Tempus LX *GPS*

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Warranty Repair

If you believe your equipment is in need of repair, call EndRun Technologies and ask for a customer service agent. It is important to contact us ýrst as many problems may be resolved with a phone call. Please have the serial number of the unit and the nature of the problem available before you call. If it is determined that your equipment will require service, we will issue an RMA number. You will be asked for contact information, including your name, address, phone number and e-mail address.

Ship the unit prepaid in the original container or a container of sufýcient strength and protection to EndRun Technologies. EndRun will not be responsible for damage incurred during shipping to us. Be sure the RMA number is clearly identiýed on the shipping container. Our policy is to repair the unit within 5 business days. If it is necessary to order parts or if other circumstances arise that require more than 5 days, an EndRun service technician will contact you.

Loaner units are not included as part of the standard warranty.

Repair After Warranty Expiration

If the warranty period has expired, we offer repair services for equipment you have purchased from EndRun. Call and ask for a customer service agent. It is important to contact us ýrst as many problems may be resolved with a phone call. Please have the serial number of the unit and the nature of the problem available before you call. If it is determined that the equipment has failed and you want EndRun to perform M h M h p ε ω p ∩ ς M.e s`of the unbM h M it om

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sions are monitored from ground stations located around the world and carefully measured relative to GPS time. The results of these measurements for each satellite are then uploaded to that satellite so that they may be incorporated into the data contained in its transmissions. The receiver can use this data to relate the time-of-arrival of the received transmissions from that satellite to GPS time.

All of this means that during normal operation, the source of the timing information being transmitted from each of the satellites is directly traceable to UTC. Due to the nature of the GPS spread spectrum Code Division Multiple Access (CDMA) modulation scheme, this timing information may be extracted by a well-designed receiver with a precision of a few nanoseconds. The GPS time and frequency engine in the Tempus LX does just that.

Where to Use It

Alarm Jack *(Option)*	This BNC connector (or terminal strip) provides the optional alarm output, and is usually not installed. If installed, see details in ***Appendix H - Specifications*** for the Alarm Output.
Prog TTL Jack *(Option)*	This BNC connector provides the optional Programmable TTL pulse rate output and is usually not installed. If installed, see details in ***Appendix J - Specifications*** for the Programmable TTL output. This pulse rate is normally shipped from the factory as 10MPPS but can be changed via the front-panel keypad or command **`botnosrbnmehf`**.
10MPPS or 100 PPS, etc. *(Option)*	This BNC connector provides an optional customer-speciýed rate output and is usually not installed. If installed, it will be labeled for the appropriate rate such as ñ10 MPPSò or ñ100 PPSò, etc. This output is set at the factory and cannot be changed. See details in ***Appendix J - Specifications*** for the Fixed Rate Output.
Serial Time Output *(Option)*	This optional DB-9M connector provides the RS-232 (or RS-422) serial I/O interface with a once-per-second ASCII time string output. For

1. The unit will light the red Alarm Status LED for about ten seconds.

2. Then it will continuously light the green Sync Status LED.

3. When the unit locks onto a GPS signal and begins to decode the timing data and adjust the local oscillator, the green Sync Status LED will þash very rapidly (about a 6 Hz rate) until the data is fully decoded and the local oscillator is fully locked to the GPS frequency.

4. Then the green Sync Status LED will pulse at precisely a 1 Hz rate, synchronized to UTC seconds, with a short on duration relative to the off duration.

At this point, the GPS time and frequency engine has fully synchronized, and you may proceed to permanently mounting the chassis and antenna in their desired locations.

If this sequence has not occurred within twenty-four hours, and you have mounted your antenna in a window or your rooftop installation has poor sky visibility, you may need to provide an accurate reference position to the unit so that it can operate with only one satellite in view. If you have mounted the antenna in a window and can easily move it to the rooftop, you should do that ýrst. Should you need to provide a reference position to the unit, refer to ***Appendix D - GPS Reference Position*** and the **`rdsforqdeonr`** command for details.

If you are unable to achieve GPS lock after trying all of these suggestions, then your Tempus LX may be damaged and should be returned to the factory for repair or exchange.

Installing the Tempus LX

FCC NOTICE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmul interference in which case the user will be required to correct the interference at his own expense.

Mount the Tempus LX

Using standard 19ò rack mounting hardware, mount the unit in the desired location. After mounting the unit and connecting the antenna cable, verify that it still acquires and tracks a GPS signal.

CAUTION

Ground the unit properly with the supplied power cord.

Position the power cord so that you can easily disconnect it from the Tempus LX.

Do not install the Tempus LX where the operating ambient temperature might exceed 122ÃF (50ÃC).

Configuring Ethernet with the Serial Port

To conýgure your ethernet interface with the serial port, after logging in as the *root* user, you must run a simple shell script called **`mdsbnmehf`** from the **`a`rg** shell prompt. This shell script will prompt you for the needed information and perform some syntax checking on your inputs. Then it will create or modify the appropriate ýles needed to conýgure the ethernet interface. The following sections will guide you in setting up communications with the Tempus LX using its RS-232 serial I/O port.

Connect the RS-232 Serial I/O Port

You will need to use the RS-232 serial I/O port if your network does not support the Dynamic Host Conýguration Protocol (DHCP). In that case, you must be able to conýgure the Tempus LX network parameters manually using the Linux console shell interface which is provided by this serial I/O port. Under certain conditions, you may also need to use the RS-232 serial I/O port if you encounter a problem while upgrading the ýrmware in your Tempus LX.

To test serial communications with the Tempus LX you will need either a VT100 compatible terminal or a terminal emulation program running on your computer. We will refer to either of these as ñterminalò for the remainder of this instruction.

1. Disconnect power from the Tempus LX.

2. Connect one end of the DB9F-to-DB9F null modem adapter cable to the serial I/O jack on the Tempus LX.

3. Connect the other end of the DB9F-to-DB9F null modem adapter cable to the terminal. If the serial I/O port on your terminal does not have a DB9M connector, you may need to use an adapter. Refer to ***Chapter 6 - RS-232 Serial I/O Port Signal Definitions*** for details on the signal wiring. *If you are using a computer for your terminal, remember which port you are using because you will need to know that in order to set up your terminal software.*

Test the Serial Port

You must conýgure your terminal m gure%%%%%%%%%l I3h port ym gqhat ort

```
/w///d////,/w//0///// 9 ƏSdlotr Kn AnnsKcqƐ
lsc9 Fhuhmf nts cduhbd 0 sn Sdlotr Kn AnnsKcq
/w//0/////,/w//1///// 9 ƏSdlotr .annsƐ
lsc9 Fhuhmf nts cduhbd 1 sn Sdlotr .anns
/w//1/////,/w//2///// 9 ƏSdlotr .knfrƐ
lsc9 Fhuhmf nts cduhbd 2 sn Sdlotr .knfr
/w//2/////,/w//8///// 9 ƏSdlotr E@BSNQX qnnserƐ
lsc9 Fhuhmf nts cduhbd 3 sn Sdlotr E@BSNQX qnnser
/w//8/////,/w//ed//// 9 ƏSdlotr TOFQ@CD qnnserƐ
lsc9 Fhuhmf nts cduhbd 4 sn Sdlotr TOFQ@CD qnnser
/w//ed////,/w/0////// 9 ƏSdlotr Gh AnnsKcqƐ
lsc9 Fhuhmf nts cduhbd 5 sn Sdlotr Gh AnnsKcq
MDS39 Khmtw SBO.HO 0-/ enq MDS3-/
HO Oqnsnbnkr9 HBLO+ TCO+ SBO+ HFLO
HO9 qntshmf b`bgd g`rg s`akd ne 401 atbjdsr+ 3Jaxsdr
SBO9 G`rg s`akdr bnmehftqdc 'drs`akhrgdc 1/37 ahmc 1/37(
MDS39 Tmhw cnl`hm rnbjdsr 0-/.RLO enq Khmtw MDS3-/-
lscaknbj^nodm
nj
Q@LCHRJ9 Bnloqdrrdc hl`fd entmc `s aknbj /
lscaknbj^qdkd`rd
nj
UER9 Lntmsdc qnns 'dws1 ehkdrxrsdl(-
Eqddhmf tmtrdc jdqmdk ldlnqx9 57j eqddc
HMHS9 udqrhnm 1-65 annshmf
.dsb.qb-c.qb-R9 .ahm9 hr ` chqdbsnqx
lscaknbj^nodm
nj
lscaknbj^nodm
nj
Kn`chmf FOR
Kn`chmf Jdxo`c.UEC
Eqh @tf 1/ //942943 1//3 ,/-6/6017 rdc 12dc 1  =▫ ▫ | Ű ▫ | Ű //9429  Ȁ                    Ȁ
```

```
Rds sgd HO `ccqdrr ne sgd rdbnmc`qx m`ld rdqudq sn trd enq cnl`hm xntq-cnl`hm-
Dmsdq rdbnmc`qx m`ld rdqudq HO `ccqdrr '```-aaa-bbb-ccc(9 081-057-0-1

Rdsshmf to SBO.HO---
Bqd`shmf .dsb.GNRSM@LD---
Bqd`shmf .dsb.qb-c.qb-hmds0---
Bqd`shmf .dsb.mdsvnqjr---
Bqd`shmf .dsb.gnrsr---
Bqd`shmf .dsb.qdrnku-bnme---

))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
)                                                                            )
)          Sgd Sdlotr KW FOR mdsvnqj bnmehftq`shnm g`r addm toc`sdc-         )
)                                                                            )
)             Okd`rd qd,anns mnv enq sgd bg`mfdr sn s`jd deedbs-             )
)                                                                            )
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
```

Verify Network Configuration

If you have made changes to your network conýguration using **mdsbnmehf**, you should shutdown the Tempus LX and reboot it. There are two ways to do this:

1. Cycle power to the Tempus LX.

2. Issue the shutdown with reboot command at the shell prompt:

```
Sdlotr KW FOR'qnns?fmso9}(,= rgtscnvm ,q mnv
```

If you are using the RS-232 serial I/O port to communicate with the Tempus LX, you will be able to see the kernel generated boot messages when the unit reboots. You should note the line

```
Bnmehftqhmf dsg/ `r 081-057-0-134---
```

if you have set up a static IP address, or this line

```
@ssdloshmf sn bnmehftqd dsg/ ax bnms`bshmf ` CGBO rdqudq---
```

if you are using DHCP. It appears near the end of the kernel generated boot messages.

