

MODEL 120A

GNSS SYNCHRONIZED CLOCK

USER MANUAL



ARBITER SYSTEMS, INC. PASO ROBLES, CA 93446

U.S.A.

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Model 120A

GNSS Synchronized Clock

Operation Manual

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What This Manual Covers

This manual describes the set up and operation of the Model 120A series GNSS synchronized clocks.

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1 General

1.1 Overview

The Model 120A GNSS Synchronized Clock is a multi-satellite system (GPS, Galileo, GLONASS, BeiDou) timing source. Designed as an economical solution for reclosers and other enclosed installations, includes a rugged, low-profile, bulkhead-mount antenna with 5 meters of cable.

The Model 120A has a seventy-two channel receiver, capable of tracking up to 3 satellite constellation systems simultaneously providing a 100 ns rms accuracy. Two pluggable terminal strip outputs provide IRIG-B unmodulated, 1 PPS, or Programmable Pulse; software selectable. These outputs are configurable to a 50-ohm driver or a high-capacity driver. The Model 120A comes standard with two communication ports, one RS-232 and one USB. A SPST relay is also included and is configurable to Out of Lock, Fault, Alarm, Stabilized, or Programmable Pulse. Low-voltage dc power input accepts + 8 Vdc to + 32 Vdc.

1.2 Equipment Included

1.2.1 Model 120A GNSS Synchronized Clock

One 1 four-position and 4 two-position pluggable terminal strip connectors installed and flange mounts attached.

1.2.2 Antenna and Cable Assembly (AS0111600)

Included: Bulkhead mounted GPS antenna that is active, low-profile, and weatherproof. It requires 2.5 Vdc to 5.5 Vdc on the male TNC connector for power. A 5-meter (16 foot) RG-174/U antenna cable with 50 ohm characteristic impedance and terminated with a female TNC connector and a male F connector.

1.2.3 Mounting Flanges (HD0089800)

The included mounting flanges (2) are pre-attached.

1.2.4 Input / Output Connectors (CN0019202)

Four 2 position pluggable terminal strip connectors for connecting the power, relay contacts and signal outputs are pre-attached to the Model 120A.

1.2.5 Input / Output Connectors (CN0019204)

One 4 position pluggable terminal strip connector for connecting serial communication port is pre-attached to the Model 120A.

1.2.6 Setup Guide (PD0058300)

Brief instructions to get started using the Model 120A.

1.3 Equipment Available

1.3.1 Micro USB Cable (CA0033700)

A 6 ft USB 2.0 A male to micro 5 pin male 28/24 AWG Cable w/ Ferrite Core (Gold Plated).

1.3.2 BNC (Male) Breakout to 100 mm Wires (AP0003400)

Transitions two wires to a male BNC connection.

1.3.3 BNC (Female) Breakout to 100 mm Wires (AP0008900)

Transitions two wires to a female BNC connection.

1.3.4 BNC (Female) Breakout to Screw Terminals (AP0014900)

Transitions wires to a female BNC connection via screw terminals.

1.3.5 BNC (Male) Breakout to Screw Terminals (AP0015000)

Transitions wires to a male BNC connection via screw terminals.

2 Specifications

2.1 Receiver Characteristics

2.1.1 Input Signal

Accepts GPS L1 C/A, Galileo E1B/C, GLONASS L1OF and BeiDou B1I on F-type connector.

2.1.2 Time Accuracy

± 100 ns rms when receiving 4 or more satellites.

2.1.3 Satellite Tracking

Seventy-two channel receiver simultaneously tracks 2 frequencies with the ability to synchronize to 72 satellites (defaults: GPS/Galileo and GLONASS). GLONASS and BeiDou cannot be selected at the same time.

2.1.4 Acquisition

Receiver: 30 seconds

Output stabilization: 2 minutes

2.1.5 Antenna

Included, bulkhead mount, active (+ 5 VLNA power) GPS L1 frequency, TNC connector.

2.1.6 Antenna Cable

RG-174/U, 5 m (16 feet) included. Terminated with TNC and F-Type connectors.

2.2 Interface

The Model 120A interface consists of a F-Type antenna connector, 4 LED annunciators, and a twelve-position pluggable 5 mm terminal strip on one panel with a micro USB connector, data LED and a recessed reset button on the opposite panel.

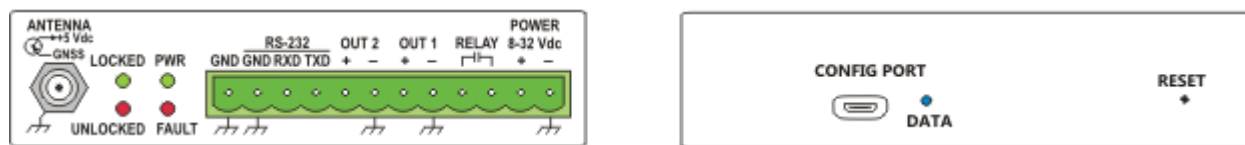


Figure 2-1: Model 120A End Panels

2.2.1 Antenna Input

The antenna input is a F-type connector for active GPS/GNSS antennas and provides 5 V LNA power (100 mA maximum).

2.2.2 LED Annunciators

Locked (green): Illuminated when the clock is actively tracking and synchronizing to satellite signals.

Unlocked (red): Illuminated when the clock is not receiving satellite signals.

PWR (green): Illuminated when the clock is receiving sufficient DC power to operate the unit.

Fault (red): Illuminated when the clock detects a fault.

2.2.3 Communication Ports

USB 2.0 micro USB connector emulates serial com port with a 115200 baud rate, 1 stop bit, 8 data bits and no parity. Used for configuration and firmware updates.

RS-232 Port communications port on 3 pins of the pluggable terminal strip (Txd, Rxd, Gnd). Used for configuration and serial broadcast signals.

- 200 to 115200 baud rates
- 7 or 8 data bits
- 1 or 2 stop bits
- Even, Odd or None parity Used for configuration and serial broadcast signals.

2.2.4 Outputs

There are two logic level (+5 Vdc) programmable pulse outputs that can be configured to one of the signals listed below with the choice between UTC or Local time and low (50 ohm) or high drive capability.

