equipment or computers by connecting to the "DATA" and "COM" signal wires or terminals. This is a 2400 Baud RS232 signal.

**OPERATION**

**APPLYING POWER**

After all wiring is complete, set the SET / RUN switch to the RUN position and apply power to the GPS Master. The displays will rotate during the self-test and then display a version number for about 3 seconds. After the version number, the display will show 1:00:00. If there are AEXX-354 and/or CC2000 Series Remote Displays connected to the 354 Output, they will not respond until the GPS Master passes through the 00<sup>th</sup> second.



**SETTING THE TIME (GPS-427A CONNECTED)**

Place the SET/RUN switch to the SET position. The clock will now prompt for a 12 or 24 hour format. It will display 24Hr for 24 hour and 12Hr for 12-hour format. To change formats press the INC (Increment) switch until the desired format is shown and then press ENTER.

The AEXX-427A will now prompt for the Time Zone Offset. The display will show 0: OFS. Using the INCREMENT switch set the desired time zone offset (0 - 23) from UTC. This number will be subtracted from the Hours of the UTC time received from the GPS-427A. Press ENTER.



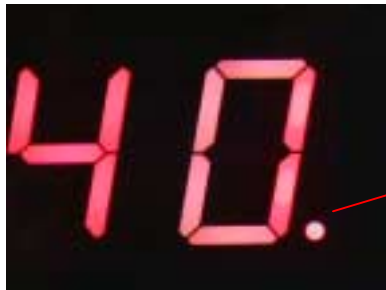
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***Always use Standard Time when determining your Time Zone Offset from UTC. For example, the Time Zone Offsets for EST, CST, MST and PST are always 5, 6, 7 and 8 respectively.***

The GPS Master will now prompt for the day of the week. It will display 1: dAy. 1 = Sunday, 2 = Monday, 7 = Saturday. Press the INCREMENT switch each time to advance the day to the desired day. Press ENTER. The day of the week is not critical, as it will be computed from the date received from the GPS.

Next it will prompt for the DST data. It will display either "n: dSt" or "Y: dSt". "n" is no DST and "Y" is yes DST. To change from one to the other, press INCREMENT. Then press ENTER. DST adjustments will occur at 2:00 AM local time according to U.S. law, which is the first Sunday in April and the last Sunday in October. AEXX-354 Remote Clocks can be set to accept or reject the DST data. CC2000 System Clocks can only read what is sent.

The GPS Master will now prompt for time. If the GPS-427A is connected, you do not have to enter time. Simply press ENTER until the display shows dONE. Then set the SET/RUN switch back to the RUN position. The master clock will go through a self-test, then display a time. This time will not be correct to the GPS. The GPS Master will acquire time from the GPS-427A the next time it passes through the 30th second. If the GPS-427A is locked on to two or more satellites, the decimal point on the 6th digit (seconds) will be lighted and the GPS Master will display UTC minus the time zone offset entered above. If the GPS-427A is not locked on to sufficient satellites, the decimal point will not be lighted. However, the GPS Master will still acquire UTC from the GPS-427A. The accuracy of this time will be dependent on the amount of time elapsed since the last time the GPS-427A has been corrected by the GPS satellites. The GPS-427A free runs on a 0.005% crystal time base when not locked on to the GPS satellites. Proper antenna location and signal reception are important for accurate updated time displays. Monitor the GPS Lock indicator (decimal point on the 6th digit) to be sure your time is most accurate.



**DECIMAL POINT INDICATES  
GPS IS LOCKED ON**

As the GPS Master passes through the 00<sup>th</sup> second, it will output its time, date, Julian Date, day of the week, and DST information to the 354 Output terminals or wires for use by the Remote Displays connected to the system.

During power outages, both the GPS-427A and the GPS Master using their respective crystal time bases will maintain the system time. When power returns the system it will be updated by the GPS-427A at its 30th second. The GPS Lock indicator may take up to 15 minutes to light. For short power outages the time and data will be available at the master and all Remote Displays and Clocks immediately after power returns, since they all have a battery or capacitive backup system.

### **SETTING THE TIME (GPS-427A NOT CONNECTED)**

This type of operation is only recommended for temporary use as the accuracy is limited, and the DST function is not available.

If you are using the GPS Master without the GPS-427A, you can set UTC time manually using the front panel switches. Time can also be set to local time if you enter a time zone offset of 0. In this mode of operation, time is controlled by the 0.005% crystal time base built-in the GPS Master.

Use the same procedure as before to set the time, day, DST and offset. Be sure to select "N" for no DST. The DST feature should not be used without the signal from the GPS-427A.

