TXU-30
Current Source
User Guide

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Chapter 1

Introduction

Welcome to the TXU-30™ User Guide.

This document is a guide to the TXU-30 Time and Frequency Domain Geophysical Current Source, and describes equipment installation procedures, safety precautions, and operation. Users should read the entire document before operating the TXU-30 to ensure that the equipment is used correctly and that the data obtained are of the highest quality possible.

About the TXU-30 current source

The Phoenix TXU-30 is a controlled current source for geophysical applications and is a member of the System2000.*net* family of instruments. The TXU-30 can be used for time domain methods (less than 100% duty cycle), or frequency domain methods (100% duty cycle). The turn-off waveform shape is suitable for Long Period Transient Electromagnetics (LoTEM). The unit can also be used for Induced Polarization (IP) methods (Frequency and Time Domain, Phase and Spectral IP), Controlled Source Audio Magnetotellurics (CSAMT) in scalar, vector, and tensor modes, and all common Time and Frequency Domain Electromagnetics functions (TDEM, FDEM).

The TXU-30 is designed to use either a grounded (or resistive) load connected to the earth by suitable electrodes, or an inductive load using a suitable loop of wire.

Fig. 1-1: TXU-30 and controller.

Microprocessor-based controllers make operating the TXU-30 easy. Simple push-buttons and toggle switches allow quick setup and adjustment, and the status of the system is displayed in large, clear LED readouts. Transmission is synchronized with GPS satellite time signals for accurate stacking of waveforms without any physical link between the TXU-30 and a separate receiving apparatus.

With Version A1 software, the TXU-30 requires an RXU-TM or RXU-TMR for current monitoring and data acquisition. The RXU-TMR is capable of radio communication with other members of the System2000.*net* family (V8 and RXU multifunction, multichannel receivers). The RXU-TM(R) continously saves time-series records of the TXU-30 output on a removeable CompactFlash™ card. With a wireless link, this information can be transmitted to a companion receiver system for real-time processing. In the absence of a wireless link, the data on the card can be uploaded to a post-processing computer.

Intended audience

This Guide is intended for use by trained geophysicists and technicians familiar with controlled-source electromagnetic techniques.

How to use this guide

The TXU-30 User Guide is organized in the chronological order in which tasks must be performed. Chapter 2 explains how to prepare the unit for use; Chapter 3 explains the various transmission modes and how to set up automatic frequency stepping; and Chapter 4 explains how to operate the system.

Appendices supply further information on:

- Fault conditions and resolution
- System specifications
- Frequency tables

A time zone map is also included for convenient reference.

All personnel who will use the TXU-30 should read this entire Guide and ensure that they understand how to operate the Current Source safely and effectively. The TXU-30 can operate at a variety of frequencies in several different modes. Ensure that the instructions appropriate for the intended mode are followed.

How to get further information and support

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Customers are encouraged to register for a log-in ID and password on our Web site. After registering, you can use the Contact Us link in your private area of the site to request technical support or report problems.

Important safety information

The safe operation of the TXU-30 is very important, and all safety instructions must be followed. ***Failure to follow the instructions in this manual could lead to damage to equipment or property and serious personal injury or death.***

Warning 

The TXU-30 is a high-power current source, and can output up to 40A at 500V or 20A at 1000V. This level of electrical power can cause serious injury or death if mishandled. Various safety features are built into the TXU-30, but there is no substitute for safe operation. ***Please read and follow all the safety instructions provided by this documentation.*** Doing so will help insure the safety and well being of the equipment and personnel.

Safety Features

The TXU-30 is equipped with several important safety features, including a system power key, Emergency Stop buttons, and electrical ground. The TXU-30

responds automatically to system faults and notifies the operator of fault conditions via LED indicators.

Major Safety Concerns

The major safety concerns specific to the operation of the TXU-30 are:

High Power Output. At maximum power, the TXU-30 output is 20kW, at a maximum of 1000V. This amount of electrical power can cause serious injury or death. Ensure that output cables are securely connected and that output electrodes are clearly marked. Take appropriate steps to prevent accidental contact with output cables and electrodes by personnel and animals.

It is important that the cables and electrodes or wire loop used for the survey work be capable of handling the anticipated output. Particular care should be given to proper installation of the electrodes and cable terminations so that electrical conductivity and heat dissipation characteristics are adequate.

Wet Weather. The interior of the TXU-30 should be kept dry. Although the cabinet protects most components, the transmitter will need to be shielded from rain and snow, particularly in windy conditions.

Danger!  Do not operate the TXU-30 in very wet weather. Wet equipment, wet clothes, and wet hands all present a hazard of electrocution in the presence of high voltage electricity. Furthermore, water may be drawn into the TXU-30 housing through the fan intake vents, causing short circuits or other damage.

Weight. The TXU-30 weighs approximately 53kg and requires at least two people to lift or move it. Use correct lifting technique, bending the knees and keeping the back straight, when lifting or moving the TXU-30. Large handles are installed on the sides of the case to make lifting by two people easy.

Use of an MG. The TXU-30 requires input power supplied by electrical mains or a motor-generator (MG). An MG presents its own safety concerns, such as high power output, fuel handling, battery charging, and

high sound pressure levels. Consult the documentation for the MG you use and follow all safety precautions.

Chapter 2

Setting Up

This chapter explains how to prepare the TXU-30 for use in the field.

Selecting a power source

To power the TXU-30, use a 3-phase 200–240V motor-generator (MG) operating at 50Hz, 60Hz, or 400Hz, capable of supplying sufficient power for your application. If you require the full 20kW output of the TXU-30, the MG should be able to supply at least 22kW. The Phoenix MG-40A is designed for the same applications as the TXU-30 and is recommended.

Alternatively, you can supply power from the electrical grid, as long as it meets the requirements of phase, wattage, and frequency described for an MG.

Designing an output loop

Some geophysical techniques require a loop rather than a dipole as the signal source. The loop size, desired current, wire gauge, and weight of the wire must all be determined when planning the survey. It is important to know the characteristics of the loop and also the characteristics of the loop-transmitter combination. For information on these characteristics, see “Transmitting Loop Characteristics” on page 85.

Ensuring adequate cooling

The TXU-30 internal components generate substantial heat when transmitting, and if the heat is not dissipated, component failure can result. Ventilation openings at the front of the case and fans at both the front and back are designed to draw air past these components to keep them cool. It is important to ensure that this system works as designed. Follow these guidelines:

- Do not operate the TXU-30 with the case cover removed. If the cover is not in place, the fans will not draw air through the front vents, and components may overheat.
- Keep the front vents and fan openings clear of obstructions.
- Keep the rear fan openings clear of obstructions to a distance of at least 30cm. Obstructions within that distance can substantially reduce the volume

of air drawn in through the front vents, and components may overheat.

- In high ambient temperatures, shade the TXU-30 from direct sun. (It may be necessary to use a café-style umbrella or market umbrella if there is no natural shade available.)

The controller does not generate significant heat; no special precautions are necessary for it.

Preparing and installing a CompactFlash card

The TXU-30 uses a removeable CompactFlash™ (CF) card to store files of frequency-stepping tables and a special table file with the extension TBL, that controls the state of the TXU-30 when it is powered on. A log file may also written to the card. The CF card fits into a slot in the front of the TXU-30, protected by a small watertight cover.

CF cards can be expensive, and they contain your valuable data. Protect them from damage by storing them in plastic or fabric cases when they are not in use.

Fig. 2-1: CompactFlash cards in protective case.

Handling CF cards

Flash memory cards can be damaged by static electricity discharges. If possible, touch a grounded object before installing or removing a CF card in an instrument or a card reader.

The Windows operating system sometimes fails to release resources and may even corrupt data when a CF card is removed from a card reader. To avoid this problem, always use the Eject command before removing the card. (To use the command, select the card in **My Computer** and click **Eject this disk** in the **System Task** list.)