- IRIG-B
- IRIG-B with C37.118 (2011) extensions
- DCF77
- Pulse Per Day (PPD)
- Pulse Per Hour (PPH)
- Pulse Per Second (PPS)

2.2.5 Relay

Form A (SPST-N)), 400 V peak ac/dc. 20 ohms-40 ohms on resistance.

Signal: Out of Lock, Fault, PPM, PPH, PPD, ST

Fail Safe: In Unlocked/Fault state (power off), contacts are open.

2.2.6 Reset Function

There is a recessed reset button on right of panel with USB port and LED. The reset button has two functions:

1. Restart the Model 120A: Press the button momentarily to restart.
2. Reset the factory defaults: Press and hold the reset button in until the 4 LEDs next to the output connector start blinking to reset.

Factory defaults:

Login

User: Administrator

Password: P4ssw_rd

Timeout: 60 minutes

GNSS

Satellites: GPS GLONASS Galileo

Antenna Delay: 30 nS

Out1 (Programmable Pulse)

Signal: IRIG-B unmodulated

C37.118: On

Time reference: UTC

Drive level: Low (50 ohms)

Out2

Signal: IRIG-B unmodulated

C37.118: On

Time reference: UTC

Drive level: Low (50 ohms)

Relay

Signal: Out of lock

Communication Ports

Baud Rate: 115200

Data Bits: 8

Parity: None

Stop Bits: 1

Broadcast: Off

Time

Local offset: 0 hours

Daylight Savings Time: Off

2.3 General

2.3.1 Power Requirements

Input accepts +8 Vdc to +32 Vdc and is not isolated, negative terminal is connected to chassis ground.

2.3.2 Dimensions

Chassis: 110 mm x 85 mm x 30 mm (4.3 inch x 3.4 inch x 1.2 inch)

Chassis with mounting brackets: 140 mm x 85 mm x 30 mm (5.5 inch x 3.4 inch x 1.2 inch)

2.3.3 Weight

0.45 kg (1 lb)

2.3.4 Temperature

-40 °C to 85 °C

3 Installation

3.1 Instrument

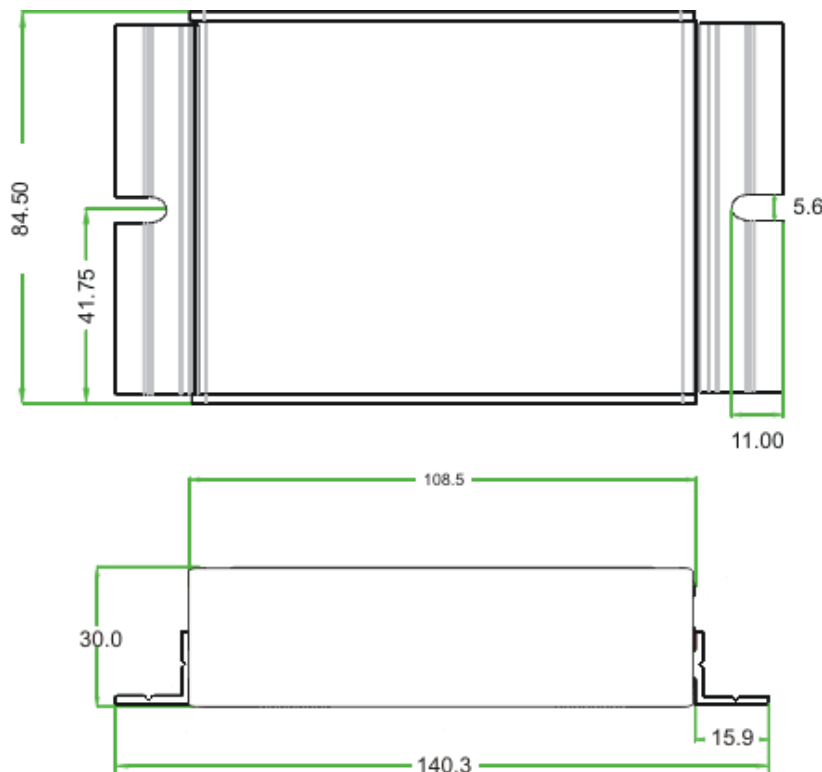
All output connections (including the RS-232 port) use Phoenix type pluggable terminal connectors with 5 mm spacing. The connector accepts between 0.25 mm and 2.5 mm diameter wire. To connect wires to any of the terminals, strip the insulation back to expose about 6.35 mm (0.25 inch) of bare wire (DO NOT tin the bare end with solder), insert the stripped wire into the terminal and turn the screw down (clockwise) to secure it in the connector.

3.1.1 Location

The Model 120A GNSS Synchronized Clock was designed for enclosed applications and will operate over a -40 °C to 85 °C temperature range. The small size allows for the unit to fit in small spaces. The case is not waterproof so it must be kept in a weather protected location.

3.1.2 Instrument Mounting

The Model 120A comes with two removable flanges with slots that can be used to secure the unit to a panel or shelf.



3.1.3 Power Requirements

The Model 120A accepts a dc input voltage between +8 Vdc and +32 Vdc. The maximum power required for operation is 5 Watts. The power is connected using a two terminal Phoenix type pluggable terminal connector with 5 mm spacing. The negative terminal of the power inlet is connected to chassis ground so the power source must be positive grounded. The power inlet is protected by an internal auto-recovering thermal fuse.

3.2 Antenna

3.2.1 Antenna Input

The Model 120A antenna input is a female Type F connector that accepts GNSS signal inputs. The 120A is designed to work with active antennas and supplies 5 Vdc to energize the antenna.