During power outages, the system time will be maintained by the GPS Master using its crystal time base. When power returns time will be displayed.

### **ADDITIONAL INFORMATION ABOUT THE GPS-427A**

The AEXX-427A time is updated once each minute by the GPS-427A as it passes through the 30th second. The GPS-427A receives Universal Coordinated Time (UTC), also known as Greenwich Mean Time from the Global Positioning System of satellites, which provide coverage over the world. They are operated and maintained by the U.S. Department of Defense.

A quartz crystal time base is provided for timekeeping during loss of GPS signal, and during power outages.

The receiver outputs NMEA1083 ASCII information via RS232 to the AEXX-427A. UTC time and date is then extracted from the data and used for resetting the time and date on the AEXX-427AA.

The GPS-427A uses either the Garmin GPS30 or the GPS35 TracPak (TM) GPS Smart Antenna. Refer to the Garmin technical manual, supplied with this manual for more details.

### **354 OUTPUT (RS232) FOR REMOTE CLOCKS AND DISPLAYS**

Local time, date, Julian date, day of the week, and DST information from the master clock are available from the 354 Output which is normally used for updating AEXX-354 and/or CC2000 Series Remote Displays. This is a 2400-BAUD signal, that is available once each minute as the master clock goes through the 00th second. It is available at the back panel of the AEXX-427A master clocks. Individual DST settings are available on the Remote Displays by factory set jumpers.

Up to 50 AEXX-354 and/or CC2000 Series devices can be connected to this signal at distances up to 2000 feet away. AE455-DR6 RS232 Drivers are available if additional displays or distances are required. Optional clock synchronization outputs are also available.

### **TYPES OF DISPLAYS**

Various types of displays are available using the AEXX-354 Series Remote Displays. Such displays can include, time, date and time, Julian Date and time, etc. Time zone displays can be

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added using the AEXX-388-X Series Time Zone Clocks. The CC2000 Series System Clocks can be used for displaying time of day only.

Some examples are shown below:



AE44-388-4 : Time Zone Display



AE212-354 : Julian Day                      Month / Day                      Time of Day



AE29-354 : Month / Day                      Time of Day

RS232 OUTPUT DATA

The AE Series GPS Master Clock transmits a series of 10-Byte messages via RS232 to AEXX-354 and CC2000 Series Remote Displays. These 10-Byte messages include Time in 12 or 24-Hour format, Date, Julian Date, Day of the Week, and other control functions.

Time Format:

Byte 0	Start Character – 11H
Byte 1	Address – 15
Byte 2	Mode – 3 for 12 Hr Format, 4 for 24 Hr Format
Bytes 3-8	Time – HHMMSS
Byte 9	0 for AM, 1 for PM

Date Format:

Byte 0	Start Character – 11H
Byte 1	Address – 13
Byte 2	Mode – 0 for ASCII Characters
Bytes 3-8	Date – MMDDYY
Byte 9	0

Day of the Week and Julian Date Format:

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Byte 0	Start Character – 11H
Byte 1	Address – 12
Byte 2	Mode – 0 for ASCII Characters
Bytes 3,4	Day of the Week – (1 through 7) 1 = Sunday, 7= Saturday
Byte 5	An ASCII Space – 20H
Bytes 6-8	Julian Day – (001 through 365, or 366 on leap years) 1 = Jan 1 <sup>st</sup>
Byte 9	0

The AE Series GPS Master Clock will automatically send these messages every minute at the 00<sup>th</sup> second.

See the AEXX-354 and/or CC2000 Series manuals supplied with those models for any further information.

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**TECHNICAL SUPPORT**

For any questions concerning installation and operation of this product, contact our factory at:

**PHONE (800) 444-7161  
OR  
FAX (318) 797-4864**

**SERVICE POLICY**

It is recommended that all service for this product be done by the factory or by a factory authorized service representative. Applied Technical Systems will provide ongoing service support in and out of warranty. Send your repairs to:

**APPLIED TECHNICAL SYSTEMS  
849 KING PLACE  
SHREVEPORT, LA 71115**

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WARRANTY POLICY**

ATS warrants its products to be free of defects in material and workmanship for a period of 24 months from the date of purchase. ATS will repair or replace any product returned to its authorized factory service center within the warranty period so long as there is no evidence that the product has been abused, misused, damaged by lightning, overloads of any kind or water, or altered in any way.

Products returned for warranty must be returned with freight prepaid. ATS will pay normal freight charges to return the product to the customer. Special premium freight requested by the customer will be charged to the customer.

ATS disclaims any warranties expressed or implied, including merchantability and/or fitness for a particular purpose. In no event shall ATS be held liable for incidental or consequential damages.