Standard versus Industrial grade

Many varieties of cards are available from several manufacturers; however, *most are not suitable for the demands of geophysics*. Standard-grade cards of the type used in digital cameras are not 100% factory tested and may corrupt or lose data. They may also not operate properly in extreme temperatures. For best results, use only cards of the type shipped by Phoenix.

Warning The TXU-30 will operate whether a card is installed or not. However, if a card is used, **turn off the TXU-30 power before installing or removing the card**.

Preparing a CompactFlash card

Cards installed by Phoenix are formatted and ready for use. If you purchase additional cards, format them before use. On a PC, use the Windows formatting utility (not a card manufacturer's utility) and specify the FAT file system (not FAT32 or NTFS).

Automatic frequency stepping. If you want to use automatic frequency stepping, read Chapter 3, "Transmission Modes and Frequency Stepping," on page 19 and create either a parameter table (.TBL) file with appropriate parameters, or one or more frequency-stepping tables. Copy the files into a folder named DATA in the root directory of the CF card you plan to use.

Log files. The TXU-30 may save in the DATA folder a number of log files with the extension TLG. A log file is used for diagnostic and troubleshooting purposes. These files are not deleted automatically, and may grow to a large number over time, eventually filling the CF card. It is good practice to remove the log files periodically, either by deleting them or by moving the files to a folder on a PC.

The log file contents are coded, not human-readable, and will have little value to an end-user. However, if problems develop with the TXU-30, Phoenix technical support may request copies of the log files by e-mail.

Installing and removing the CompactFlash card

Warning Never insert or remove a CompactFlash card when the TXU-30 is powered! Serious damage to the unit may result.

The CF card slot is located on the front of the TXU-30. (See Fig. 2-2.)

The card and slot are protected from dirt and moisture by a tight-fitting cover; keep the cover in place except when installing or removing a card.

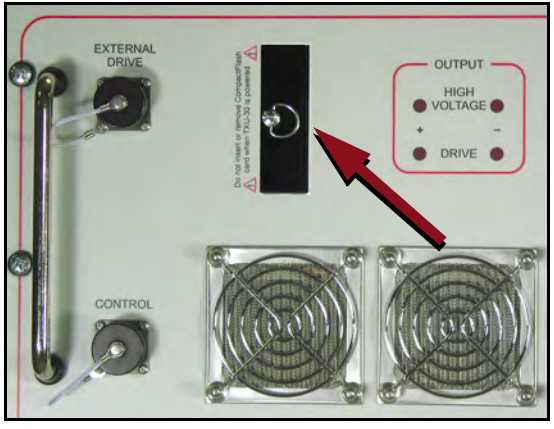


Fig. 2-2: CF card slot on front panel.

To remove the card slot cover:

1. Locate the card slot on the front of the TXU-30.
2. Unlock the card slot cover by lifting the ring on the handle and turning it 90° counterclockwise.
3. Lift the slot cover away from the TXU-30.

To replace the card slot cover:

1. Align the ring of the slot cover at right angles to the length of the cover.
2. Place the bevelled edge of the cover against the right side of the card compartment and push the cover handle fully into the case.
3. Turn the cover handle one-quarter turn clockwise to lock.

Fig. 2-3: CompactFlash card eject button.

To insert the CompactFlash card:

1. Ensure that the TXU-30 is powered off.
2. Remove the card slot cover.
3. Hold the CompactFlash card by the bottom corners, with the card label facing left.
4. Slide the card gently into the slot and press it into place.
5. Replace the card slot cover.

To remove the CompactFlash card:

1. Ensure that the TXU-30 is powered off.
2. Remove the card slot cover.
3. Eject the card partially by pressing the small square button above it. (See Fig. 2-3.)
4. Hold the card by the two corners and withdraw it from the slot.
5. Replace the card slot cover.

Connecting the cables

Seven cables must be connected to the TXU-30: three for AC input, two for high voltage output, and one each for the GPS antenna and the controller. These cables

are supplied with the TXU-30. The controller cable is stored in a canvas bag in the controller lid.

In addition, a ground connection must be made. You will need to supply a length of wire and a steel or copper rod electrode to ground the TXU-30.

Handling locking-ring connectors

Control panel connections are made with military-grade cylindrical bayonet-lock connectors equipped with protective caps or locking rings. (See Fig. 2-4.)

Fig. 2-4: Military-grade cylindrical connector and cap.

The GPS antenna connection is made with a similar but smaller locking connector. (See Fig. 2-5.)

Fig. 2-5: GPS connector.

To remove a protective cap:

1. On the TXU-30, push on the cap and turn it counterclockwise.
2. On a cable end, hold the cap in one hand and with the other hand, push the locking ring toward the cap and turn the ring counterclockwise.

To connect a cable:

- Fit the cable end to the receiving terminal and turn the locking ring clockwise until it locks in place.

To disconnect a cable:

- Push the locking ring toward the terminal and turn the ring counterclockwise.

To keep connectors clean:

1. If both the cable end and the terminal have caps, join the caps to each other after connecting the cable.
2. When disconnecting equipment, always replace the protective caps immediately and lock them in place. When the controller is not in use, keep the lid closed.

Connecting the ground electrode

For safest operation, always ground the TXU-30. Drive a suitable steel or copper rod well into the earth near the TXU-30 and connect it to the GND terminal on the rear of the cabinet. (See Fig. 2-6.)

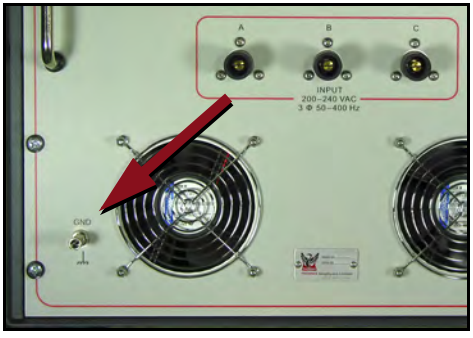


Fig. 2-6: Location of the GND terminal.

Connecting the output cables

Each of the two output cables terminates with a Cam-Lok™ connector for connection to the TXU-30 and with a threaded stud in a connector box for connection to electrode cables or a cable loop. (See Figure 2-7 on page 15.)

The connector for the positive output is red and the cable is marked by a wrapping of red rubber.

To assure a good electrical connection, Phoenix recommends that you crimp ring terminals securely to the electrode cables or loop ends.

Fig. 2-7: Output cables, colour-coded for polarity.

Tip The Cam-Lok™ connectors used on some cables can be difficult to connect, especially when new. If necessary, apply a little moisture to the rubber to reduce friction.

To connect the output cables:

1. Remove the four screws from the covers of the output cable connector boxes and lift off the covers.
2. Connect the electrode cables (or the two ends of a cable loop) to the threaded studs in the output cable connector boxes using the nuts and washers supplied.
3. Replace the connector box covers and screws.
4. At the TXU-30 rear panel, hold the Cam-Lok™ studs with the flat surface facing up and insert them all the way into the output terminals, making sure the red Cam-Lok connector goes to the + (red) output terminal.
5. Turn the connectors clockwise until they stop (approximately one-half turn).
6. Test the security of the connections by pulling on the connectors.

Connecting the AC input cables

The three AC input cables terminate with Cam-Lok™ connectors on each end. The male connectors (uniform diameter) connect to the MG; the female connectors (stepped diameter) connect to the TXU-30. (See Fig. 2-8.)

To connect the AC input cables:

1. At the MG output panel, hold the connectors with the raised circle facing up and push them all the way on to the output terminals.
2. Turn the connectors clockwise until they stop (approximately one-half turn).
3. Test the security of the connections by pulling on the connectors.
4. At the TXU-30 rear panel, repeat the process with the female connectors and the three INPUT terminals marked A, B, and C.