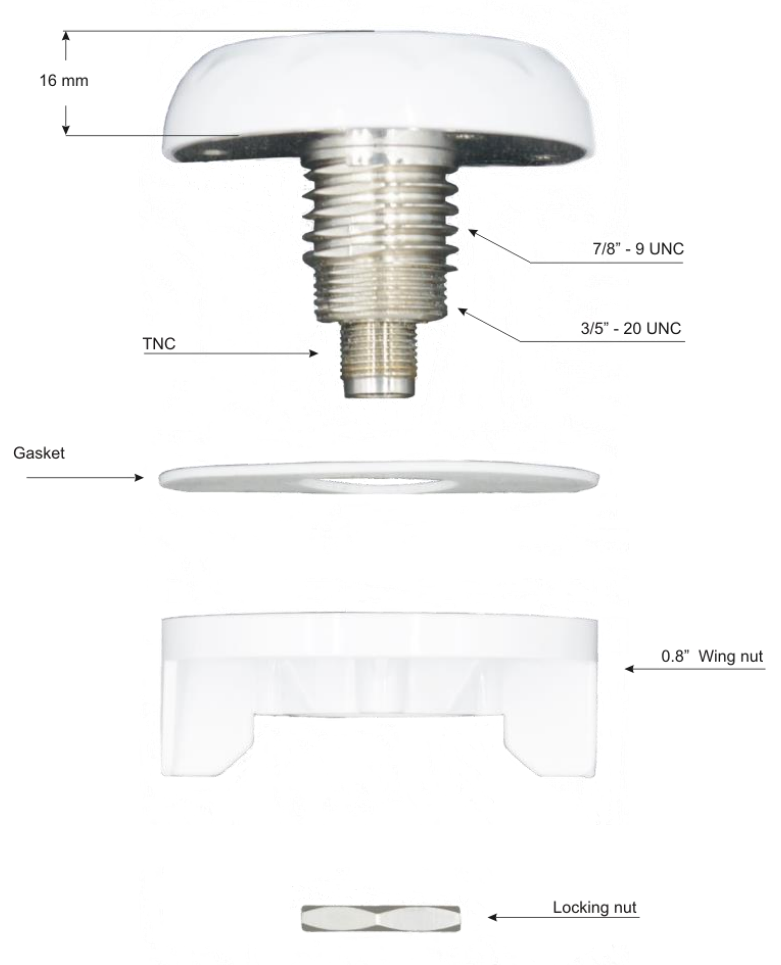
3.2.2 Antenna Location

The GPS antenna supplied with the 120A is waterproof and designed for outdoor use in all weather conditions and is designed to mount on the top of the control box through a 23 mm (7/8 inch) hole in the top of the cabinet. The antenna can be mounted in an alternate location and comes standard with a five-meter (16 feet) antenna cable.

3.2.3 Antenna Mounting

Position the antenna to have a clear view of the sky in all directions of the compass for best satellite tracking.

1. Place the gasket onto the antenna.
2. Pass the antenna base through the 23 mm (7/8 inch) hole in the top of the cabinet.
3. Spin the plastic base nut onto the antenna.
4. Spin the metal locking nut onto the antenna.
5. Attach the TNC cable end to the antenna and hand tighten.
6. Route the cable as needed to the clock.
7. Attach the F-type connector to the clock and hand tighten.



4 Configuration

All clock configuration is performed via the USB port or the RS-232 port using a standard ASCII terminal program and serial commands, there are no physical jumpers or switches to set. Firmware updates are only available over the USB management port.

4.1.1 Connecting

The CONFIG PORT and the RS-232 port have equal functionality except firmware updates must use the CONFIG PORT. To start the configuration process, make a serial connection using a terminal program with the following default settings:

- Baud Rate: 115200
- Data Bits: 8
- Stop Bits: 1
- Parity: N

Default Username: Administrator

Default Password: P4ssw_rd

When first connecting, press ENTER to see the Username prompt, type the username, press ENTER, and then type the password and press ENTER. A successful login will display the prompt ">". An unsuccessful login will display the message: "Error 9: Invalid username/password". If you receive this message double check the password, username, and make sure that CAPS LOCK is not on.

4.1.2 Permissions

The available command set depends upon the user role. The default user "Administrator" (role: Admin Config) allows total access to the command set without any restrictions. There are four roles available for each user:

1. Admin Config – Ultimate user role with no restrictions; has all available commands: add, audit, broadcast, delete, dst, firmware, gnss, localoffset, logout, ool, output, password, position, readconfig, relay, serial, status, time, timeout, users, whoami, writeconfig, and ?.
2. Admin – Administration role limited to configuring user-related settings with the following commands: add, audit, delete, firmware, logout, password, readconfig, status, timeout, users, whoami, writeconfig, and ?. Other commands are limited to status only.
3. Config – Configuration role limited to configuring unit-related settings with the following commands: broadcast, dst, firmware, gnss, localoffset, logout, ool, output, password, position, relay, serial, status, time, timeout, whoami, and ?.
4. Read Only – Operator role limited to status only with the following commands: broadcast, dst, firmware, gnss, localoffset, logout, ool, output, password, position, relay, serial, status, time, timeout, whoami, and ?.

Attempting to enter commands without the proper "role" will display the message: "Error 7: No Permission".

User Notes:

1. Multiple users and roles can be added.
2. Username length is a minimum of 8 alphanumeric characters and must start with an alpha character.
3. Password length is a minimum of 8 characters and must contain 1 upper case, 1 lower case, 1 number, and 1 non-alphanumeric character.
4. Command syntax for setting usernames and passwords requires the use of quotes around the values.

4.1.3 Sending Commands

The serial commands are divided by security role: Admin, Config and Read Only. All users have access to the read-only command set in addition to their primary role. All commands use the following nomenclature:

Text without brackets is the command

Text within <variable> are variables required for the command to function

Text within {optional} are optional parameters

Text within "<text>" quotes indicate the required parameter needs to have quotation marks around it.

For example, to add a user named operator1 with an admin role and a password of Admin-120A without the ability to change the user password would have two acceptable commands.

The syntax is:

```
add "<username>" "<password>" <role> {<pw_perm>}
```

and filled in, would look like:

```
add "operator1" "Admin-120A" 2 0
```

or

```
add "operator1" "Admin-120A" 2
```

The {<pw_perm>} portion of the command is optional and if it is not specified will be 0.

A helpful tip is the use of the "?" command. A lone question mark will display the available commands for the logged in user. A "?" following a command will give the available options and syntax for that command.

Example: "dst ?" will return the syntax for setting Daylight Saving Time.