If you are using DHCP and are not using the RS-232 serial I/O port, you will have to check the DHCP conýguration information maintained by your DHCP server to determine the expected IP address and log in to the Tempus LX using **sdkmds** or **rrg** to verify successful DHCP conýguration. Refer to the subsequent topics in this section

If you are not using DHCP, addresses are hard-coded in the kernel. IP addresses to the

OpenSSH implementations for Linux. Refer to ***Appendix A - Security*** for more information about the secure shell protocol.

Using Telnet

When establishing a **sdkmds** connection with your Tempus LX, logging in directly as *root* is not permitted. This is a security measure that makes it slightly more difýcult to gain access by simply trying passwords, since it is also necessary to know the name of a user. When you initiate a **sdkmds** session with the Tempus LX, this banner will be displayed:

```
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
)          Vdkbnld sp     Vdc˚ ı "           Ψ  atq▫ ↨Ψ=  Ÿ q
```

```
Sdlotr KW FOR'qnns?fmso9}(,=
```

This last line is the standard Tempus LX GPS shell prompt. The Tempus LX uses the **a`rg** shell, which is the Linux standard, full-featured shell. After conýguring the unit, you should change the passwords using the **fmsoo`rrvc** command issued from the shell prompt.

Issuing **dwhs** will close the **rrg** session.

Using HTTP

You may monitor the status of the Tempus LX via the HTTP interface. For security reasons, you may not change any settings via the HTTP interface. See ***Chapter 8 - HTTP Interface*** for more information.

IMPORTANT

SSH, Telnet, SNMP and HTTP are all enabled with default passwords. To ensure security, change the passwords or disable the protocols.

To change the passwords for SSH, Telnet and HTTP use the **fmsoo`rrvc** command. To change the passwords/community strings for SNMP see @oodmchw B , RM L O.

To disable Telnet use the **hmdscbnmehf** command. To disable SSH, SNMP and HTTP see @oodmchw @ , Rdb t qhsx+ Chr`akhm f Oqnsnbnkr.

Configuring the Network Time Protocol

Now that the network has been conýgured and tested, you may conýgure the operation of the NTP server. By default, the Tempus LX is conýgured to respond to NTP requests from clients that may or may not be using MD5 authentication. If the clients are using MD5 authentication, they must be conýgured properly with the same MD5 authentication keys as the Tempus LX. If you need to modify the factory default Tempus LX MD5 keys (recommended) or set up broadcast/multicast operation, then you will need to re-conýgure the NTP subsystem. You may perform the conýguration from either a **sdkmds** or **rrg** session, the front-panel keypad, or the local RS-232 console.

NOTE

If you would like to configure your server for multicast operation, configure it as you would for broadcast operation, with the exception that you must enter this specific NTP multicast address: 224.0.1.1, when you are prompted to enter the broadcast address.

Configuring NTP Using the Front-Panel Keypad

To conýgure NTP using the front-panel keypad go to the Main Menu display. Press the RIGHT arrow key until the ñNTPò selection is highlighted. Press ENTER again. Press the RIGHT arrow key to highlight ñSetupò and press ENTER. From this display you can conýgure broadcast/multicast

Configuring NTP Using the Network Interface or Serial Port

The following is a transcript of the question and answer conýguration utility provided by **msobnm, ehf**. The user entered parameters are underlined:

```
Sdlotr KW FOR'qnns?fmso9}(,= msobnmehf

))))))
```

cn mns v`ms sn trd rnld ne sgd jdxr hm xntq mso-jdxr ehkd+ cn mns dmsdq sgdl gdqd- MSO vhkk sqd`s sgnrd jdxr `r ətmsqtrsdcƐ-

Bkhdmsr sg`s trd `mx ne sgd əsqtrsdcƐ jdxr hm sgdhq MSO onkkhmf o`bjdsr vhkk qdbdhud `tsgdmshb`sdc qdokhdr eqnl sgd Sdlotr KW FOR- Vgdm xnt g`ud dmsdqdc `kk ne sgd əsqtrsdc jdxrƐ sg`s xnt mddc+ dmsdq ydqn `s sgd mdws oqnlos enq ` jdx mtladq-

Dmsdq ` sqtrsdc jdx mtladq '0,54423(nq / sn pths9 0

Dmsdq ` sqtrsdc jdx mtladq '0,54423(nq / sn pths9 1

Dmsdq ` sqtrsdc jdx mtladq '0,54423(nq / sn pths9 /

,,,MSO Aqn`cb`rs.Ltkshb`rs Bnmehftq`shnm

Vntkc xnt khjd sn dm`akd ȸ xdos t m ab`rs B= ` h À À À sƐ

Basic NTP Client Setup

Basic setup is relatively simple, if:

Å You have been able to successfully communicate with the Tempus LX on your network.

Å You have installed NTP on your client computer.

Configure NTP

You must edit the *ntp.conf* ýle which **msoc**, the NTP daemon, looks for by default in the the */etc* directory. Add this line to the ntp.conf ýle:

```
rdqudq 081-057-0-134
```

This line tells **msoc** to use the NTP server at address 192.168.1.245 in addition to any other servers which might also be conýgured in the clientôs *ntp.conf* ýle.

Re-start **msoc** to have it begin using the Tempus LX server. Use the NTP utility **msop** to check that **msoc** is able to communicate with the Tempus LX. After issuing the command

```
msop
```

you will see the **msop** command prompt:

```
msop=
```

Use the command

```
oddqr
```

to display the NTP peers which your computer is using. One of them should be the Tempus LX server which you have just conýgured. You should verify that it is being óreachedô. (You may have to continue issuing the peers command for a minute or two before you will see the óreachô count increment.) If you have other peers conýgured, verify that the offset information for the Tempus LX server peer and your other peers is in agreement to within a few milliseconds, assuming that the other peers are synchronized to that level of accuracy.

It may also be useful to start the NTP daemon in ódebugô mode (**msoc ,c**) to conýrm successful conýguration. Refer to the NTP documentation for detailed usage of these debug utilities.

MD5 Authenticated NTP Client Setup

MD5 authenticated setup is relatively simple, if:

Å You have been able to successfully communicate with the Tempus LX on your network.

Å Your Tempus LX has been conýgured to perform authentication either by factory default, or by running the **msobnmehf** shell script. The example Tempus LX authentication conýguration shown in ***Chapter 2 - Configuring the Network Time Protocol*** will be assumed in the example conýguration commands shown here.

Å You have installed NTP on your client computer.

Å You have successfully performed the ***Basic NTP Client Setup*** on your client computer.

Create the ntp.keys File

You must create a ýle named *ntp.keys* in the */etc* directory. It must be a copy of the one residing in the */etc* directory of your Tempus LX. You can **sdkmds** into your Tempus LX and start an **eso** session with your client computer to send the Tempus LXôs */etc/ntp.keys* ýle to your client computer, use the secure copy utility **rbo**, or you can just use a text editor on your client computer to create an equivalent ýle.

IMPORTANT

Handling of the .dsb.mso-jdxr file is the weak link in the MD5 authentication scheme. It is very important that it is owned by qnns and not readable by anyone other than qnns.

After transferring the ýle by **eso**, and placing it in the */etc* directory on the client computer, issue these two commands at the shell prompt:

```
bgnvm qnns-qnns .dsb.mso-jdxr
bglnc 5// .dsb.mso-jdxr
```

Configure NTP

You must edit the *ntp.conf* ýle which **msoc**, the NTP daemon, looks for by default in the */etc* directory. Assuming that you have created two trusted keys as shown in the example in the previous chapter, add these lines to the end of the *ntp.conf* ýle:

```
jdxr .dsb.mso-jdxr
sqtrsdcjdx 0 1
```

Modify the line added previously in ***Basic NTP Client Setup*** so that authentication will be used with the Tempus LX server using one of the trusted keys, in this case key # 1:

```
rdqudq 081-057-0-134 jdx 0
```

Re-start **msoc** to have it begin using the Tempus LX server with MD5 authentication. Use the NTP utility **msop** to check that **msoc** is able to communicate with the Tempus LX. After issuing the command

```
msop
```

you will see the **msop** command prompt:

```
msop=
```

Use the command

```
oddqr
```

to display the NTP peers which your computer is using. One of them should be the Tempus LX server which you have just conýgured. You should verify that it is being óreachedô. (You may have to continue issuing the peers command for a minute or two before you will see the óreachô count increment.)

You can verify that authentication is being used by issuing the command

`rrnbh`shnmr

to display the characteristics of the client server associations. In the ñauthò column of the display, you should see ñOKò for the row corresponding to the Tempus LX server. If you see ñbadò, you should wait a few minutes to be sure that there is a problem since ñbadò is the initial state of this setting. If the ñbadò indication persists then you must check your conýguration for errors. Typically this is due to a typing error in creating the */etc/ntp.keys* ýle on the client that causes a mismatch between the keys being used by the server and client. (If you transfer the ýle by **eso** or **rbo**, this shouldnôt be a problem.) It is also possible to have a typing error in the */etc/ntp.conf* ýle that causes the needed key to not be included in the ñtrustedkeyò list.

Broadcast/Multicast NTP Client Setup

Broadcast/multicast client setup is relatively simple, if:

Å You have been able to successfully communicate with the Tempus LX on your network.