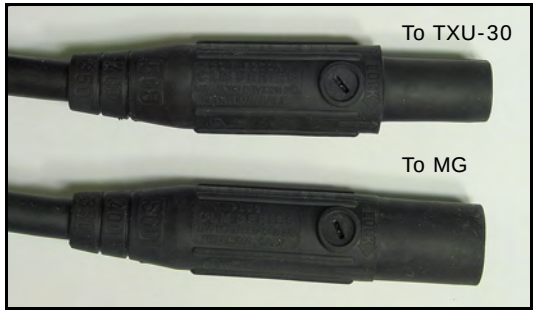


Fig. 2-8: AC cable connectors. Note raised circles.

Connecting and positioning the GPS antenna

The global positioning system (GPS) antenna must be connected to the TXU-30 when operating or calibrating the equipment, because the satellites provide the time signals necessary to synchronize with other instruments. The cable has two connectors: one with slots for quick connection to the TXU-30, and one with threads for connection to the antenna. (See Figure 2-9 on page 17.)

Fig. 2-9: GPS antenna cable connectors.

To connect the GPS antenna:

1. Screw the threaded connector of the antenna cable to the underside of the antenna head.
2. Remove the protective cap from the GPS terminal on the TXU-30 rear panel and connect the antenna cable as described on page 13.
3. Open the antenna tripod and position the GPS antenna so that it is level, stable, and has unobstructed sight lines to as much of the sky as possible. If necessary, tape the antenna tripod to another object (e.g., a stake, post, or larger tripod) so that it is raised above tall grass or shrubs.

Tip If you must stretch the cable in order to position the antenna, prevent damage to the connectors by providing strain relief at each cable end. Tape the cable to the tripod and to the TXU-30 chrome guard so that there is some slack at each connector.

Connecting the controller

The controller in its separate case is designed to operate the TXU-30 from several metres away, such as in the cab of a truck. This flexibility allows the operator to work in more comfort, and away from the noise of the MG. A 5 m cable is supplied to connect the controller to the TXU-30.

To connect the controller:

1. Remove the protective caps from the controller cable as described on page 13.
2. Remove the protective cap from the CONTROL terminal on the TXU-30.
3. Connect the cable to the terminals.

Chapter 3

Transmission Modes and Frequency Stepping

This chapter explains the transmission modes and frequencies available. It also tells you how to use the TblEdit program on a PC to create startup files and to control automatic frequency stepping.

Use of the frequency-stepping tables is explained in Chapter 4.

Understanding the transmission modes

The TXU-30 Current Source output is adjustable for both frequency domain (FD) and time domain (TD) methods. In time domain, output can be bipolar or unipolar.

The TXU-30 has a built-in table of frequencies that can be selected manually using the controller, as explained in Chapter 4. However, Phoenix current source controllers and System 2000.*net* receivers are also capable of automatically transmitting and receiving specific signal frequencies according to a GPS-synchronized schedule. (The built-in frequency table contains only a small subset of the frequencies that are possible using a schedule.)

Frequency stepping schedules

Schedule files can be created on a PC and the files transferred to the instruments, or a schedule can be created by the instruments in real time, calculated from a small set of parameters. Schedule files created for the TXU-30 specify a waveform, a series of frequencies, a duration for each frequency, and the requested current for each frequency. Schedule files are binary files (not text files) and have the extension .tfs.

Schedules created by the TXU-30 in real time are determined by a few parameters saved in a file. These schedules specify a waveform, a series of frequencies, a minimum duration for each frequency, a minimum number of cycles for low frequencies, and the requested current. Optionally, an automatic current roll-off can be specified to prevent inductive loads from triggering a fault at higher frequencies. (Alternatively, the Auto-Limit feature can be used; see “Auto-Limit: controlling output voltage automatically” on page 57.)

Phase

For synchronization with other Phoenix GPS-equipped instruments, the phase is such that if the waveform were extended backward in time, the centre of the

positive *on* time (or the negative *on* time in unipolar negative) would align with 2000/01/01 00:00:00 UTC.

Note Leap seconds may occur at the beginning of January or July every few years, as determined by the International Earth Rotation and Reference Systems Service (IERS). If a leap second happens to occur while the transmitter is generating a waveform, there may be a discrepancy of 1s in its phase. To prevent problems, consult the IERS Web site (www.iers.org) for notifications, and avoid transmitting during the occurrence of a leap second.

Frequency

System 2000.*net* instruments derive frequencies from a 921.6kHz base frequency, and therefore may not be able to produce exactly the requested frequency. Use at least 6 (preferably 8) significant digits when specifying a frequency. The instruments will calculate the closest approximation possible.

The highest frequencies available are 9600Hz for frequency domain modes; 30Hz for time domain modes; and 8Hz for the special FD9 mode (f + 9f).

For best results in frequency domain methods, use frequencies from Table 3-1 on page 22. For time domain methods, use frequencies at or below 30Hz from the same table.

Table 3-1: Recommended frequencies

Frequency (Hz)									
				1024.0000	512.0000	256.0000	128.0000	64.00000	32.00000
								61.44000	30.72000
	7680.000	3840.000	1920.000	960.0000	480.0000	240.0000	120.0000	60.00000	30.00000
				948.1481	474.0741	237.0370	118.5185	59.25926	29.62963
								56.88889	28.44444
			1706.667	853.3333	426.6667	213.3333	106.6667	53.33333	26.66667
								51.20000	25.60000
	6400.000	3200.000	1600.000	800.0000	400.0000	200.0000	100.0000	50.00000	25.00000
		3072.000	1536.000	768.0000	384.0000	192.0000	96.0000	48.00000	24.00000
								47.40741	23.70370
		2844.444	1422.222	711.1111	355.5556	177.7778	88.8889	44.44444	22.22222
					341.3333	170.6667	85.3333	42.66667	21.33333
	5120.000	2560.000	1280.000	640.0000	320.0000	160.0000	80.0000	40.00000	20.00000
				614.4000	307.2000	153.6000	76.8000	38.40000	19.20000
9600.000	4800.000	2400.000	1200.000	600.0000	300.0000	150.0000	75.0000	37.50000	18.75000
				568.8889	284.4444	142.2222	71.1111	35.55556	17.77778
								34.13333	17.06667
8533.333	4266.667	2133.333	1066.667	533.3333	266.6667	133.3333	66.6667	33.33333	16.66667

Table 3-1: Recommended frequencies (cont'd)

Frequency (Hz)					Period (s)	Frequency	Period (s)	Frequency	Period (s)
16.00000	8.000000	4.000000	2.000000	1.000000	*1.000000*	0.500000	*2.000000*	0.250000	*4.000000*
15.36000	7.680000	3.840000	1.920000	0.960000	*1.041667*	0.480000	*2.083333*		
15.00000	7.500000	3.750000	1.875000	0.937500	*1.066667*	0.468750	*2.133333*	0.234375	*4.266667*
14.81481	7.407407	3.703704	1.851852	0.925926	*1.080000*	0.462963	*2.160000*		
14.22222	7.111111	3.555556	1.777778	0.888889	*1.125000*	0.444444	*2.250000*		
13.33333	6.666667	3.333333	1.666667	0.833333	*1.200000*	0.416667	*2.400000*	0.208333	*4.800001*
12.80000	6.400000	3.200000	1.600000	0.800000	*1.250000*	0.400000	*2.500000*	0.200000	*5.000000*
12.50000	6.250000	3.125000	1.562500	0.781250	*1.280000*	0.390625	*2.560000*		
12.00000	6.000000	3.000000	1.500000	0.750000	*1.333333*	0.375000	*2.666667*	0.187500	*5.333333*
11.85185	5.925926	2.962963	1.481481	0.740741	*1.350000*	0.370370	*2.700000*	0.185185	*5.400000*
11.11111	5.555556	2.777778	1.388889	0.694444	*1.440000*	0.347222	*2.880000*		
10.66667	5.333333	2.666667	1.333333	0.666667	*1.500000*	0.333333	*3.000000*	0.166667	*5.999999*
10.00000	5.000000	2.500000	1.250000	0.625000	*1.600000*	0.312500	*3.200000*	0.156250	*6.400000*
9.60000	4.800000	2.400000	1.200000	0.600000	*1.666667*	0.300000	*3.333333*	0.150000	*6.666667*
9.37500	4.687500	2.343750	1.171875	0.585938	*1.706667*				
8.88889	4.444444	2.222222	1.111111	0.555556	*1.800000*	0.277778	*3.600000*	0.138889	*7.199999*
8.53333	4.266667	2.133333	1.066667	0.533333	*1.875000*	0.266667	*3.750000*		
8.33333	4.166667	2.083333	1.041667	0.520833	*1.920000*	0.260417	*3.840000*		