4.2 Clock Configurable Parameters

4.2.1 GNSS

Global Navigation Satellite Systems setting allows to pick the satellite constellation to track and get timing information from. The Model 120A can receive GPS, Galileo, GLONASS and Beidou signals and can actively track up to 3 systems at a time. The Model 120A cannot receive both GLONASS and BeiDou simultaneously.

4.2.2 Local Offset

Local Offset allows the user to set a local time zone and is entered in times +/- from UTC time. For example, Pacific Standard Time is entered as -8 as it is 8 hours behind UTC.

4.2.3 DST

Daylight Savings Time is the seasonal adjustment to adjust local time by adding an hour according to your local laws. The Model 120A can be set to off (no time added), on (1 hour added to your local time) and auto (add an hour automatically according to the custom programming). The auto selection allows the user to set the month, day, hour, and minutes when an hour is added and then removed.

4.2.4 Outputs

There are two output signals on the Model 120A, Out1 and Out2. The outputs are limited to digital signals and are selectable between 2 different drive levels. The low drive (LD) level (50-ohm impedance) is designed to drive lighter loads and minimizes overshoot and ringing. The high drive (HD) level is designed to drive multiple heavy loads and is current limited to 250 mA of drive current with a 10-ohm source resistance. Each output is independently configured to one of the following programmable pulse signals in either UTC time or Local time:

- Unmodulated IRIG-B
- Unmodulated IRIG-B with C37.118

- DCF77
- Pulse Per Day (PPD)
- Pulse Per Hour (PPH)
- Pulse Per Second (PPS)

4.2.4.1 Unmodulated IRIG-B

IRIG-B is a serial time code developed by the US military's Inter-Range Instrumentation Group for range timing that has been adopted by many different industries. The IRIG-B timecode has a time frame of 1 second with an index count of 10 milliseconds and contains Time Of Year (TOY) in days, hours, minutes, seconds, and year information in a BCD format and seconds-of-day in SBS. The Model 120A supports the unmodulated (DC level shift) versions of the IRIG-B standard B000 and B003, B004 (RCC 200-16) in both local or UTC time. The control functions of B000 and B004 follow IEEE C37.118 timing specifications.

4.2.4.2 DCF77

DCF77 is a one-minute time code with an amplitude-modulated, pulse-width coded 1 bit/s data signal. The first 20 bits are special flags. The minutes are encoded in bits 21–28, hours use bits 29–34, and the date is transmitted during seconds 36–58. In the event of an added leap second, a 0-bit is inserted during the 59th bit.

4.2.4.3 Pulse Per Day (PPD)

Provides a pulse every day at the start of the day with a 10 ms pulse width.

4.2.4.4 Pulse Per Hour (PPH)

Provides a pulse once an hour at the top of the hour. The delay value, from 0 to 10000 ms can be used to offset from top of the hour.

4.2.4.5 Pulse Per Second (PPS)

The one pulse-per-second output is a pulse transmitted at the start of every second with a 10 ms pulse width. The rising edge is the on-time mark of the signal.

4.2.5 SPST Relay Contact

A Form A SPST solid state relay provides contact closure for several clock conditions and programmable pulse modes. The contacts are normally open (NO). "Normally" refers to the relay condition when the clock is powered off. Out of Lock and Fault are considered failsafe as when the condition is met the relay is asserted and the contacts are closed. Power failure will result in open contacts and indicates a fault and out of lock condition. Available settings are:

- Disabled
- Open
- Closed
- Out of Lock (OOL)
- Fault
- Pulse Per Minute (PPM)
- Pulse Per Hour (PPH)
- Pulse Per Day (PPD)
- Single Trigger (ST)

OOL – Indicates if the GNSS receiver is receiving enough satellites to produce an accurate time. The contacts will be open when there are not enough satellites and will be closed when satellites are being tracked. The activation/deactivation can be delayed from 1-99 minutes.

Fault – Indicates if an internal error is affecting proper operation of the Model 120A. The relay contacts will be open in the presence of a fault and closed under normal operation. Please see section 5.3 for detailed fault information.

PPM – Provides a 10 ms contact closure once a minute at the top of the minute.

PPH – Provides a 10 ms contact closure once an hour at the top of the hour.

PPD – Provides a 10 ms contact closure once a day at the start of the day.

ST - Provides a pulse transition at the chosen day, month year, hour, minute, and second. Single Trigger polarity may start as either high (positive) or low (negative). When the trigger occurs, it transitions to the opposite polarity and remains at that value until Single Trigger is deliberately reset.

4.2.6 Serial Port

The Model 120A comes with a 3-wire RS-232 DTE serial interface that can be used to configure and communicate with the clock or to output a broadcast string. The serial port baud, data bit length, stop bits and parity are configurable. The broadcast mode can be set to 1 of 9 predefined outputs or the custom setting which allows the user to configure one. A null-modem cable is required for proper communications.

120A	Terminal
Tx	Receive
Rx	Transmit
GND	Ground

4.2.7 Downloading a Configuration File

The Model 120A current configuration can be downloaded to a binary file using the serial command “readconfig”. Sending the “readconfig” command will initiate an X-modem transfer and the Model 120A will wait for an X-modem handshake to start sending the file when ready. The user must use a terminal program capable of an X-modem transfer to receive the file. A successful process will look like:

```
>read
Start binary file transfer (Xmodem receive)...
>
Success!
>
```

4.2.8 Uploading a Configuration File

The Model 120A configuration can be uploaded to a binary file using the serial command “writeconfig”. Sending the “upconfig” command will initiate an X-modem transfer and the Model 120A will wait for an X-modem handshake to start sending the file when ready. The user must use a terminal program capable of an X-modem transfer to receive the file and when done must log into the Model 120A again. A successful process will look like:

```
>write
Start binary file transfer (Xmodem send)...
>
Config updated, rebooting unit...
>ð
120A Main: 1.01-16
  Boot: 1.00-10
  FPGA: 1.00
Username:
```

5 Operation

5.1 Startup

Upon proper power application the Model 120A Power LED will illuminate green and the bootup process starts. The clock will start off in the unlocked state (Red unlocked LED will be illuminated) and if there are no faults the Locked LED and the Fault LED will be off.