Å Your Tempus LX has been conýgured to perform broadcasts or multicasts by running the **mso, bnmehf** shell script. (This is not the factory default conýguration, so be sure to run **msobnmehf**.)
If you are going to use MD5 authentication, your Tempus LX must have been conýgured to operate with authentication in the broadcast/multicast mode, and you must know which of the trusted keys it is using for broadcast/multicast operation. The example Tempus LX conýguration shown in ***Chapter 2 - Configuring the Network Time Protocol*** will be assumed in the example conýguration commands shown here.

Å

If you are using authentication, you can verify that authentication is being used by issuing the command

Re-start **msoc-dwd** to have it begin using the Tempus LX server with MD5 authentication. By default, the NTP installation program installs **msoc-dwd** as a service called Network Time Protocol, and starts it. You must use the Services utility in Control Panel to stop the Network Time Protocol service and then re-start it.

Use the NTP utility **msop-dwd** to check that **msoc-dwd** is able to communicate with the Tempus LX. By default it is installed in the *\Program Files\Network Time Protocol* sub-directory of your Windows NT/2000/XP partition. From a console window, after issuing the command

```
msop
```

you will see the **msop-dwd** command prompt:

```
msop=
```

Use the command

```
oddqr
```

to display the NTP peers which your computer is using. One of them should be the Tempus LX server which you have just conýgured. You should verify that it is being óreachedô. (You may have to continue issuing the peers command for a minute or two before you will see the óreachô count increment.)

You can verify that authentication is being used by issuing the command

```
`rrnbh`shnmr
```

to display the characteristics of the client server associations. In the ñauthò column of the display, you should see ñOKò for the row corresponding to the Tempus LX server. If you see ñbadò, you should wait a few minutes to be sure that there is a problem since ñbadò is the initial state of this setting. If the ñbadò indication persists then you must check your conýguration for errors. Typically this is due to a typing error in creating the *\winnt\system32\drivers\etc\ntp.keys* ýle on the client that causes a mismatch between the keys being used by the server and client. (If you transfer the ýle by **eso** or **rbo**, this shouldnôt be a problem.) It is also possible to have a typing error in the *\winnt\system32\drivers\etc\ntp.conf* ýle that causes the needed key to not be included in the ñtrustedkeyò list.

Broadcast/Multicast NTP Client Setup

Broadcast/multicast client setup is relatively simple, if:

Å You have been able to successfully communicate with the Tempus LX on your network.

Å Your Tempus LX has been conýgured to perform broadcasts or multicasts by running the **mso, bnmehf** shell script. (This is not the factory default conýguration, so be sure to run **msobnmehf**.) If you are going to use MD5 authentication, your Tempus LX must have been conýgured to operate with authentication in the broadcast/multicast mode, and you must know which of the trusted keys it is using for broadcast/multicast operation. The example Tempus LX conýguration shown in ***Chapter 2 - Configuring the Network Time Protocol*** will be assumed in the example conýguration commands shown here.

Å You have installed NTP on your client computer.

Å You have successfully performed the ***MD5 Authenticated NTP Client Setup*** on your client computer, if you plan to use MD5 authentication.

Configure NTP Client for Broadcast

You must edit the *ntp.conf* ýle which **msoc-dwd**, the NTP daemon, looks for by default in the the *\winnt\system32\drivers\etc* directory or, for XP, the *\windows\system32\drivers\etc* directory. Assuming that your Tempus LX server has been conýgured to use key 2 for broadcast authentication as shown in the example in chapter 2, make sure that key 2 is included in the **sqtrsdcjdx** line, and add this line to the end of the *ntp.conf* ýle:

```
aqn`cb`rsbkhdms
```

If you are not using MD5 authentication, you would add these lines:

```
chr`akd `tsg
aqn`cb`rsbkhdms
```

You may remove the line added previously in ***Basic NTP Client Setup***:

```
rdqudq 081-057-0-134
```

or the authenticated version added in ***MD5 Authenticated NTP Client Setup***:

```
rdqudq 081-057-0-134 jdx 0
```

Configure NTP Client for Multicast

You must edit the *ntp.conf* ýle which **msoc-dwd**, the NTP daemon, looks for by default in the the *\winnt\system32\drivers\etc* directory or, for XP, the *\windows\system32\drivers\etc* directory. Assuming that your Tempus LX server has been conýgured to use key 2 for broadcast authentication as shown in the example in chapter 2, make sure that key 2 is included in the **sqtrsdcjdx** line, and add this line to the end of the *ntp.conf* ýle:

```
ltkshb`rsbkhdms 113-/-0-0
```

or for IPv6:

```
ltkshb`rsbkhdms ee/4990/0
```

If you are not using MD5 authentication, you would add these lines:

```
chr`akd `tsg
ltkshb`rsbkhdms 113-/-0-0
```

or for IPv6:

```
chr`akd `tsg
ltkshb`rsbkhdms ee/4990/0
```

You may remove the line added previously in ***Basic NTP Client Setup***:

```
rdqudq 081-057-0-134
```

or the authenticated version added in ***MD5 Authenticated NTP Client Setup***:

```
rdqudq 081-057-0-134 jdx 0
```

Test Broadcast/Multicast

Restart **msoc-dwd** to have it begin using the Tempus LX as a broadcast or multicast server. By default, the NTP installation program installs **msoc-dwd** as a service called Network Time Protocol, and starts it. You must use the Services utility in Control Panel to stop the Network Time Protocol service and then restart it.

Use the NTP utility **msop-dwd** to check that **msoc-dwd** is able to communicate with the Tempus LX. By default it is installed in the *\Program Files\Network Time Protocol* sub-directory of your Windows NT/2000/XP partition. After issuing the command

```
msop
```

you will see the **msop-dwd** command prompt:

```
msop=
```

Use the command

```
oddqr
```

to display the NTP peers which your computer is using. One of them should be the Tempus LX server which you have just conýgured. You should verify that it is being óreachedô. (You may have to continue issuing the peers command for a minute or two before you will see the óreachô count increment.)

If you are using authentication, you can verify that authentication is being used by issuing the command

```
`rrnbh`shnmr
```

to display the characteristics of the client server associations. In the ñauthò column of the display, you should see ñOKò for the row corresponding to the Tempus LX server. If you see ñbadò, you should wait a few minutes to be sure that there is a problem since ñbadò is the initial state of this setting. If the ñbadò indication persists then you must check your conýguration for errors. Typically this is due to a typing error in creating the *\windows\system32\drivers\etc\ntp.keys* ýle on the client that causes a mismatch between the keys being used by the server and client. (If you transfer the ýle by **eso** or **rbo**, this shouldnôt be a problem.) It is also possible to have a typing error in the *\windows\system32\drivers\etc\ntp.conf* ýle that causes the needed key to not be included in the ñtrustedkeyò list.

Keypad EDIT Lockout

As a security feature, the Network Administrator can disable all editing processes done through the front-panel keypad. This action should be performed to prevent unauthorized modiýcation of the instrument. When the EDIT key has been p ¥ Ç ¥ I Ç M d I p è Ÿ Th Ψ M Є

System Status: Indicates either OK or þashing FAULT. A fault status indicates that one or more of the built-in fault checking processes has detected an error condition. See ***Faults Display*** in this chapter for more information.

An alternate Time/Status display can be viewed by pressing the right arrow key. You can go back to the original Time/Status display by pressing the left arrow key.

than 55,000 will set the DAC fault þag that will appear in the fault status display. The Time/Status display will also indicate a fault condition.

The oscillator type indicates the oscillator that is installed. Possible oscillator types are:

Temperature-compensated crystal oscillator (TCXO)
Medium-stability oven oscillator (MS-OCXO)
Rubidium oscillator (Rb)

Antenna Fault Mask

This setting allows you to prevent the antenna fault from creating an alarm conditon. Some installations may need to mask this fault due to special antenna situations like splitters or DC blocks that confuse the antenna detection circuit.

Signal Loss Fault Mask

This setting allows you to prevent a signal loss fault from creating an alarm condition. Some installations may need to mask this fault when operating the NTP server as a Stratum 2 server.

Clock Menu

The Clock Menu provides access to the parameters related to timekeeping. These are Time Mode, Local Offset, Hours Format, and Daylight Savings Time. These displays are all described below.

Time Mode

Time mode deýnes the time format used for the front-panel time display and, if installed, the optional time code or Serial Time output. The time mode does not affect the NTP output, which is always UTC. Possible values for the time mode are GPS, UTC, and local time. GPS time is derived from the GPS satellite system. UTC is GPS time minus the current leap second correction. Local time is UTC plus local offset and Daylight Savings Time. The local offset and daylight savings time displays are described below.

Local Offset

CPU I/O Menu

The CPU I/O Menu is an optional menu selected from the Main Menu. It provides access to the 1PPS Pulse Width, Time Code Output Format, Programmable TTL Output and Serial Time Output.

1PPf ˜ ς ΙΨahΙ Εp ς ΫςΩ S Mesoselec= Ε

Network6 Setup (Optional)

This display is only available if your Tempus LX has been conýgured with IPv6. It is selected from the Main Menu and provides the ability to view and modify the IPv6 network settings. Refer to ***Chapter 7 - IPv6 Information***.

NTP Menu

The NTP Menu is selected from the Main Menu and provides access to the NTP Status and NTP Setup displays described below:

NTP Status

This display provides information associated with the NTP Subsystem.

```
NTP STATUS   Stratum -  1      Offset -  +0.0000007 sec
             Source - GPS   LI Bits -  None
```

Stratum: This stratum ýeld has three possible values:

- Stratum 1: The server is fully synchronized and accurate.
- Stratum 2: The server is synchronized to a stratum 1 server with IP address shown in Source.
- Stratum 16: The server is unsynchronized. NTP clients will not use a Stratum 16 server.