Table 3-1: Recommended frequencies (cont'd)

Frequency	Period (s)	Frequency	Period (s)	Frequency	Period (s)	Frequency	Period (s)	Frequency	Period (s)
0.1250000	*8.00000*	0.0625000	*16.00000*	0.0312500	*32.00000*	0.01562500	*64.0000*	0.00781250	*128.000*
0.1200000	*8.33333*	0.0600000	*16.66667*	0.0300000	*33.33333*	0.01500000	*66.6667*	0.00750000	*133.333*
0.1171875	*8.53333*								
0.1111111	*9.00000*	0.0555556	*18.00000*	0.0277778	*36.00000*	0.01388889	*72.0000*	0.00694444	*144.000*
0.1041667	*9.60000*	0.0520833	*19.20000*	0.0260417	*38.40000*	0.01302083	*76.8000*		
0.1000000	*10.00000*	0.0500000	*20.00000*	0.0250000	*40.00000*	0.01250000	*80.0000*	0.00625000	*160.000*
0.0937500	*10.66667*	0.0468750	*21.33333*	0.0234375	*42.66667*				
0.0925926	*10.80000*	0.0462963	*21.60000*	0.0231482	*43.20000*	0.01157407	*86.4000*	0.00578704	*172.800*
0.0833333	*12.00000*	0.0416667	*24.00000*	0.0208333	*48.00001*	0.01041667	*96.0000*	0.00520833	*192.000*
0.0781250	*12.80000*	0.0390625	*25.60000*						
0.0750000	*13.33333*	0.0375000	*26.66667*	0.0187500	*53.33333*	0.00937500	*106.6667*	0.00468750	*213.333*
0.0694444	*14.40000*	0.0347222	*28.80000*	0.0173611	*57.60000*	0.00868056	*115.2000*	0.00434028	*230.400*
0.0666667	*15.00000*	0.0333333	*30.00000*	0.0166667	*59.99999*	0.00833333	*120.0000*	0.00416667	*240.000*
								0.00390625	*256.000*

Automatic modes

The TXU-30 can be programmed to follow an automatic frequency-stepping schedule, and can also be programmed to start up in a pre-determined configuration. Two different automatic frequency-stepping modes are available: the file-based mode and the parameter-based mode.

The files controlling automatic operation must be present on the CompactFlash (CF) card, which must be installed before powering on the TXU-30. The startup configuration and parameter-based frequency stepping configuration (explained next) are stored in a file with the extension .tbl. Frequency-stepping schedules are stored in files named with a number from 2 to 9 and the extension .tfs.

When these binary .tbl and .tfs files are saved on an instrument's CF card, you can choose which schedule to activate by selecting an Auto mode on the TXU-30 controller. You can also specify when creating the startup configuration (.tbl) file which schedule to activate when the instrument is powered on.

In order to synchronize the transmitter and receivers, identical schedules must be activated on all instruments used in a survey.

When a System 2000.*net* transmitter or receiver is powered on, it searches the CF card for a file named Startup.tbl. If it finds such a file, it uses the parameters contained in that file. If a Startup.tbl file is not found, the instrument starts up in its default configuration.

Parameter-based frequency stepping. In the parameter-based mode (*Auto-1* in the TXU-30 display), the instrument builds a frequency-stepping table that can contain up to 100 entries, including up to 20 that you specify. This mode includes an automatic current roll-off feature that helps to avoid problems with inductive loads. The TblEdit program allows you to specify and save the parameters in a file with the extension .tbl. The file name must be the reserved name, Startup.tbl.

The advantage of the parameter-based mode is that you can set only a few parameters and have the instrument calculate all the table entries automatically following the pattern you establish. (If you want to

specify more unique entries, it is better to use the file-based mode.)

File-based frequency stepping. In the file-based mode (*Auto-2* to *Auto-9* in the TXU-30 display), the instrument reads a schedule of frequencies (with associated durations and current levels) from a schedule file stored on the CF card. The TblEdit program allows you to create, modify, and save schedule files. Each file can contain up to 100 entries specifying the waveform, the frequency, the current, and the duration. Schedule files have the extension .tfs.

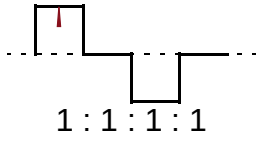
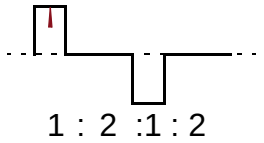
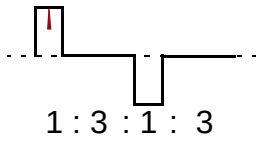
Note A schedule (.tfs) file contains only frequency-stepping parameters. A table (.tbl) file contains more than just frequency-stepping parameters. It also specifies the geophysical method, channel assignments, gains, filter settings, and so on. A table file may even specify that a particular schedule file is to be loaded at startup.

Schedule alignment to UTC. The system calculates each schedule in the automatic modes to begin at 00:00:00 UTC each day and repeat continuously. For this reason, it is best to plan your schedules so that an integral number of repetitions can occur in a 24-hour period. If the total duration of your schedule does not divide evenly into 24h and you happen to be working at 00:00:00 UTC, you will experience an abrupt return to the first frequency in the schedule.

Waveforms. Table 3-2 on page 27 illustrates the waveform that will be generated for each time domain and frequency domain code setting in the schedule files.

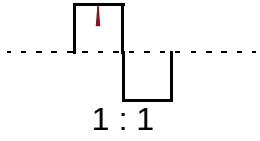
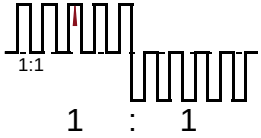
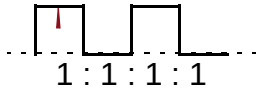
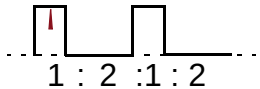
Controller Display. During operation, the MODE display in the SETUP rectangle shows an abbreviation denoting the waveform. The first two characters denote the domain—either *TD* (time domain) or *FD* (frequency domain). If these two characters are followed by a number, that number represents the percentage duty cycle or the special compound waveform, *FD9*. Finally, if the output is not bipolar, the last character is either *P* for unipolar positive or *N* for unipolar negative.

Table 3-2: Transmission Modes and Resulting Waveforms

Controller Display	Domain	Ratio ON:OFF	Duty Cycle	Waveform	WFRM Value (RXU-TMR)
T050	Time	1:1	50% bipolar		1
T033	Time	1:2	33.33% bipolar		2
T025	Time	1:3	25% bipolar		3

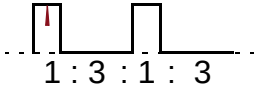
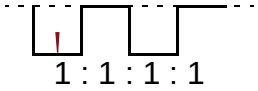
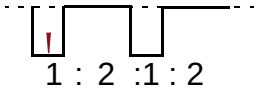
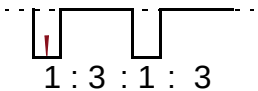
= Aligned with 2000/01/01 00:00:00 UTC.