If connected to the serial or config port with a terminal program you will see:

```
120A Main: 1.01-16
  Boot: 1.00-10
  FPGA: 1.00
```

Username:

>status

```
Receiver Version: SW=ROM CORE 3.01 (107888) HW=00080000
GNSS : GPS  GLONASS  Galileo  BEIDOU
Tracked: 0      0      0      N/A
SN/O : 0      0      0      N/A
Not Yet Locked
Time Quality:
Time Local: 00/00/0000 00:00:00
Time UTC : 00/00/0000 00:00:00
```

Which will progress to:

>status

```
Receiver Version: SW=ROM CORE 3.01 (107888) HW=00080000
GNSS : GPS  GLONASS  Galileo  BEIDOU
Tracked: 8      7      5      N/A
SN/O : 40     31     37     N/A
Locked
Time Quality: 100nS
Time Local: 05/06/2020 16:27:58
Time UTC : 05/06/2020 23:27:58
DST: auto -7:00
```

5.2 Reset

A recessed RESET button is located on the far right of end panel that contains the CONFIG PORT. This button is used to reboot or set reset the unit to factory defaults.

- Reboot: Soft power cycle. Does not change configuration.
 - Press, hold until all LEDs are on, release.
- Defaults: Reset configuration to factory defaults.
 - Press, hold until all LEDs flash, release.

5.3 Faults

The 1133A has built in error checking and will illuminate the Fault (red) annunciator if the clock detects a problem. In addition to the panel LED, the clock will also indicate the error when using the status command on the serial or management ports as a system error and would look like:

```
>status
Receiver Version: SW=ROM CORE 3.01 (107888) HW=00080000
GNSS : GPS  GLONASS  Galileo  BEIDOU
Tracked: 8    6    5    N/A
SN/O : 40    31    38    N/A
Locked
Time Quality: 100nS
Time Local: 05/05/2020 15:00:02
Time UTC : 05/05/2020 22:00:02
DST: auto -7:00
System Error(s):
1) PP1 short
```

The system errors can be split into internal errors and external errors. Internal errors will require sending the unit in for repair while the external errors can be fixed in the field.

System Error(s):

Internal

BootLoaderMissing	Boot loader missing, indicates issues with loading firmware at startup
VCXO/PLL	Timing loop problems
GnssNotDetected	GNSS receiver error
SPI EEPROM	Internal EEPROM error
SPI Flash not detected	Internal Flash error
SPI Flash error	Internal Flash ready error

External

Antenna short	The 120A antenna output is shorted and is trying to pull more than the maximum allowed current out. Disconnect the antenna cable and check the cable and antenna for issues.
OUT1 short	The load on output 1 exceeds the 250 mA maximum. Disconnect load and inspect cabling for shorts. If no shorts found reduce load by disconnecting devices.
OUT2 short	The load on output 2 exceeds the 250 mA maximum. Disconnect load and inspect cabling for shorts. If no shorts found reduce load by disconnecting devices.

6 Firmware Updates

Firmware updates are posted on our website: www.arbiter.com under the specific product and are available as a free download.

6.1 Requirements

To update firmware, you will need a computer running a terminal program that supports Xmodem transfers, a USB 2.0 A male to micro 5 pin male cable, and the firmware upgrade file (m120-fw_vXXXX.bin).

6.2 Procedure

- Connect the USB cable to the Model 120A config port and a USB port on your computer.
- Open a terminal program and log into the Model 120 using Admin_Config privileges
- Verify the firmware version installed by sending the “firmware” command.
- Send the command “firmware update”, wait for the prompt “Start binary file transfer (Xmodem send)...”
- Select and send the firmware file using the Xmodem transfer of the terminal program
- When the firmware has been updated you will get a “Success!” notification, press enter to get the login screen.

The sequence will look like this:

```
>firmware update
Starting boot loader...
Boot Loader Version: 1.00-10
Start Xmodem transfer...
Success!
120A Main: 1.02-4
  Boot: 1.00-10
  FPGA: 1.00
Username:
```

6.3 Verifying

To verify the firmware has been updated, log into the Model 120A and send the “firmware” command. The Model 120A will respond with:

```
120A Main: 1.02-4
  Boot: 1.00-10
  FPGA: 1.00
```

Appendix A IRIG-B Timecode

IRIG-B is a serial time code developed by the US military's Inter-Range Instrumentation Group for range. The IRIG-B timecode has a time frame of 1 second with an index count of 10 milliseconds and contains Time Of Year (TOY) in days, hours, minutes, seconds, and year information in a BCD format and seconds-of-day in SBS.

Three functional groups of bits in the IRIG-B time code are arranged in the following order: Binary Coded Decimal (BCD), Control Function (CF) and Straight Binary Seconds (SBS). The BCD group, with IEEE C37.118.1 OFF, contains only time information including the seconds, minutes, hours and days, recycling yearly. With IEEE C37.118.1 ON, BCD adds year information. The CF group contains other information including time quality, leap year, pending leap seconds and parity. Reference bits separate the various components of the IRIG-B time code.

Figure A-1 illustrates the primary differences between modulated and unmodulated IRIG-B. You will notice that the while modulated IRIG-B is distinctive because of the 1 kHz sinewave carrier, it is similar to unmodulated IRIG-B since the peak-to-peak values of the carrier follow the same form as the peaks of the digital waveform, which contain the information. Note that the first reference bit of both modulated and unmodulated IRIG-B is in sync with the rising edge of a 1 PPS signal.