Source: The synchronization source is named here. For the Tempus LX GPS the source is GPS, IP address of upstream source, or none.

Offset: The NTP offset indicates the accuracy of the NTP system clock relative to the GPS Subsystem clock. Initially, if the offset between the NTP system clock and the GPS Subsystem clock is large the display will indicate ñnot availableò. After the GPS Subsystem locks, the NTP clock will synchronize to the GPS Subsystem. Once synchronization is complete, the typical offsets will range over approximately +/- 1 microsecond.

LI Bits: Shows the status of the leap indicator bits as sent by the Tempus LX time server to the clients in the NTP reply packets. Descriptions of the leap indicator are:

00 - None: No fault and no pending leap second.
01 - Insert Pending: No fault and a leap second insertion is pending.
10 - Delete Pending: No fault and a leap second deletion is pending.
11 - Fault: Unsynchronized fault condition exists.

NTP Setup

This display provides access to the NTP broadcast and multicast settings and provides the user with a convenient means of checking the current conýguration and allows limited setup. You may also perform a more complete broadcast/multicast conýguration via a **`sdkmds`** or **`rrg`** session or the local RS-232 console using the **`msobnmehf`** utility. This utility provides a more secure means of setup and so is more complete. It will allow you to select keys and identify trusted keys.

Available User Commands

COMMAND	FUNCTION
accessconýg	Interactive shell script that guides the user in configuring **`sdkmds, rrg`** and

gntpversion	Prints the Linux/NTP Subsystem software version information to the console.
gptpstat *(optional)*	Prints the status of the optional PTP/IEEE-1588 subsystem.
help	Prints help for Tempus LX commands (not Linux).
inetdconýg	Interactive shell script that allows the user to conýgure the list of protocol servers which are started by the **`hmdsc`** server daemon running in the Tempus LX.
kplockstat	Prints the front-panel keypad lockout status.
lockoutkp	Locks out access to the front-panel keypad EDIT key.
netconýg	Interactive shell script that allows the user to conýgure the IP network subsystem of the Tempus LX.
ntpconýg	Interactive shell script that guides the user in conýguring the NTP subsystem. Allows conýguration of MD5 authentication and broadcast/multicast mode. All parameters are retained in non-volatile FLASH disk storage.
ptpconýg ptp2conýg *(optional)*	Interactive shell script that guides the user in conýguring parameters for the optional PTP/IEEE-1588 protocol.
ptpversionconýg *(optional)*	Interactive shell script that guides the user in selecting either PTP/IEEE-1588 version 1 or version 2.
setantþtmask	Command to enable or mask the Antenna Fault.
setgpsdynmode	Allows the user to set the dynamic mode of operation of the GPS Subsystem.
setgpsrefpos	Interactive shell script that prompts the user for an accurate reference position, performs syntax and argument validity checking then passes the position to the GPS Subsystem.
setsigþtmask	Command to mask or enable the Signal Loss Fault.
sigþtmask	Prints the current setting for the Signal Loss Fault mask.
unlockkp	Unlocks access to the front-panel keypad EDIT key.
updaterootþag	Command to update the þag stored in FLASH that is read by the Linux bootloader at boot time to select operation with either the FACTORY or UPGRADE root ýle system.
upgradegps	Shell script that facilitates the GPS Subsystem ýrmware upgrade process.
upgradekernel	Shell script that facilitates the Linux kernel ýrmware upgrade process. Limited applicability. Use with caution.

cpusertimeconfig

This command starts an interactive shell script that will allow the root user to change the settings of the optional Serial Time Output. The user-selectable outputs are the format (Sysplex, Truetime, EndRun, EndRunX, NENA0, NENA1, NENA8 and NMEA), the baud rate (4800, 9600, 19200, 57600) and the parity (ODD, EVEN, or NONE). The three NMEA sentences can also be changed but are applicable only if the Output Format is NMEA. More information about the various formats is in ***Appendix F - Serial Time Output***.

Set:	**`botrdqshldbnmehf`**
Tempus LX response:	Interactive shell script is started.

eraserootfs_1

This command erases the UPGRADE root ýle system FLASH partition in preparation for performing a Linux/NTP Subsystem ýrmware upgrade. See ***Appendix B - Upgrading the Firmware*** for more information.

Set:	**`dq`rdqnnser^0`**
Tempus LX response:	Erase progress as percent is shown.

gpsdynmode

This command displays the current GPS Subsystem dynamic mode of operation. It has two possible settings: ON or OFF. When it is ON, it is assumed that the Tempus LX is installed on a moving platform. When it is OFF, it is assumed that the Tempus LX is installed in a stationary location.

When the dynamic mode is OFF, the Tempus LX will use its accurate reference position to implement Timing Receiver Autonomous Integrity Monitoring (TRAIM) for the utmost in reliability during any GPS system faults. In addition, single satellite operation is possible once an initial accurate position has been determined.

When the dynamic mode is ON, only a very minimal TRAIM algorithm is in effect because the accurate reference position is not static. In addition, a minimum of four satellites must be visible and only 3-D position ýxes are used. When the dynamic mode is ON, the source reported for the accurate reference position by **`forqdeonr`** is set to DYN.

Query:	**`forcxmlncd`**
Tempus LX response:	**`NEE`**

gpsrefpos

This command displays the current GPS Subsystem reference position. The source of the position, which is one of UNK (unknown), DYN (dynamic), USR (user entered) or AVG (24 hour average of GPS ýxes) is displayed ýrst. The WGS-84 latitude and longitude in degrees, minutes, seconds format and the height above the WGS-84 reference ellipsoid in meters follow. Refer to ***Appendix D - GPS Reference Position*** for details.

Query:	**`forqdeonr`**
Tempus LX response:	

Ũ ▫M

gpsstat

This command allows the user to query the status of the GPS Subsystem. During normal operation, the NTP daemon polls the GPS Subsystem every 16 seconds. The results of this poll are used to steer the system clock and are saved to a log ýle. This command parses and formats the data contained therein and prints this ýxed-length string having these ýelds:

```
KJRS@S SENL < > XD@Q CNX GG9LL9RR-rrrrrrrrr KR KE R M UBC@B B.Mn EKSR
```

Where:

LKSTAT is the tracking status of the engine, either LOCKED or NOTLKD.

TFOM = ? A detailed explanation of TFOM is in ***Appendix E - Time Figure-of-Merit***. Brieþy, TFOM indicates clock accuracy where:

3	time error is < 100 ns
4	time error is < 1 us
5	time error is < 10 us
6	time error is < 100 us
7	time error is < 1 ms
8	time error is < 10 ms
9	time error is > 10 ms, unsynchronized state if never locked to GPS.

YEAR is the year of the UTC timestamp of the most recent NTP polling request received by the GPS engine from the NTP reference clock driver.

DOY is the day-of-year of the UTC timestamp of most recent NTP polling request received by the GPS engine from the NTP reference clock driver.

HH:MM:SS.sssssssss is the hour, minute, second.subsecond UTC timestamp of the most recent NTP polling request received by the GPS engine from the NTP daemon reference clock driver.

LS is the current number of leap seconds difference between the UTC and GPS timescales (13 at the time of this writing).

LF is the future (at the next UTC midnight) number of leap seconds difference between the UTC and GPS timescales (13 at the time of this writing).

S is the Signal Processor State

To change cntpuser password:

Set:	**`fmsoo`rrvc bmsotrdq**
Tempus LX response:	The passwd interactive utility starts.

gntprootfs

This command displays the currently booted root ýle system image. It can be either TempusLXGPS_0 (factory image) or TempusLXGPS_1 (ýeld upgrade image). Refer to

Query: **fmsoudqrhnm**
Tempus LX response:
Sdlotr KW FOR 5/0/,//31,/// u 0-// Vdc I`m 05 11927910 TSB 1//3

help

This command displays a list A N DSdlotr Ψ ζ NM Ÿ A ≠ A

setgpsdynmode

This command accepts a single argument: ON or OFF to allow the user to set the dynamic mode of operation of the GPS Subsystem. By default, the unit is conýgured for static operation, so this setting is OFF. If the Tempus LX will be mounted on a moving platform, like a ship, then this setting must be changed to ON. The change takes place immediately and is stored non-volatilely.

Set:	**`rdsforcxmlncd NM`**
Tempus LX response:	**`FOR Cxm`lhb Lncd hr NM-`**

setgpsrefpos

This command starts an interactive shell script that will allow the user to set the accurate, reference position of the Tempus LX. By default, the unit is conýgured to locate itself using the GPS satellites. In some situations, visibility of the sky is limited and the unit will not be able to determine its position. In this case, the user must determine an accurate WGS-84 position by other means and input it using this command. If you need to set the accurate reference position, you must run this script as root. The changes take place immediately. Refer to ***Appendix D - GPS Reference Position*** for details. *If the GPS dynamic mode setting is ON (see* **`forcxmlncd`**/**`rdsforcxmlncd`** *commands), then running this script will have no effect.*

In addition to setting a new accurate, reference position, the user can also invalidate an existing one. This will force the Tempus LX to re-establish a new reference position using the GPS satellite constellation.

Set:	**`rdsforqdeonr`**
Tempus LX response:	Interactive shell script is started.

setsigfltmask

This command allows the user to enable or mask the Signal Loss Fault. Parameter for this command is either MASKED or ENABLED. Setting this command to MASKED will prevent a signal loss fault from creating an alarm condition. Some installations may need to mask this fault when operating the NTP server as a Stratum 2 server. The factory default setting is ENABLED.

Set:	**`rhfeksl`rj L@RJDC`**
Tempus LX response:	**`Rhfm`k Knrr E`tks L`rj rds sn L@RJDC`**

sigfltmask

This command displays the current setting for the Signal Loss Fault Mask.