Table 3-2: Transmission Modes and Resulting Waveforms (cont'd)

Controller Display	Domain	Ratio ON:OFF	Duty Cycle	Waveform	WFRM Value (RXU-TMR)
F1	Frequency	—	100% bipolar		4
F19	Frequency (f + 9f)	10:8	55.55% bipolar		5
T150P	Time	1:1	50% unipolar positive		6
T133P	Time	1:2	33.33% unipolar positive		7

= Aligned with 2000/01/01 00:00:00 UTC.

Table 3-2: Transmission Modes and Resulting Waveforms (cont'd)

Controller Display	Domain	Ratio ON:OFF	Duty Cycle	Waveform	WFRM Value (RXU-TMR)
T025P	Time	1:3	25% unipolar positive		8
T050N	Time	1:1	50% unipolar negative		9
T033N	Time	1:2	33.33% unipolar negative		10
T025N	Time	1:3	25% unipolar negative		11

= Aligned with 2000/01/01 00:00:00 UTC.

Preparing files using TblEdit

TblEdit ("Table Editor") is a program that runs on a Windows PC, providing a graphical interface that allows you to create startup table files (.tbl) and schedule files (.tfs) easily.

Note that in normal practice, you will create at the same time startup and/or schedule files for all the instruments used in the survey. Therefore, you will need to know the serial numbers of all the instruments and sensors and other factors such as expected contact resistance, power-line frequency, and planned site spacing before you begin working with TblEdit.

This section describes how to use TblEdit to set up only the TXU-30. For complete information on the TblEdit program and instructions for setting up other instruments in the System 2000.*net* family, refer to the System 2000.*net* User Guide.

Overview

The general sequence of steps when using TblEdit is:

1. Set up the acquisition parameters (the geophysical method to be used, gains, filters, sensor serial numbers, etc).
2. Set up the site parameters (receiver serial numbers, channel assignments, array layout, survey project information, etc.)
3. Set up automatic frequency stepping (file-based, parameter-based, or both), or if manual control will be used, set up the starting frequency.
4. Optionally, set up radio communication parameters.
5. Save startup files for all the instruments.
6. Copy the startup and schedule files to the CF card(s) to be used in the instruments.

Starting the program

Start TblEdit as you would any other Windows program: either double click a desktop shortcut, or select the program from the **Start** menu.

Setting up the acquisition parameters

The geophysical method chosen determines the parameters available in the rest of the program's windows. Therefore the method and its associated gains, filters, and so on must be selected first.

To set up the acquisition parameters:

1. From the **Edit** menu, select **Acquisition Parameters**...

   The **Acquisition Parameters** dialog box appears. (See Fig. 3-2.)

2. In the **Function** area, select the method. (See Fig. 3-1.)

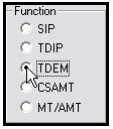


Fig. 3-1: The **Function** area of the **Acquisition Parameters** dialog box.

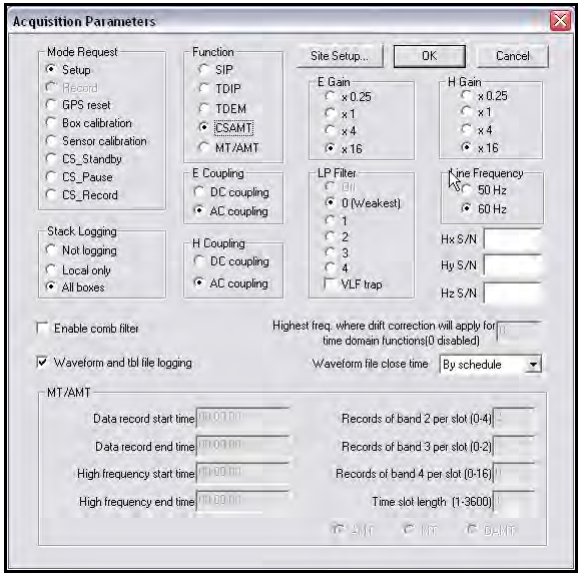


Fig. 3-2: The **Acquisition Parameters** dialog box.

3. Set the remaining parameters according to your survey conditions. Refer to the System 2000.*net* User Guide for instructions.

Setting up the site parameters

The site parameters include the serial numbers of the receivers, channel assignments, array layout, and project information. Refer to the System 2000.*net* User Guide for instructions on setting up site parameters for the method you are using.

To set up site parameters:

1. In the **Acquisition Parameters** dialog box, click the **Site Setup** button. (See Fig. 3-3.)

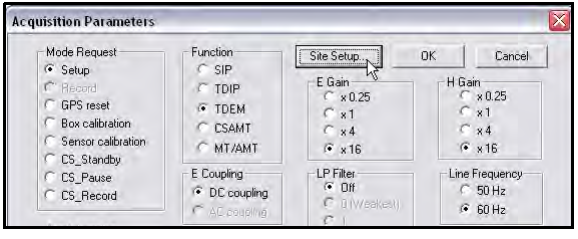


Fig. 3-3: The **Site Setup** button.

The **Input V8 and TMR Serial Number** dialog box appears.

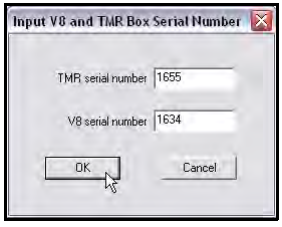


Fig. 3-4: The **Input V8 and TMR Serial Number** dialog box.

2. Type the 4-digit serial numbers of the V8 and/or RXU-TMR and click OK.

The **Site Setup** dialog box for the selected method appears. (See Fig. 3-5.)

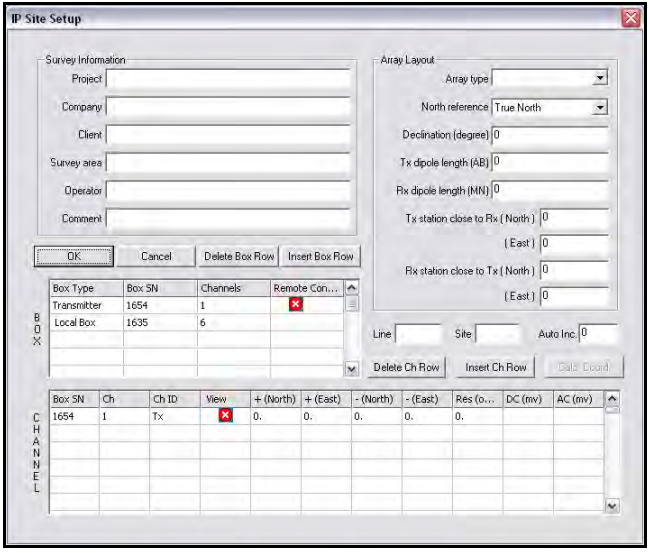


Fig. 3-5: The **Site Setup** dialog box (IP method shown).

3. Enter the information required for the method you are using, according to the System 2000.*net* User Guide.

4. For SIP, TDIP, or TDEM, enter the information required in the **Array Layout** area for the TXU-30 dipole or loop length and location co-ordinates.

5. Click OK to close the **Site Setup** dialog box, and again to close the **Acquisition Parameters** dialog box.

Note With early versions of the TXU-30 that require an RXU-TMR for current monitoring, the RXU-TMR is referred to as the “Transmitter” when assigning channel numbers.

Setting a default frequency (non-Auto modes)

If you don’t plan to use automatic frequency stepping, you may still find it convenient to program the TXU-30 to start up ready to transmit at a particular, default frequency.