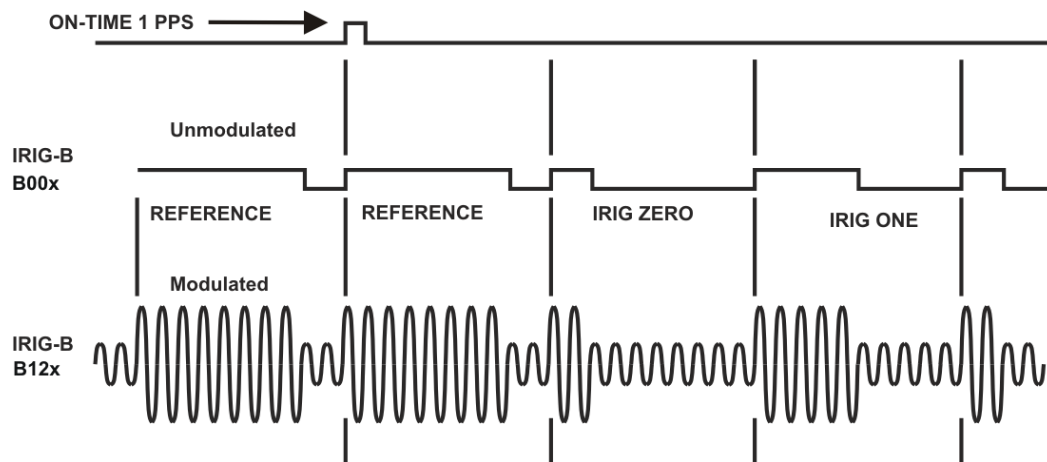


Figure A-1: IRIG-B Waveforms

A.1 IRIG-B IEEE C37.118.1

As mentioned above, turning IEEE C37.118.1 ON in the clock enables extra bits of the Control Function (CF) portion of the IRIG-B time code. Within this portion of the time code, bits are designated for additional features, including:

- Calendar Year (old method, now called BCD_{YEAR})
- Leap seconds, and leap seconds pending
- Daylight Saving Time (DST), and DST pending
- Local time offset
- Continuous Time quality (new with C37.118.1)
- Parity
- Position identifiers

To be able to use these extra bits of information, protective relays, RTU's and other equipment receiving the time code must be able to decode them. Consult your equipment manual to determine if the IEEE C37.118.1 feature should be turned ON in the clock. To view details of the IEEE Std C37.118.1, please check with the IEEE.

The Model 120A supports the unmodulated (DC level shift) versions of the IRIG-B standard B000 and B003, B004 (RCC 200-16) in both local or UTC time. The control functions of B000 and B004 follow IEEE C37.118 timing specifications.

Appendix B Serial Commands

The CONFIG PORT and the RS-232 port have equal functionality except firmware updates must use the CONFIG PORT. To start the configuration process, make a serial connection using a terminal program with the following default settings:

- Baud Rate: 115200
- Data Bits: 8
- Stop Bits: 1
- Parity: N

Default Username: Administrator

Default Password: P4ssw_rd

Administration Commands (Admin)		
Function	Command	Action / Response
List Users	users	Returns current list and roles of users
Add User	add "<username>" "<password>" <role> {<pw_perm>}	Where: "<username>" = Min 8 char, alphanumeric, starts with alpha "<password>" = Min 8 char, At least 1 upper/lower/number/non-alphanumeric <role> = 0-Rd Only, 1-User Config, 2-User Admin, 3-Admin Config <pw_perm> = 0-Can't change password, 1-Can change password (optional: 0 default) Quotes are required around the username and password.
Delete User	delete "<username>"	Removes the listed user and roles. Quotes are required around the username.
Set Password	password "<newpassword>"	Min 8 char, At least 1 of each upper/lower/number/non-alphanumeric. Quotes are required around the password.
Console Timeout	timeout {<min>}	Sets the inactivity time before automatically logging the user out. Range: 1 to 60 minutes. If no number is included then the current setting is returned.

Administration Commands (Admin)		
Function	Command	Action / Response
Update Firmware	firmware {<update>}	Start binary file transfer (Xmodem send)... Requires Admin Config privileges.
Show Audit Log History	audit	Displays log of system and user events in the following format: Event #, User, Description
Download Configuration	read{config}	Start binary file transfer (Xmodem receive)...
Upload Configuration	write{config}	Start binary file transfer (Xmodem send)...
Exit Interface	logout	Logs current user out of the UI.

Configuration Commands (Config)		
Function	Command	Action / Response
Select Satellite Systems	gnss <sat-sys> {<sat-sys> {<sat-sys>}}	Where: <sat-sys> = GPS, GLONASS, Galileo, BEIDOU
Set Antenna Cable Delay	gnss <Antenna Delay>	Where: <Antenna Delay> = 0-999999ns
Set Daylight Saving Time	dst <off on auto>	Where: off = no hours added to local time on = 1 hour added to local time auto = automatically add 1 hour based on current programming
Set Daylight Saving Automatic Changeover Date/Time	dst <mon> <week> <day> HH{:MM} <mon> <week> <day> HH{:MM}	Where: <mon> = January–December <week> = Week of month: 1 = 1 st ; 2 = 2 nd ; 3 = 3 rd ; 4 = last; 5 = 2 nd from last, 6 = 3rd from last <day> = Monday-Sunday HH:MM = Change over time (hours:minutes)
Set Local Time Zone	localoffset {+ -}HH{:MM}	Where: +/-HH:MM is local time offset from UTC
Set Out Of Lock	ool <min>	Where: <min> 0–99 minutes; 0 = off
Set Out 1 and Out 2 Output Signals	out{put} <1 2> <IRIG IRIGC37 DCF77 PPD> <UTC local> {<LD HD>} out{put} <1 2> <PPH> {<LD HD>} out{put} <1 2> <PPS> <1..999> {<LD HD>} out{put} <1 2> <delay> ; <delay> = 0-10000ns	Where: <1 2> designates Out 1 or Out 2 IRIG is standard IRIG-B without year information (B000) IRIGC37 is IRIG-B with C37.118 extensions version 2011 DCF77 = DCF77 output signal PPD = Pulse Per Day UTC = Coordinated Universal Time local = Local time LD = Low Drive (50 Ohm output impedance) HD = High Drive capability (120 mA) PPH = Pulse Per Hour PPS = Pulse Per Seconds delay = in nanoseconds. Ex: output 2 10 = 10 ns delay on output 2.