Query:	**`rhfeksl`rj`**
Tempus LX response:	**`Rhfm`k Knrr E`tks hr DM@AKDC`**

unlockkp

This command unlocks access to the front-panel keypad EDIT key. When the EDIT key is locked, it will prevent unauthorized tampering with the unit. All other keys are still enabled so you may continue to read the status and current settings of the Tempus LX. Refer to the **`joknbjrs`s`** and **`knbjntsjo`** commands.

Set: **tmknbjjo**
Tempus LX response: **Eqnms,o`mdk jdxo`c DCHS jdx dm`akdc-**

updaterootflag

This command allows the user to update the conýguration of the Linux bootloader after a new root ýle system image has been uploaded to the UPGRADE root ýle system partition, */dev/rootfs_1* of the Tempus LX FLASH disk. It may also be used to reset the default back to the FACTORY root ýle system partition. Refer to ***Appendix B - Upgrading the Firmware*** for detailed instructions for performing the upgrade procedure. One argument is accepted, whose value is either 0 or 1, causing a þag to be set that will indicate to the bootloader which root ýle system image should be loaded by default. If an argument value of 2 is given, then the currently conýgured default root ýle system is shown.

Set: **toc`sdqnnsek`f 0**
Tempus LX response: **TOFQ@CD hr sgd cde`tks qnns ehkd rxrsdl-**

Query: **toc`sdqnnsek`f 1**
Tempus LX response: **TOFQ@CD hr sgd cde`tks qnns ehkd rxrsdl-**

upgradegps

This script allows the user to upgrade the GPS Subsystem ýrmware. It requires one argument: the path to the binary ýle to be uploaded to the GPS engine. It issues the commands over the serial port to the GPS Subsystem that are needed to start the X-modem ýle transfer, and then displays the responses from the GPS Subsystem to the console. When the X-modem óCô character appears, indicating that the GPS Subsystem is ready to receive the ýle, you must hit the <ENTER> key, and the transfer will begin. After about one minute, it should complete, at which point you should see the GPS Subsystem boot messages appear on the console. From these, you will be able to verify that the ýrmware was successfully upgraded.

In the example console output below, lines which begin with ñ---ò are generated by the **tofq`cdfor** script. All other lines are from the GPS Subsystem, with the exception of the shell message indicating that the process **b`s ; .cdu.`ql^trdq** has been terminated, which is normal. In this example, the óCô character was received three times before the user hit the <ENTER> key to begin the transfer. The last three lines are the boot messages that are sent by the GPS Subsystem as it comes up. The ýrmware version should match that of the binary ýle that was uploaded. See ***Performing the GPS Upgrade*** in ***Appendix B - Upgrading the Firmware*** for more information.

Set: **tofq`cdfor .slo.5/0/,//1/,///-ahm**
Tempus LX response:

```
,,,Vgdm xnt rdd sgd _B_ bg`q`bsdq+ ghs ;dmsdq= sn adfhm sgd tokn`c-

V`hshmf enq cnvmkn`c trhmf WLNCDL 017 nq WLNCDL 0J 'ansg vhsg BQB(-
Bnmsqnk W vhkk `anqs cnvmkn`c-
BBB
,,,Rs`qshmf ehkd tokn`c+ rgntkc s`jd `ants 8/ rdbnmcr---

.rahm.tofq`cdfor9 khmd 159 16507 Sdqlhm`sdc            b`s ;.cdu.`ql^trdq

,,,Xnt rgntkc rdd sgd FOR rtarxrsdl rs`qsto ldrr`fd mnv-  He mns+ xnt
,,,l`x mddc sn bgdbj xntq ahm`qx ehkd `mc qd,odqenql sgd oqnbdctqd-
```

```
Sdlotr Annskn`cdq 5/0/,//4/,/// u 0-// , L`x 17 1//3 069209/4
EV 5/0/,//1/,/// u 0-// , @tf 07 1//3 0/936930
EOF@ 5/1/,///4,/// u /1/1
```

upgradekernel

This script allows the user to change the Linux kernel ýrmware. It requires one argument: the path to the ýle to be uploaded to the Tempus LX. Changing the Linux kernel ýrmware will enable IPv6 operation and should only be done if you have a requirement for IPv6. See ***Chapter 7 - IPv6 Information*** and ***Performing the Linux Kernel Upgrade*** in ***Appendix B - Upgrading the Firmware*** for more information.

Set	**`tofq`cdjdqmdk .slo.mdvjdqmdkhl`fd`**
Tempus LX response:	Interactive shell script is started.

RS-232 Serial I/O Port Signal Definitions

The RS-232 DB9M connector on the rear panel of the Tempus LX is wired as shown below. In order to connect the Tempus LX to another computer, a null-modem adapter must be used. The serial cable provided with the shipment is wired as a null-modem adapter and can be used to connect the Tempus LX to your computer.

Tempus LX DB9M Pin	Signal Name
1	Not Connected
2	Receive Data (RX)
3	Transmit Data (TX)
4	Data Terminal Ready (DTR)
5	Ground
6	Data Set Ready (DSR)
7	Request To Send (RTS)
8	Clear To Send (RTS)
9	Not Connected

IPv6-Capable syslog-ng

To enable remote syslogging to an IPv6 host, you will need to edit the new */etc/syslog-ng.conf* ýle and copy it to */boot/etc*. At boot time, the presence of both the **rxrknf,mf** daemon and the *boot/etc/syslog-ng.conf* ýle will cause the new IPv6-capable **rxrknf,mf** daemon to be started instead of the previous **rxrknfc.jknfc** pair of daemons. These two ýles remain on the system for backward compatibility with customersô existing */etc/syslog.conf* setups, but they are not IPv6 capable. If you are not currently directing your system logs to a remote host, or you are not using IPv6, then there is little or need or beneýt to changing to **rxrknf,mf**.

IPv4-Only Protocols

There are several protocols which are not IPv6 capable: **sdkmds** (client and server), **gsso**, **eso** and **cgbobc**. Due to their intrinsic insecurity, **sdkmds** and **eso** are repidly being deprecated, and probably have little business running over an IPv6 network. The address autoconýguration capabilities of IPv6 make the DHCP protocol less important, however it is likely that the new **cgbou5** capability will appear in a future upgrade.

Antenna Fault Mask

This ýeld shows the current setting for the Antenna Fault Mask. When the antenna fault is masked

Daylight Savings Time (DST), DST Start, DST End
The DST ýelds show whether DST is enabled and if so, what the DST Start and Stop Times are. For example, in most of the U.S.A. the DST Start Time is the 2nd Sunday in March at 2 a.m. The DST End Time is the 1st Sunday in November at 2 a.m. To change the DST settings use the **`fmso, shldlncdbnmehf`** command.

I/O Page

This page shows any installed CPU Options and their settings. These are optional outputs that are generated from the CPU Module in the Tempus LX. A basic Tempus LX Time Server has no CPU Options installed. Possible options are a 1PPS Output, a Time Code (or AM Code) Output, a Programmable TTL Output, and a Serial Time Output. Use commands **`botnosrbnmehf`** and **`botrdq, shldbnmehf`** via the network/serial port to change the settings of the CPU Options.

Faults Page

This page lists all possible fault conditions of the GPS Subsystem. The various faults are described below:

FLASH
This fault indicates that the microprocessor was unable to verify a write to the FLASH non-volatile parameter storage area. This should not ever occur under normal operation. The unit should be returned to the factory for repair.

FPGA
This fault indicates that the microprocessor was unable to conýgure the FPGA. This would be a fatal fault and the unit should be returned to the factory for repair .

Signal
This fault indicates that the unit has not been able to acquire a GPS signal for one hour while the Time Figure of Merit has been 9, the unsynchronized condition. This could be due to a variety of reasons. If there are no other faults that could explain the inability to receive a signal, then there could be an or antenna failure or blockage. If the condition persists indeýnitely, and a problem with the antenna is not evident, the unit may need to be returned to the factory for repair.

DAC
This fault indicates that the electronic frequency control DAC for the oscillator has reached either the high (55000) or low (10000) limit while locked to the GPS signal. Unless the unit is being subjected to out-of-speciýcation environmental conditions, this would indicate that the oscillator frequency has drifted near to the end of life region. This should normally only occur after about ten years of operation. The unit will continue to function until the oscillator frequency ýnally reaches one of the actual DAC endpoints. The unit should be returned to the factory for oscillator replacement at the your convenience.

Antenna
This fault indicates that the GPS antenna or downlead cable has a fault. It indicates either an over or under current condition. Usually it means that the antenna downlead cable is not plugged into the connector on the rear of the Tempus LX. If the condition persists after checking the antenna/downlead for obvious faults, this is a fatal fault and the unit should be returned to the factory for repair.

Polling Events

This fault indicates that the GPS Subsystem is not receiving polling request from the Linux/NTP Subsystem. This could be due to a hardware or software failure. If the condition persists after cycling the power to the unit, this is a fatal fault and the unit should be returned to the factory for repair.

Time Reference

This fault indicates that the microprocessor received an erroneous time input from the GPS engine. If the condition persists please report it to the factory (1-877-749-3878).

GPS Engine

This fault that the microprocessor is unable to establish communications with the GPS engine. Please report this fault condition to the factory (1-877-749-3878).

Network Page

This page shows the IPv4 network conýguration. Fields are:

DHCP

By default, the Tempus LX will conýgure itself using the Dynamic Host Conýguration Protocol (DHCP). If you need to set up static IP conýguration, you must use the **`mdsbnmehf`** command via the network/serial port. Thie ýeld will show whether DHCP is enabled or disabled.

Address, Gateway, Netmask

These ýelds show the settings for the IP address, gateway and netmask. To change these settings use the **`mdsbnmehf`** command via the network/serial port.

Network (IPv6) Page

This page shows information related to the IPv6 network parameters. If your Tempus LX does not have IPv6 then there will be no ýelds on this page. For more information on IPv6 see ***Chapter 7 - IPv6 Information***.