To set a default frequency:

1. From the **Edit** menu, select **Frequency Stepping Parameters...**

   The **Frequency Stepping Parameters** dialog box for the selected method appears. (See Fig. 3-6.)

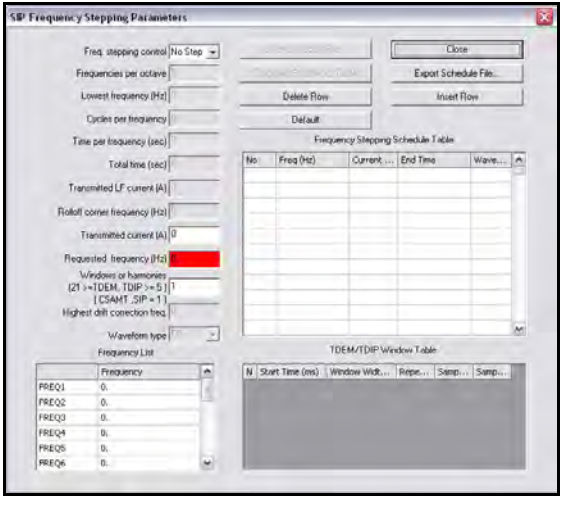


Fig. 3-6: The **Frequency Stepping Parameters** dialog box (SIP method shown).

2. From the **Freq. stepping control** list, choose **No Step**.

   The **Requested frequency** of 0 becomes highlighted in red.

3. Edit the value of the **Requested frequency**.
4. Click **Close** to return to the main program window.

Creating a frequency schedule file

You can store up to eight frequency schedule files on the instrument's CF card, and then choose which one to use by selecting Auto-2 through Auto-9 on the TXU-30 controller. The number of the Auto mode corresponds to the name of the schedule file (2.tfs through 9.tfs).

To begin creating schedules:

- From the **Edit** menu, select **Frequency Stepping Parameters...**

  The **Frequency Stepping Parameters** dialog box for the selected method appears. (See Fig. 3-6.)

Recommended settings. When you select the geophysical method in the **Acquisition Parameters**

dialog box, TblEdit automatically selects values for frequency stepping that are suitable for most applications of the selected method. The easiest and recommended way to set up frequency stepping files is to use these default values.

To use recommended settings:

1. In the **Frequency Stepping Parameters** dialog box, click **Default**.

   If frequency stepping is not appropriate for the selected method, then the **Freq. Stepping Control** will be set to **No Step** and the **Requested Frequency** will be highlighted in red. (See Figure 3-6 on page 34.)

   If frequency stepping is appropriate for the selected method, then the **Select Default Stepping Cycle** dialog box appears. (See Fig. 3-7.)

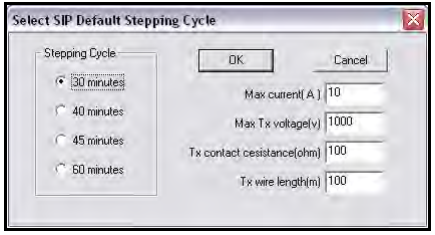


Fig. 3-7: The **Select Default Stepping Cycle** dialog box.

2. In the **Stepping Cycle** area, select the total duration of the frequency stepping table. (See Fig. 3-8.)

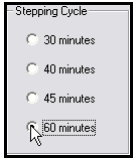


Fig. 3-8: **Stepping Cycle** area.

3. Edit the values for **Current**, **Voltage**, **Resistance**, and **Wire Length**, as required for your application.
4. Click OK to close the dialog box.

In the **Frequency Stepping Parameters** dialog box, **Auto Step** is selected as the **Freq. Stepping Control**, and the **Frequency List** and **Frequency Stepping Schedule Table** are populated with appropriate values. (See Fig. 3-9.)

5. If you are satisfied with the recommended settings, click **Export Schedule File...**

   A standard Windows **Save As** dialog box appears.

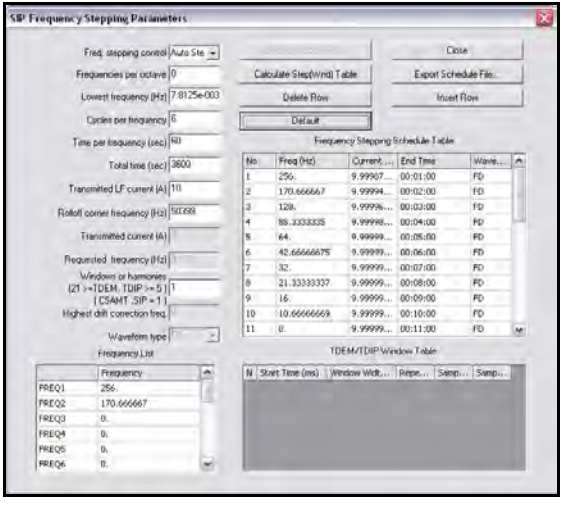


Fig. 3-9: Default values applied.

6. Navigate to the folder where you want to save the file, name the file with a single digit from 2 to 9 keeping the default .tfs extension, and click **Save**.

Customized settings. If the frequency-stepping table created by clicking **Default** does not suit your needs, use the information that follows to customize the table.

You can edit the parameters that were used to create the **Frequency Stepping Schedule Table**. (See "Setting up an Auto Stepping frequency table" on page 37.) You can also edit the table directly.

Note If any of the frequencies in the **Frequency Stepping Schedule Table** are invalid (they cannot be generated accurately from the base clock frequency of 921.6kHz), they will be highlighted in red. You should correct these values using Table 3-1 on page 22 before continuing.

To customize the Frequency Stepping Schedule Table:

1. If you want TblEdit to recreate the Table starting from different parameters, read the next section and change the parameters accordingly.

If you want to edit the table directly, do any of the following:

- Click any cell of the table and type a new value.
- Click any cell of the table, then click and drag to select individual characters or groups of characters. Type new values.
- Click **Insert Row** to insert a new blank row above the selected cell. Click in the new cells and type new values.
- Click **Delete Row** to delete the entire row containing the selected cell.

2. When you have finished editing the table, click **Export Schedule File...**

   A standard Windows **Save As** dialog box appears.

3. Navigate to the folder where you want to save the file, name the file with a single digit from 2 to 9 keeping the default .tfs extension, and click **Save**.
4. If you want to create additional schedule files, repeat this procedure, saving each file with a different name.

Tip You can save schedule files using names that are more meaningful than the digits from 2 to 9. However, because of the correspondence between the file name and the Auto mode number, only files named with the digits 2 to 9 can be used by the TXU-30. Therefore, when copying files to the CF card, make sure that you rename the schedule files you want to use.

Setting up an Auto Stepping frequency table

In the Auto Stepping mode (*Auto-1* in the TXU-30 display), the instrument builds a frequency-stepping schedule in real time in a pattern determined by parameters that you specify. The parameters are saved in a table file, and no external schedule of frequencies needs to be loaded. The schedule created from the parameters can contain up to 100 entries, including up to 20 non-pattern frequencies that you specify. The advantage of the Auto Stepping mode is that you can set only a few parameters and have the instrument calculate all the table entries automatically. (If you

want to specify more non-pattern entries, it is better to use the file-based mode.)

Recommended settings. The advice given under "Creating a frequency schedule file" on page 34 to use the **Default** button is also applicable to Auto Stepping. Customization of the Auto Stepping parameters is more complex than for schedule files.

Customized settings. If the frequency-stepping schedule created by clicking **Default** does not suit your application, use the information that follows to customize the schedule.

The instrument creates the frequency stepping schedule using three types of parameters:

- **FREQn**, specified values for the first frequencies in the schedule ($1 \le \mathbf{n} \le 20$).
- **Lowest frequency**, an approximate value for the last frequency in the schedule.
- **Frequencies per octave**, an integer that determines the number of frequencies per octave to complete the schedule automatically. (An octave is the span between two frequencies, one of which is twice the other.)