Configuration Commands (Config)		
Function	Command	Action / Response
Set Relay Signal	relay <mode> relay OOL {fault} relay PPD <UTC local> relay ST <day> <mon> <year> HH:MM:SS <UTC local>	Where: <mode> = disabled, OOL (Out of Lock), fault, close, open, PPM (Pulse per Minute), PPH (Pulse per Hour), PPD (Pulse per Day), ST (Single Trigger). *ST requires setting the date and time.
Set Serial Port	ser{ial} <baud> <length> <stop> <parity>	Where: <baud> = 1200-115200 <length> = 7 or 8 <stop> = 1 or 2 <parity> = N, E or O
Select Serial Broadcast	br{oadcast} <B#> <UTC local>	Where: <B#> = Broadcast number 0 = Off 1 = ASCII Std 2 = Vorne Std 5 = Ext. ASCII 6 = ASCII+Qual 7 = Year+ASCII 8 = Custom 9 = NEMA \$GPGLL 10 = NEMA \$GPZDA
Set Custom Broadcast String	br{oadcast} <custom> "<string>"	Where: "<string>" is the custom string setting. Quotes are required around the string. Without "<string>" returns current setting.

Status Commands (Read Only)		
Function	Command	Action / Response
Help	?	Displays a list of the available commands
Command Specific Help	<command> ?	Displays the correct syntax and options for the listed command. Where <command> is any of the available commands for the user role.
Show Current Status	status	Displays the 120A status. Example: Receiver Version: SW=ROM CORE 3.01 (107888) HW=00080000 GNSS: GPS GLONASS Galileo BEIDOU Tracked: 7 3 4 N/A SN/O : 42 34 41 N/A Locked Time Quality: 100nS Time local: 03/30/2020 18:41:11 Time UTC: 03/31/2020 01:41:11 DST: auto -7:00
Show Current User	who{ami}	Displays the current logged in username. Example: Username: Administrator
Show Programmable Pulse Setting	out{put}	Displays the current output configuration. Example: OUT# Mode Time Drive Delay 1 IRIGB C37.118-on UTC LD 0 2 IRIGB C37.118-on UTC LD 0
Show Out of Lock Setting	ool	Displays current out-of-lock setting in minutes. Example: Out-of-lock: 1 (min)
Show Local Offset	localoffset	Displays time zone setting in hours:minutes: Example: Local Offset: -8:00
Show Firmware Version	firmware	Displays the current version of installed firmware: Main, Boot, FPGA
Show Time	time	Displays the current date and time: MM/HH/YYYY hh:mm:ss Local hh:mm:ss UTC
Show Daylight Saving Setting	dst	Displays the current setting (on, off, auto) along with the changeover settings for the auto mode. Example: DST auto Start: Mar 2nd Sunday 02:00 Stop: Nov 1st Sunday 02:00
Show Relay Setting	relay	Displays the relay mode. Example: relay: OOL

Status Commands (Read Only)		
Function	Command	Action / Response
Show Serial Port Setting	ser{ial}	Displays the serial port settings. Example: serial: 115200,8,1,N
Show Serial Broadcast Setting	br{oadcast}	Displays the broadcast mode. Example: broadcast: ASCII Std(1) UTC
Show Custom Broadcast String	br{oadcast} custom	Displays the current custom broadcast string

B.1 Constructing a Custom String

This section provides the character set and rules for constructing a custom string. At the end of this section is a tutorial on how to construct strings using some of the standard broadcast strings as examples.

Custom Broadcast Character Set

Character	Meaning
//	/ character
Cssnn	Xor checksum of specified range, where ss = start location (hex value from 00 to FF) and nn = number of bytes (hex value from 00 to FF)
D	Day of month: 01, . . . , 31
d	Day of year: 001, . . . , 366
e f	GNSS elevation: ±ddddd.dd length = 10 Fractional Seconds: 00, . . . , 99
Hxx	Hexadecimal value where xx is a hex value from 00, . . . , FF
h	Hour: 00, . . . , 23
Ln	LCD front panel display buffer, 2 lines, 20 characters: L1 = top line; L2 = bottom line
m	Minute: 00, . . . , 59
M	Month: 01, . . . , 12
O o	Local hour offset: ±hh where hh=00, . . . , 12 Local minute offset: 0, . . . , 59 minutes
Pi	Latitude: where i = 1, degrees (dd); = 2, Minutes (mm); = 3, Fractional minutes (mmm); = 4, Seconds (ss); = 5, Fractional seconds (fff); = 6, N (North) or S (South)
pi	Longitude: where i = 1, degrees (ddd); = 2, minutes (mm); = 3, fractional minutes; = 4, seconds (ss); = 5, fractional seconds (fff); = 6, E (East) or W (West)
r	Carriage return and line feed = <CR><LF>
Sii	String Type where ii: 01 = Status change; 02 = Vorne Opt28; 03 = Opt28 ASCII; 04 = True Time Opt28
s	Seconds: 00, . . . , 59
Txx	On time character where xx is a hex value from 01 to FF (Note: Must be at the start or end of the string!)
U	Unlock time: 00, . . . ,99 minutes
vnn	Option 28 values: 01 = Time Deviation; 02 = Frequency; 03 = Frequency Deviation; 04 = Amplitude; 05 = Phase Angle
W	Day of week: 1, . . . , 7 where 1 = Sunday
w	Day of week: 1, . . . , 7 where 1 = Monday
y	Year: 00, . . . , 99
Y	Year: 2000, . . . , 2xxx
z	Display number

Table B-1 Characters used with Custom Strings

Table B-1 Notes. Conditionals can use any of the above, with the exception of Cssnn and Txx, in addition to any string characters. CONDITIONALS CANNOT BE NESTED!

True/False Condition

Command: `/[ii? < t > / : < f > /]` where:

< t > = True condition < f > = False condition ii: 01 = Locked; 02 = Status change; 03 = Locked with max accuracy; 04 = Fault; 05 = Daylight Saving Time change pending; ; 06 = Unlocked LED status (whether Unlocked LED On/Off)

Ordinal Condition

Command: `/[ii? < 0 > / : ,..., < n > / ; < e > }` where:

< 0 > , < 1 > , ..., < n > = ordinal position

< e > = Else condition ii: 01 = Time Quality (13 possible ordinals); 02 = Time Quality for True Time format (5 possible); 03 = Time Zone Indicator (3 possible, 0=DST active, 1=Not active, 2=UTC)