Network (DNS) Page

This page shows the IP address of the primary and secondary domain name servers.

NTP Page

The NTP Status page shows all information related to NTP operation. Fields are:

Status

The stratum ýeld has three possible values:

The secure copy utility, **rbo**, eliminates the need to use the insecure **eso** protocol for transferring program updates to the Tempus LX.

¢TTP may be completely disabled by conýguration of */etc/rc.d/rc.local*.

Access via SNMP is conýgurable to provide the security of the latest version 3 Internet standard which supports both view-based access control and user-based security using modern encryption techniques. Previous versions v1 and v2c supported access control essentially via passwords transmitted over the network in plain text. Refer to ***Appendix C ï Simple Network Management Protocol*** which is dedicated to conýguration of SNMP for details.

Individual host access to protocol server daemons such as **hm-sdkmdsc+ rmloc** or **rrgc** may be controlled by the **sboc** daemon and directives contained in the ýles */etc/hosts.allow* and */etc/hosts.deny.*

Risky protocols like TIME, DAYTIME and TELNET may be completely disabled by conýguration of the **hmdsc** super-server daemon.

The last two topics are supported on the Tempus LX by a pair of shell scripts which ease conýguration for the inexperienced user of Unix-like operating systems. These are **`bbdrrbnmehf** and **hmdscbnmehf**.

Using Edit

A very compact editor with WordStar command keystrokes is available on the system for editing ýles: **dchs**. If you start **dchs** without giving it a ýle name to open, it will display its help screen, showing all supported keystrokes.

Limiting Access

By default, the unit is conýgured to allow access by all users via Telnet, SSH and SNMP. To ensure security you should restrict access by using the **`bbdrrbnmehf** command.

`bbdrrbnmehf modiýes two ýles which are used by **sboc** and the standalone daemons, **rmloc** and **rrgc**, to determine whether or not to grant access to a requesting host: */etc/hosts.allow* and */etc/hosts/deny*. These two ýles may contain conýguration information for a number of protocol servers, but in the Tempus LX only access control to the protocol server daemons **hm-sdkmdsc, rrgc** and **rmloc** is conýgured.

As shipped from the factory, these two ýles are empty. When the user runs **`bbdrrbnmehf**, these lines are added to the */etc/hosts.deny* ýle:

in.telnetd: ALL
sshd: ALL
snmpd: ALL

This tells **sboc** to deny access to **hm-sdkmdsc** and **rrgc** to all hosts not listed in the */etc/hosts.allow* ýle. The **rmloc** and **rrgc** daemons also parse this ýle prior to granting access to a requesting host. Then the user is prompted to enter a list of hosts that will be granted access to **hm-sdkmdsc, rrgc** and **rmloc**. These appear in the */etc/hosts.allow* as lines like this:

in.telnetd: 192.168.1.2, 192.168.1.3
sshd: 192.168.1.2, 192.168.1.3
snmpd: 192.168.1.2, 192.l68.1.3

This simple shell script handles the needs of most users, however the syntax of these two ýles supports elaborate conýguration possibilities which are beyond the capabilites of this simple shell script. Advanced users who need these capabilities will need to edit these two ýles directly and then copy them to the */boot/etc* directory. (See ***Using Edit*** above.) Be careful to maintain the proper ownership and access permissions by using **bo ,o** when copying the ýles.

To control access via HTTP, the user must edit the */etc/apache/httpd.conf* ýle and add the equivalent deny followed by allow directives. For example, the default ýle contains these lines:

```
# Controls who can get stuff from this server.
#
   Order allow,deny
   Allow from all
</Directory>
```

To restrict access to a speciýc host with IP address xxx.xxx.xxx.xxx, you would modify the directives as so:

```
# Controls who can get stuff from this server.
#
   Order allow,deny
   Deny from all
   Allow from xxx.xxx.xxx.xxx
</Directory>
```

Disabling Protocols

You may completely disable any of the following protocols: Telnet, TIME, DAYTIME, SSH, SNMP and HTTP.

Disable Telnet, TIME and DAYTIME

To disable Telnet, TIME and DAYTIME use the **hmdscbnmehf** command. **hmdscbnmehf** modiýes the */etc/inetd.conf* ýle which is read by **hmdsc** to start-up various protocol server daemons when requests from remote hosts are received. Currently, three servers are conýgurable via **hmdscbnm, ehf**: TIME and DAYTIME, whose daemons are contained within the **hmdsc** daemon itself, and **hm-sdkmdsc**. Any one or all of these may be enabled or disabled for start-up.

Disable SNMP and HTTP

To disable SNMP and HTTP, edit a system start-up script called */etc/rc.d/rc.local*. This script starts several of the daemons running on the system. You should follow the instructions contained in comments in the ýle for disabling the **rmloc** and **gssoc** daemons. Placing a **#** character at the beginning of a line makes it a comment line so that it will not be executed. (See ***Using Edit*** above.)

Disable SSH

To disable SSH, edit a system start-up script called */etc/rc.d/rc.inet2*. This script starts several of the daemons running on the system. You should follow the instructions contained in comments in the ýle for disabling the **`rrgc`** daemon. Placing a **#** character at the beginning of a line makes it a comment line so that it will not be executed. (See ***Using Edit*** above.)

IMPORTANT

After editing .dsb.qb-c.qb-knb`k `mc.nq .dsb.qb-c.qb-hmds1

2. If your Tempus LX does not have access to the internet, you must ýrst download the appropriate ýles from the endruntechnologies.com website to the computer that you will be using later to access the Tempus LX via its HTTP interface. Use the link shown above to get the ýles. After saving the ýles, use the Tempus LX HTTP interface to select the previously saved ýles for upload to the Tempus LX. One for the Linux Subsystem and the other for the GPS Subsystem. Then follow the remaining prompts from the HTTP interface to complete the upgrades. (You will need to authenticate the root user name and password.)

If you are using **rrg**, you may open a command window on the remote computer and securely transfer the root ýle system image using **rbo** from the remote computer to your Tempus LX. A command like this should be used:

```
rbo Ðo 5/0/,//3w,///^2-//-fy qnns?fmso-xntq-cnl`hm9.cdu.qnnser^0
```

Update the default ýle system partition by issuing this command on your Tempus LX.

```
toc`sdqnnsek`f 0
```

You should see this line displayed:

```
TOFQ@CD hr sgd cde`tks qnns ehkd rxrsdl-
```

Now reboot the system by issuing this command at the shell prompt:

```
rgtscnvm Ðq mnv
```

Wait about 90 seconds for the system to shutdown and reboot. Then log in to the Tempus LX using **sdkmds** or **rrg**. If all has gone well, you should be able to log in the usual way. After you have entered your password, the system message will be displayed. You should notice that it now indicates the software version and date of the upgrade that you previously downloaded. You can also check this at any time by issuing

```
fmsoudqrhnm
```

which will cause the system message to be re-displayed.

You can also check to see which root ýle system image the system is currently booted under by issuing this command at the shell prompt:

```
fmsoqnnser
```

Which should cause this to be printed to the console:

```
ANNS^HL@FD<SdlotrKWFOR^0
```

If so, and your unit seems to be operating normally, you have successfully completed the upgrade. If your unit does not boot up successfully, and you are not able to **sdkmds** or **rrg** into the system after 90 seconds, then there has been some kind of problem with the upgrade. It is possible that the ýle downloaded was corrupt or that you forgot to set your FTP download ýle mode to binary when downloading the ýle--either from the EndRun Technologies website or when transferring it to the Tempus LX.

Recovering from a Failed Upgrade

To restore your Tempus LX to a bootable state using the factory root ýle system, you must use the serial I/O port and reboot the Tempus LX by cycling the power. Refer to ***Chapter 2 ï Connect the Serial I/O Port and Test the Serial I/O Port*** for setup details. When you have connected your terminal to the serial I/O port, apply power to the Tempus LX.

Pay close attention to the terminal window while the unit is rebooting. After the Linux bootloader displays the message

Performing the GPS Subsystem Upgrade

has completed, and that its start-up messages should appear. First the bootloader message will appear:

```
Sdlotr Annskn`cdq 5/0/,//4/,/// u 0-// , L`x 17 1//3 069209/4
```

In about ten seconds, the GPS engine application start-up messages should appear:

```
EV 5/0/,//1/,/// u 0-// , @tf 07 1//3 0/936930
EOF@ 5/1/,///4,/// u /1/1
```

The ýrmware version should match that of the binary ýle that you uploaded. At this point, the **`to, fq`cdfor`** script terminates its execution, and you will again have the standard Tempus LX console prompt.

After about one minute, you should query the GPS ýrmware version using the command:

```
forudqrhnm
```

The upgraded version information should be displayed.

Problems with the GPS Subsystem Upgrade

Should you have difýculties with the upgrade due to a corrupt ýle, power failure during upload, or other accident, do not be alarmed. Even though you may have lost the existing application program, the GPS engine bootloader program will remain intact. On boot up, it will check to see if a valid application program is in the FLASH memory. If there is not, it will immediately go into the ó ogr S ∩

Please type the following command but do not press enter:

dbgn ,d əqdbnudq[qƐ = .cdu.`ql^trdq

Now wait until you see another bootloader message come out and then press enter. You will then see the ñCò come out every 3 seconds. You then kill the previous **b`s** command by entering:

jhkk #

You should see a command prompt. Now issue this command to re-transfer the correct binary ýle:

tofq`cdfor .slo.5/0/,//1/,///^2-/0-ahm

TEMPUSLXUNISON-MIB

Which is located on your Tempus LX in this ASCII ýle:

/usr/local/share/snmp/mibs/TEMPUSLXUNISON-MIB.txt

In addition to a complete set of NTP and GPS status objects, the MIB deýnes four SMIv2 notiýcation objects:

NTP Leap Indicator Bits status change
NTP Stratum change
GPS Fault Status change
GPS Time Figure of Merit change

Invocation of the SNMP daemon

The SNMP daemon, **snmpd** is started from the */etc/rc.d/rc.local* system start-up script with this line:

```
snmpd -m ñ$MIBNAMEò -Ls d -c /etc/snmpd.conf
```

By default, it will listen on port 161 for SNMP queries from the network management system. If you would like to have it listen on another port, you could edit the ýle by adding **,o onqs** to the end of this line, where **port** is the number of the port you would like for the agent to listen on. If you would like to disable starting of the **rmloc** daemon altogether, you can either remove this line or place a **#** character at the beginning of the line so that it will not be executed. (A very compact editor with WordStar command keystrokes is available on the system for this purpose: **dchs**. If you start **dchs** without giving it a ýle name to open, it will display its help screen, showing the supported keystrokes.)