Although you can specify all 20 values for the **FREQn** parameter, you will typically specify only a few of them, establishing a starting frequency and/or a pattern of frequency stepping, and allowing the **Lowest frequency** and **Frequencies per octave** to determine the remaining schedule entries based on that starting frequency or pattern.

Note When specifying the first frequencies in the schedule, always start with **FREQ1** and work consecutively. Unused parameters should be set to a value of 0.

Specifying non-pattern and pattern frequencies. You can specify one or more frequencies at the beginning of the schedule—for example, a 1Hz test signal—that will not affect the automatic calculation of the remaining frequencies. As detailed below, the automatic calculation is based on the frequencies in the last octave that you specify.

To specify frequencies:

1. In the **Frequency Stepping Parameters** window of TblEdit, edit the **FREQ1** Frequency cell, assigning it a value less than or equal to the highest frequency suitable for the method you're using (9600Hz for frequency domain, 30Hz for time domain, or 8Hz for the special FD9 mode).
2. Edit one or more cells from **FREQ2–FREQ20**, assigning them the desired frequencies. End with the sequence of frequencies that you want to use as the frequency-stepping pattern.
3. Leave all remaining **FREQn** cells set to a value of 0.

Selecting a frequency-stepping pattern. There are two patterns that can complete the frequency schedule:

- Equally spaced divisions of descending octaves, starting with the last non-zero value of the specified frequencies.
- A sequence of frequencies (equally or unequally spaced) per descending octave, based on the last sequence of specified frequencies that are in descending order and span less than an octave.

Tip To gain a better understanding of how Auto-stepping works and to see typical parameter values for the geophysical method you're using, click **Default** in the **Frequency Stepping Parameters** window.

To select equally spaced divisions of the octave:

1. In the **Frequency Stepping Parameters** window, choose **Auto Step** as the **Freq. stepping control**.
2. Edit the **Lowest frequency** parameter, assigning it the approximate value of the lowest frequency you want. (As explained under "Frequency" on page 21, not all frequencies can be generated by the TXU-30.)
3. Edit the **Frequencies per octave** parameter, assigning it the number of frequencies per octave you want.
4. Click **Calculate Step(Wnd) Table** to update the **Frequency Stepping Schedule Table**.

   When TblEdit completes the schedule, it will start with the last non-zero value of **FREQn** and repeatedly multiply by $2^{-1/(\text{Frequencies per octave})}$ until the schedule is full or the **Lowest frequency** has been reached.

To select a repeating sequence of frequencies per octave:

1. In the **Frequency Stepping Parameters** window, choose **Auto Step** as the **Freq. stepping control**.
2. Start with the lowest-numbered unassigned parameter among **FREQ1–FREQ20**. Edit that parameter, assigning it the highest frequency of the pattern.
3. Edit the next parameters in sequence, assigning them consecutively lower frequencies in the pattern. The difference between the first and last frequencies of the sequence must be less than an octave. Ensure the remaining **FREQn** parameters are set to a value of 0.
4. Click **Calculate Step(Wnd) Table** to update the **Frequency Stepping Schedule Table**.

   When TblEdit completes the schedule, it will repeatedly divide each frequency in the sequence by 2 until the schedule is full or the **Lowest frequency** has been reached.

Setting up the timing. Three parameters control the timing:

- **Cycles per frequency**, the minimum number of cycles generated for each frequency. (The **Time per frequency** parameter may cause a longer duration for a given frequency.) Use **Cycles per frequency** to ensure that enough cycles of very low frequencies are transmitted.
- **TPFR, Time per frequency**, the duration in seconds for which each frequency is generated, unless the **Cycles per frequency** parameter causes a longer duration for a given frequency. Use **Time per frequency** to set the duration for the relatively high frequencies.
- **TTOT, Total time**, controls the duration in seconds of the entire table. If **Total time** = 0, then the length of the schedule is controlled by **Time per frequency** and **Cycles per frequency**. If **Total time** is not 0, then the schedule is truncated or the duration of the last frequency is extended accordingly. It is best to use **Total time** to ensure that your schedule can be repeated an integral number of times in 24h. (See “Schedule alignment to UTC” on page 26.)

To set up the schedule:

1. Edit the **Time per frequency**, **Cycles per frequency**, and **Total time** parameters, assigning them the appropriate values for your application.
2. Click **Calculate Step(Wnd) Table** to update the **Frequency Stepping Schedule Table**.

Setting up automatic current reduction (roll-off). If the transmitter load is inductive, then the achievable current will drop as frequency increases. If the output current falls too far below the requested current, a fault will be triggered. To avoid this condition, either use the Auto-Limit feature while transmitting (see “Auto-Limit: controlling output voltage automatically” on page 57) or set up a roll-off frequency in Auto Stepping to reduce the requested current as frequency increases. The effect of automatic current reduction is shown in Fig. 3-10.

Two parameters control the automatic reduction of requested current:

- **Transmitted LF current** (Transmitted Low Frequency current), in amperes.
- **Rolloff corner frequency**, the frequency at which the requested output current will be reduced to about 70% of **Transmitted LF current**.

The transmitted current for each frequency *f* in the table is equal to:

$$\frac{\text{LF transmitted current}}{\sqrt{(1 + ((f)/(\text{Rolloff corner frequency}))^2)}}$$

To set up automatic current reduction:

1. Edit the **Transmitted LF current** and **Rolloff corner frequency** parameters, assigning them the appropriate values for your application.
2. Click **Calculate Step(Wnd) Table** to update the **Frequency Stepping Schedule Table**.

Completing the Auto Stepping setup. Click **Close** to return to the TblEdit main window, and turn to “Saving the startup files” on page 43 to complete the file preparation.

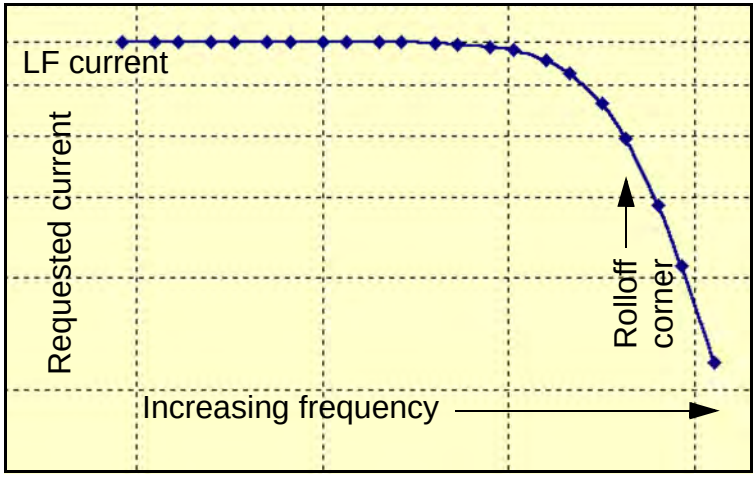


Fig. 3-10: Automatic current reduction.

Setting up radio communication

If you plan to use radio networking among the other System 2000.*net* instructions (V8, RXU-TMR, RXU) used in the survey, you should set up the communication parameters at this time. All instruments used in a survey must have compatible settings. Refer to the System 2000.*net* User Guide for instructions.

Note Version A1 software on the TXU-30 does not support radio communication directly from the transmitter. Use an RXU-TMR to acquire transmitter data and communicate with other instruments on a radio network.

Specifying the frequency-stepping default

After you create one or more schedule files or set up Auto-stepping in a table file, you can specify which condition should apply when the TXU-30 starts up. If you specify that a schedule file should be used, it must be present on the instrument's CF card.

To specify the frequency-stepping default:

- From the **Freq. stepping control** list, select **No Step**, **Auto Step**, or the name of the file you want to be loaded when the TXU-30 starts up. (See Fig. 3-11.)