Binary	Hex	Value (worse case accuracy)
1111	F	Fault-clock failure, time not reliable
1011	B	10 seconds
1010	A	1 second
1001	9	100 milliseconds (time within 0.1s)
1000	8	10 milliseconds (time within 0.01s)
0111	7	1 millisecond (time within 0.001s)
0110	6	100 microseconds (time within 10 ⁻⁴ s)
0101	5	10 microseconds (time within 10 ⁻⁵ s)
0100	4	1 microsecond (time within 10 ⁻⁶ s)
0011	3	100 nanoseconds (time within 10 ⁻⁷ s)
0010	2	10 nanoseconds (time within 10 ⁻⁸ s)
0001	1	1 nanosecond (time within 10 ⁻⁹ s)
0000	0	Normal operation, clock locked

Table B-2 List of Possible Time Quality Levels, Ordinal 01

Symbol	ASCII Character	Accuracy
(space)	32	locked, maximum accuracy
.	46	Error < 1 microsecond
*	42	Error < 10 microseconds
#	35	Error < 100 microseconds
?	63	Error > 100 microseconds

Table B-3 List of True Time Quality Levels, Ordinal 02

Using Ordinals and Conditionals

An ordinal returns an ASCII character or characters (e.g. 1, 2, 3, ..., good, bad, etc.) for a requested value (e.g. clock accuracy). A conditional returns an ASCII character or characters (e.g. 0, 1, locked, unlocked, etc.) based on a true/false request (e.g. Is there a Fault?). Illustrated below are several examples of using ordinals and conditionals when constructing a custom string. You can even construct standard strings to check your work. All the ordinal/conditional examples below use the ASCII Standard broadcast string.

Ordinal 01. This ordinal consists of 13 different accuracy values as listed in Table B-2. Notice the ordinals (0, 1, 2, ..., B, F) are all represented in this example. All need not be used as shown in the second example. This example more closely follows the 1201B/C accuracy, not signaling a change until reaching 1 microsecond.

```
/T01/d:/h:/m:/s/{01?0/:1/:2/:3/:4/:5/:6/:7/:8/:9/:A/:B/:F/}/r
/T01/d:/h:/m:/s/{01?0/:0/:0/:0/:4/:5/:6/:7/:8/:9/;out of lock/}/r
```

Note that the accuracy values (e.g. 0, 1, 2, ..., F) can be replaced with textual values. For example, note that the value "out of lock" in the second example replaced everything after "9" in the first example.

Ordinal 02. This ordinal consists of 5 different accuracy values as listed in Table B-3.

/T01/d:/h:/m:/s/{02? /:./:~/:#/:?/}/r

Ordinal 03. This ordinal consists of three different time zone values: DST active (i.e. Daylight Saving Time), DST inactive (i.e. Standard Time) and UTC time.

/T01/d:/h:/m:/s/{03? DST Active/: DST Inactive/: UTC/}/r

Conditional 03. In this condition the clock is queried for a locked condition. It answers true with a space if locked and false with a question mark if unlocked.

/T01/d:/h:/m:/s/[03? /:~/}/r

B.2 Custom Broadcast String Setup Example

In this section, you will find an example of constructing a custom broadcast string that produces one of the standard broadcasts. By building up a custom string that produces a standard broadcast, you to compare the output your custom string produces with that of the standard broadcast. If the outputs agree, then your custom string must be correct. This should give you some confidence in constructing your own broadcast string.

ASCII Standard

Desired Output: <soh>ddd:hh:mm:ss <CR><LF>

Custom String Code: /T01/d:/h:/m:/s/r

Command: broadcast custom "/T01/d:/h:/m:/s/r"

Input String Construction Notes: The method of starting the ASCII Standard broadcast is using the "br 8 UTC" or "br 8 local" command. Custom string entry always begins with the 'br custom'. The T01 specifies the on-time character as a Hex 01, which is the Start of Header. Notice that these characters are preceded by the "/", which precedes each of the other (Table B-1) characters. "d" is for Julian Day, "h" if for hours, "m" is for minutes, "s" is for seconds, and "r" is for carriage return, line feed. The ":" subdivides the Julian day, hour, minute and second, and no space between characters. After typing in the Input String Code (as shown above), press the Enter key. The code's acceptance is indicated by a carriage return line feed.

Common ASCII Characters

Listed below are a few common ASCII control characters used with the Model 120A clock. For a more complete listing of ASCII characters, you will need to consult an additional source. Other printable characters may be typed in as seen on a keyboard.

Decimal	Hex	Abbreviation	Description
0	00	NUL	Null Character
1	01	SOH	Start of Header
7	07	BEL	Bell (sound)
10	0A	LF	Line Feed
13	0D	CR	Carriage Return

Table B-4 Short Table of ASCII Characters

Appendix C Antenna Placement

Section 3.2 covers the basic mounting of the antenna. Here are some tips for optimal antenna placement:

- Position so it has a clear view of the horizon in all directions. Tall buildings, trees, and other high-powered transmitting antennas can interfere with tracking satellites.
- If it must be mounted on the side of a building then choose the side closest to the equator.
- Protect it from the elements such that snow does not accumulate on it.

Appendix D Troubleshooting

- Locked and Unlocked LEDs are both off: Check that power supply is correct (8-32 Vdc). Using an AC supply can cause the Model 120A to power on but continually reset only illuminating the Power LED.
- Model 120A will not lock to satellites: Check the antenna cable and antenna for any damage. Use the ASCII status command to check for faults and tracking information.
- Fault LED is illuminated
- IRIG-B Time is incorrect: Check settings to make sure the unit is set for the correct time reference, UTC or Local. If Local is selected, verify local offset and daylight savings settings are correct.

Appendix E Glossary

Broadcast – Serial data sent out over the serial port once per second.

DST - Day Savings Time, the

GNSS - Global Navigation Satellite System is a general term describing any satellite constellation that provides positioning, navigation, and timing (PNT) services on a global or regional basis. Including GPS, BeiDou, Galileo and GLONASS

BeiDou is a global GNSS owned and operated by the People's Republic of China.

Galileo is a global GNSS owned and operated by the European Union.

GLONASS is a global GNSS owned and operated by the Russian Federation.

GPS is a global GNSS owned and operated by the United States

Local Offset – Is the difference between local time and UTC time determined by time zones.

OOL – Out of lock is the term used when satellite signals are not available and the clock is unable to receive time.

Appendix F Clock Drawings