IMPORTANT

After editing .dsb.qb-c.qb-knb`k, you must copy it to the .anns.dsb.qb-c directory and reboot the system. It is very important to retain the access mode for the file, so be sure to use **bo ,o** when performing the copy. During the boot process, the files contained in the .anns.dsb.qb-c directory are copied to the working .dsb.qb-c directory on the system RAM disk. In this way the factory defaults are overwritten.

Quick Start Configuration -- SNMPv1/v2c

You should be able to compile the TEMPUSLXUNISON-MIB ýle on your SNMP management system and access the variables deýned therein. The factory default community names are ñTempusLX-Unisonò for the read-only community and ñendrun_1ò for the read-write community. This is all that is required for operation under v1 and v2c of SNMP.

IMPORTANT

You must kill the **rmloc** process prior to editing, .anns.mds,rm l o.rm l oc-bnme. Otherwise, the secret key creation may not complete properly. Issue the command **or ,d** to have the operating system display the list of running processes. Look for the PID of the **rmloc** process and issue the kill command to stop it. For example, if the PID listed for the **rmloc** process is 53, then you would issue this command: **jhkk 42**. You can verify that the process was terminated by re-issuing the **or ,d** command.

After rebooting, the agent will read the */boot/net-snmp/snmpd.conf* conýguration ýle and compute secret key(s) for each of the users and delete the **bqd`sdTrdq** lines from the ýle. It will then write the secret key(s) to the ýle. These lines begin with the string, **trlTrdq**. In this way, un-encrypted passwords are not stored on the system.

IMPORTANT

To generate new keys, stop the **rmloc** process, delete the existing **trlTrdq** key lines from the file .anns.mds,rm l o.rm l oc-bnme and then add new **bqd`sdTrdq** lines. Then reboot the system.

This example gives the simplest conýguration to begin using SNMPv3 but doesnôt make use of the full capabilities of the VACM in deýning groups and views for ýne-grained access control. The factory default */etc/snmpd.conf* ýle contains commented blocks of lines that can be uncommented to give you a basic conýguration that uses the User-based Security Model (USM) described in RFC-2274 and the View-based Access Control Model (VACM) described in RFC-2275. The comments included in the ýle should help you in modifying it for your speciýc requirements.

Disabling The SNMP Protocol

To disable SNMP you need to edit a system start-up script called */etc/rc.d/rc.local*. This script starts several daemons. You can either remove the line that lists SNMP or you can place a **#** character at the beginning of the line so that it will not be executed. (A very compact editor is available on the Tempus LX system called **dchs**. If you start **dchs** without giving it a ýle name to open, it will display its help screen, showing all supported editing keystrokes.)

IMPORTANT

After editing .dsb.qb-c.qb-knb`k, you must copy it to the .anns.dsb.qb-c directory and reboot the system. It is very important to retain the access mode for the file, so be sure to use **bo ,o** when performing the copy. During the boot process, the files contained in the .anns.dsb.qb-c directory are copied to the working .dsb.qb-c directory on the system RAM disk. In this way the factory defaults are overwritten.

Truetime Format

EndRunX (Extended) Format

The EndRunX format is identical to the EndRun format with the addition of two ýelds - the current leap second settings and the future leap second settings. The following string is sent once each second:

T YYYY DDD HH:MM:SS zZZ m CC FF<CR><LF>

T	is the Time Figure of Merit (TFOM) character described in ***Appendix E - TFOM***. This is the ñon-timeò character.
YYYY	is the year
DDD	is the day-of-year
:	is the colon character (0x3A)
HH	is the hour of the day
MM	is the minute of the hour
SS	is the second of the minute
z	is the sign of the offset to UTC, + implies time is ahead of UTC.
ZZ	is the magnitude of the offset to UTC in units of half-hours. Non-zero only when the Timemode is Local.
m	is the Timemode character and is one of: G = GPS L = Local U = UTC
CC	is the current leap seconds.
FF	is the future leap seconds, which will show a leap second pending 24 hours in advance.
<CR>	is the ASCII carriage return character (0x0D)
<LF>	is the ASCII line feed character (0x0A)

NENA Format

TZ=XX	is the time zone where XX is 00 through 23
<CR>	is the ASCII carriage return character (0x0D). The ýrst <CR> is the on-time character.
<LF>	is the ASCII line feed character (0x0A).

NENA1

<CR><LF>Q^WWW^DDMMMYY^HH:MM:SS<CR><LF>

Q	is the time quality indicator and may be either: <space> ASCII space character (0x20) which indicates locked. ? ASCII question mark (0x3F) which indicates the unsynchronized condition. This is the ñon-timeò character.
^	is the space character (0x20).
WWW	is the day-of-week (MON, TUE, WED, THU, FRI, SAT
DD	is the day-of-month (1-31)
MMM	is the month (JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC)
YY	is the two-digit year
:	is the colon character (0x3A)
HH	is the hour-of-the-day (00-23)
MM	is the minute-of-the-hour (00-59)
SS	is the second-of-the-minute (00-60)
<CR>	is the ASCII carriage return character (0x0D). The ýrst <CR> is the on-time character.
<LF>	is the ASCII line f ` A MA M the

GLL (Position Data)

The GLL sentence identiýes the position ýx, time of position ýx, and status. Examples are below:

$GPGLL,,,,,,,V,N*64<CR><LF>
$GPGLL,3827.030,N,12244.020,W,173423.00,A,A*34<CR><LF>

Msg ID	$GPGLL	
Field 1	3827.030	Latitude in ddmm.mmm
Field 2	N	Direction of latitude (N=north, S=south)
Field 3	12244.020	Longitude in dddmm.mmm
Field 4	W	Direction of longitude (W=west, E=east)
Field 5	173423.00	UTC time of ýx (hhmmss.ss)
Field 6	A	A=data valid, V=data not valid
Field 7	A	A=autonomous mode, N=data not valid
Checksum	*34	
Msg End		

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Version PTPv2 or PTPv1

In the Tempus LX, you may use the PTPv1 protocol or the PTPv2 protocol. PTPv2 is the default. In order to change the selection from PTPv2 to PTPv1 you can use either the keypad/display or the serial/network port.

Changing PTP Version Using the Keypad/Display

If your unit has the optional PTP capability then there will be an item in the list of Main Menu selections called: ñPTPò. Press the RIGHT/LEFT arrow key until this is highlighted and press ENTER to select it. Then press the RIGHT/LEFT arrow keys to highlight ñVersionò and press ENTER.

Press EDIT to change the PTP version from version 2 to version 1 and vice-versa. Press the HELP key at any time to view the context-sensitive help information. When you are ýnished the unit will reset.

Changing PTP Version Using the Network or Serial Port

The **osoudqrhnmbnmehf** command starts an interactive shell script that will allow you to change the P t & c r

One ýle is modiýed, */etc/ptp2.conf*. This is a non-volatile stored ýle in the FLASH disk */boot/etc* directory. You must reboot the Tempus LX after running this script for the changes to take effect.

The following is a transcript of the question and answer conýguration utility provided by ptp2conýg. The user-entered parameters are underlined:

Tempus LX GPS(root@gntp)-> ptp2conýg

```
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
))))))))))))))Oqdbhrhnm Shld Oqnsnbnk HDDD,0477 U1 Bnmehftq`shnm)))))))))))))))))
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
)                                                                                        )
)   Sghr rbqhos vhkk `kknv xnt sn bnmehftqd sgd oso1-bnme ehkd                          )
)   sg`s bnmsqnkr sgd OSO U1 c`dlnm nodq`shnm-                                          )
)                                                                                        )
)   Xnt vhkk ad `akd sn bnmehftqd sgd OSO rxmb hmsdqu`k+ `mmntmbd hmsdqu`k+             )
)   oqhnqhsx0+ oqhnqhsx1+ cdk`x ldbg`mhrl + oso cnl`hm+ shld lncd+ `mc ssk-             )
)                                                                                        )
)   Sgd bg`mfdr xnt l`jd mnv vhkk mns s`jd deedbs tmshk xnt qd,anns sgd                 )
)   Sdlotr KW FOR-  He xnt l`jd ` lhrs`jd+ itrs qd,qtm oso1bnmehf oqhnq sn              )
)   qd,annshmf-                                                                          )
)                                                                                        )
)   Xnt vhkk mnv ad oqnlosdc enq sgd mdbdrr`qx rds to o`q`ldsdqr-                        )
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))

,,,OSO Rxmb Hmsdqu`k Bnmehftq`shnm

Rds sgd OSO Rxmb Hmsdqu`k hm rdbnmcr '0 nq 1( 0

,,,OSO `mmntmbd hmsdqu`k Bnmehftq`shnm

Rds sgd OSO @mmntmbd Hmsdqu`k hm rdbnmcr '0+ 1+ 3+ 7+ 05( 05

,,,OSO Oqhnqhsx0 Bnmehftq`shnm

Rds sgd OSO Oqhnqhsx0 u`ktd '/,144( 016

,,,OSO Oqhnqhsx1 Bnmehftq`shnm

Rds sgd OSO Oqhnqhsx1 u`ktd '/,144( 017

,,,OSO Cdk`x Ldbg`mhrl D1D nq O1O

Rds sgd OSO Cdk`x Ldbg`mhrl 'D1D nq O1O( O1O

,,,OSO Cnl`hm Bnmehftq`shnm

Rds sgd OSO Cnl`hm u`ktd '/,144( /
```

```
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
)                                                                            )
)  Sgd Sdlotr KW FOR Oqdbhrhnm Shld Oqnsnbnk HDDD,0477 U1 bnmehftq`shnm g`r   )
)  addm toc`sdc-                                                             )
)                                                                            )
)             Okd`rd qd,anns mnv enq sgd bg`mfdr sn s`jd deedbs-             )
)                                                                            )
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
```

Now reboot the system by issuing this command at the shell prompt:

`rgtscnvm ,q mnv`

PTPv2 Status Using the Network or Serial Port

The **`foso1rs`s`** command allows you to query the status of the PTPv2 subsystem. The ptp2d daemon running on the system updates the */var/log/ptp.monitor* every ýve seconds under normal operation. This logýle is parsed and formated to provide the status string having these ýelds:

`U  RH  @H  O0  O1  CL  CNL  LNCD  SSK  BK@RR  RB@KD  RS@SD  BKJHC  TSB TSBU`
`B@  K48  K50  SS  ES`

Where:

V	is the IEEE-1588 version 2 for the 2008 standard.
SI	is the PTP sync interval, either 1 or 2 seconds.
AI	is the PTP announce interval, either 1, 2, 4, 8, or 16 seconds.
P1	is the PTP priority 1 in a range from 0 to 255.
P2	is the PTP priority 2 in a range from 0 to 255.
DM	is the PTP delay mechanism , either E2E or P2P.
DOM	is the PTP domain, in a range from 0 to 255.
MODE	is the PTP time mode, either UTC or PTP.
TTL	is the PTP multicast ttl in a range from 1 to 255.
CLASS	is the PTP clock class either SYNCHRONIZED, HOLDOVER, or UNLOCKED.
SCALE	is the PTP timescale either PTP or ARB.
STATE	is the PTP port state either MASTER, PASSIVE, or LISTENING.
CLKID	is the PTP clock source either GPS, or OSC.

Identiýer	PTP Stratum	Offset to UTC
GPS or ATOM	1	< 25 nanosecs
GPS or ATOM	2	< 100 nanosecs
GPS or ATOM	3	> 100 nanosecs
GPS or ATOM	255	Never locked

The PTP leap_59 and leap_61 report either TRUE or FALSE. FALSE is reported when no leap insertion or deletion is pending. The leap_61 reports TRUE on the day of a leap second insertion. The leap_59 is TRUE on the day of a leap second deletion.

The PTP Time Mode is user conýgured, either UTC or PTP. When UTC time mode is conýgured the clock transmits the UTC epoch. When the Time Mode is PTP the clock transmits the PTP epoch (TAI). See ***About the PTP Second and UTC Time*** below for more information.

The PTP Multicast TTL value is factory set to the IEEE-1588 standard that deýnes TTL=1. The TTL value may be set to any value from 1-255. When set to any value other than 1, you must also conýgure the PTP Slave accordingly.

About the PTP Second and UTC Time

The PTP Time Mode selections are PTP and UTC. The IEEE-1588 standard deýnes the PTP epoch beginning at 0 hours on 1 January 1970. The time measured since this epoch is designated in the standard as PTP seconds. The PTP second is monotonic so does not include leap seconds.

Unlike PTP, the UTC second is not monotonic, that is, from time-to-time there will be leap second insertions. The last second of a leap day is 23:59:60 making the day one second longer than a normal day ending at 23:59:59.

PTP Second

When the PTP Time Mode is set to PTP, the slave clocks must utilize the current leap second and leap second pending þags (leap_59 or leap_61) to convert the PTP second to UTC.

UTC Time

When the PTP Time Mode is set to UTC, then there will be a one second jump in time when a leap second insertion occurs. If the PTP slave does not account for this, it will also jump. Avoid this by using PTP Time Mode.

GPS Antenna Kit

The time server ships with a free GPS Antenna Kit which includes 50 feet (15 meters) of antenna cable. This amount of cable is sufýcient for the majority of GPS antenna installations. Longer cable runs can also be accommodated. Below is a list of the items in a typical GPS Antenna Kit, part number 0610-0007-001:

- GPS Antenna (part #0502-0012-000)
- Antenna Mounting Adaptor (part #0602-0035-000)
- PVC Mounting Pipe (part #0100-0009-018)
- Hose Clamps (part #0100-0008-000)
- 50 feet of RG-59U (Belden 9104) Cable/TNC Male (part #0600-0013-050)
- GPS Antenna Inside Window Mount Kit (part #0608-0002-001)

Following is the Installation Guide for a rooftop mount that is included with the antenna kit.

Long Cable Runs

Most GPS Time Servers are installed with only 50 feet (15 meters) of antenna cable. However, there are many circumstances where 50 feet is inadequate. EndRun can accommodate a cable length of up to 1000 feet using a combination of low-loss cable and preampliýers.

Recommended Cable

The factory-supplied GPS cable is RG-59 Belden 9104 or Belden 1505A, depending on length. If you are responsible for the GPS installation and you are supplying the cable then you need to make sure it is comparable with less than 10 dB of loss at 1.5 GHz. Choosing a cable type that is different can cause a myriad of GPS reception problems. If the cable length is less than 700 feet then Belden 9104 is appropriate. If the cable length is greater than 700 feet then Belden 1505A is the cable of choice. You will also need preampliýers if the cable length is greater than 250 feet. See the chart below for details.

Using GPS Preamplifiers

EndRun produces a GPS Preampliýer which is a very high-performance, low-noise, inline ampliýer for difýcult GPS signal environments and long cable runs (greater than 250 feet of factory-supplied cable). The following table shows the number of preamplifers we recommend for each GPS antenna installation using our GPS receiver and our factory-supplied cable. Installations using other cable types may have different preamplifer requirements.

Cable Length	Cable Type	Number of Preampliýers
Up to 250 feet (76 meters)	RG-59 Belden 9104	0
251 to 500 feet		

INSTALLATION GUIDE

GPS Antenna Rooftop Mounting Guidelines
(with In-Line Amplifier)

DC Power (option):

38-72 Vdc, 1.5A maximum.
3-position terminal block on rear panel: +DC IN, SAFETY GROUND, -DC IN
(Floating power input: Either ñ+ò or ñ-ò can be connected to earth ground.)

Size:

Chassis:	1.75òH x 17.0òW x 10.75òD
Antenna:	3.5ò Dia. x 2.5ò H
Weight:	< 5 lb. (2.70 kg.)

Environmental:

Operating Temperature:	0Á to +50Á C
Operating Humidity:	0 to 95%, non-condensing
Storage Temperature:	-40Á to +85Á C
Antenna Operating Temperature:	-40Á to +85Á C

Optional Outputs:

See ***Chapter 2 - Physical Description*** for more information on these outputs.

1 PPS: Positive TTL pulse @ 50 or RS-422 levels.
Width: User selectable to 20 us, 1 ms, 100 ms, 500 ms.
Accuracy: < 30 nanoseconds to GPS Time when locked.*
Stability: TDEV < 20 ns, ^{5} seconds.
Connector (TTL): Rear-panel BNC jack labeled ñ1PPSò.
Connector (RS-422): Rear-panel DB-9M jack labeled ñ1PPS RS-422ò.
Pinout (RS-422): Pin 3 is +signal. Pin 6 is -signal. Pin 5 is GND.
* <100 nanoseconds to UTC. Constraints in the official GPS specification prohibit claiming an accuracy to UTC better than 100 nanoseconds.
Note: To change the pulse width refer to the ***Option I/O Menu*** in ***Chapter 5 - Front-Panel Keypad and Display*** or the **`botnosr`** and **`botnosrbnmehf`** commands in ***Chapter 6- Control and Status Commands***.

AM Code: 1 Vrms @ 50 , 1 KHz carrier.
Signal: Amplitude-modulated (AM), 3:1 ratio.
Format: User selectable to IRIG-B (120/IEEE-1344, 122, 123), NASA-36, 2137.
Connector: Rear-panel BNC jack labeled ñAM CODEò.
Note: To change the time code format refer to the ***Option I/O Menu*** in ***Chapter 5 - Front-Panel Keypad and Display*** or the **`botnosr`** and **`botnosrbnmehf`** commands in ***Chapter 6- Control and Status Commands***.

Prog TTL Pulse Rate: Positive TTL pulse @ 50 on BNC jack.
User-Selectable Output Type: On-time pulse rate, a digital time code, or synthesized rate.
Rate: User selectable to 1, 10, 100, 1K, 10K, 100K, 1M, 5M, 10M PPS, IPPM, 1PP2S.
Duty Cycle: 50% except 1PPS which mimics the 1PPS Output defined above.
Accuracy: $< 10^{-13}$ to UTC for 24-hour averaging times when locked.
Stability: $\hat{R}_y(\hat{r}) < 10^{-9}$ for $\hat{r} < 10^2$ seconds, $\hat{R}_y(\hat{r}) < 10^{-7}/\hat{r}$ for $\hat{r} > 10^2$ seconds.
Synthesized Rate (option): 1PPS to 10 MPPS in 1PPS steps with optional DDS upgrade.
Connector: Rear-panel BNC jack labeled ñPROG TTLò.
Note: To change the output selection refer to the ***Option I/O Menu*** in

Alarm: MMBT2222A open collector, grounded emitter. Hill ȵ m Ÿ I Ưd ɖ Ÿ a 1

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