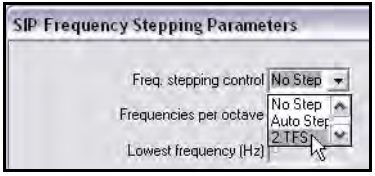


Fig. 3-11: Selecting a default schedule (.tfs) file.

Saving the startup files

After you have set up the survey parameters and/or Auto-stepping parameters, you should save startup table files to a folder on your PC.

Saving the TXU-30 startup table file. With current TXU-30 software, the file name must be Startup.tbl. Follow these instructions to save the TXU-30 startup table file. (You can also use this procedure to save the receiver startup table files; they should be named with their respective serial numbers.)

To save a single startup file:

1. From the **File** menu, select **Save As**.

   A standard Windows **Save As** dialog box appears.

2. Navigate to the folder where you want to save the file.
3. Name the file with either the receiver's serial number or, for the TXU-30, the reserved name Startup, keeping the default .tbl extension, and click **Save**.

Saving multiple receiver startup table files. You can name and save a series of files manually as just described, but TblEdit makes it easy to save files for all the survey receivers at once.

To save files for all receivers:

1. From the **File** menu, select **Save *.TBL Files for All Boxes**

   The **Save RXUTMR Startup File** dialog box appears. (See Fig. 3-12.)

2. If required, edit any of the RXU parameters displayed in the dialog box.
3. In the **File Name** area, select **SerialNumber.tbl**.

4. In the lower left of the dialog box, *do not* select **Save startupfile for TXU30**. This option is for a future release of TXU-30 software.

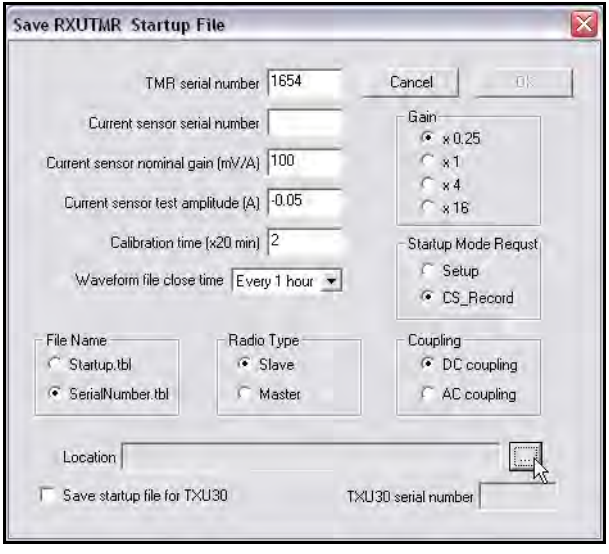


Fig. 3-12: The **Save RXUTMR Startup File** dialog box, with the mouse pointer on the **Location** ellipsis button.

5. Click the **Location** ellipsis button (see Fig. 3-12) and navigate to the folder where you want to save the files.
6. Click OK to select the folder and click OK to save the RXU startup table file.

   The **Save V8 Startup File** dialog box appears. (See Fig. 3-13.)
7. If required, edit any of the V8 parameters displayed in the dialog box.
8. In the **File Name** area, select **SerialNumber.tbl**.
9. Click OK to save the V8 startup table file in the same folder as the other startup files.

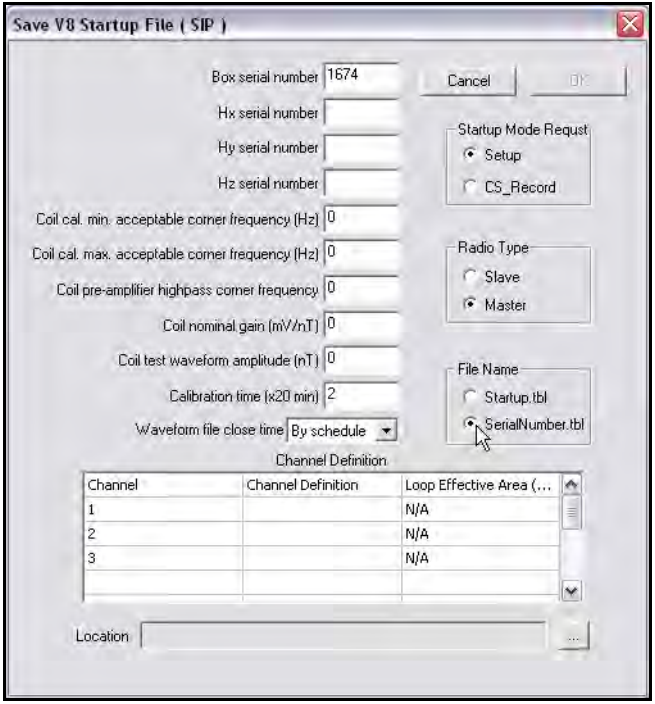


Fig. 3-13: The **Save V8 Startup File** dialog box.

Copying the files to the CF card(s)

When a System 2000.*net* receiver is powered on, it searches the CF card for a startup table (.tbl) file named with its own serial number. If such a file is found, the parameters in it determine the instrument's configuration. The only other similar file that an instrument will use is one with the reserved name, Startup.tbl.

This design means that you can copy all of the table files that you saved in the previous step to all the CF cards used in the survey: the instruments will simply ignore table files named with serial numbers other than their own. The advantage is that any CF card prepared in this way can be installed in any instrument. There is therefore no risk that the wrong table file will be used or that the correct table file will be missing.

If you choose to use the file name Startup.tbl for each instrument, you will have to manage the copying of files and installation of cards individually and much more carefully.

To copy the files to the CF cards:

- Put each CF card in your card reader in turn and use the Windows commands (drag and drop or copy and paste) to copy all the receivers' serial-numbered table files and the TXU-30's Startup.tbl file to every card.

Editing saved schedule files

Schedule files are binary files that cannot be edited in a text editor. However, you can easily open them in TblEdit, either to examine their content or to make changes.

To edit a saved schedule file:

1. From the **Edit** menu, choose **Frequency Stepping Parameters...**

   The **Frequency Stepping Parameters** dialog box appears.

Fig. 3-14: The **Frequency Stepping Parameters** dialog box with **Open Schedule File** button disabled.

2. If the **Open Schedule File** button is disabled, then from the **Freq. stepping control** list, choose any numbered .tfs file name. (The choice you make has no effect on which file is actually opened.)

   The **Open Schedule File** button is enabled.

3. Click **Open Schedule File**.

   A standard Windows **Open** dialog box appears.

4. Navigate to the folder containing the file you want to edit, and click **Open**.
5. Examine and/or edit the **Frequency Stepping Schedule Table** as explained earlier in this chapter.

6. To save the schedule file with the same or a different name, click **Export Schedule File**, or to discard the changes, click **Close**.

Chapter 4

This chapter explains how to start and stop transmission and how to adjust and monitor operation.

Transmitting with the TXU-30

Starting the TXU-30

Before using the TXU-30, ensure that:

- the equipment has been properly set up and all cables connected, as explained in Chapter 2 on page 7.
- any needed startup or frequency-stepping files have been copied to the CF card and that the card is installed in the TXU-30.

Understanding safety features

The TXU-30 is protected by both hardware and software safety features, and will stop transmitting automatically if a fault is detected. In addition, three manual safety controls are available to help protect personnel: two EMERGENCY STOP buttons and the main power switch.

To turn off output power in an emergency:

- Press the red EMERGENCY STOP button on either the TXU-30 or the controller.

For greatest safety, or if there appears to be a problem within the TXU-30 itself, turn off both input and output power.

To turn off both input and output power in an emergency:

1. Press the red EMERGENCY STOP button on either the TXU-30 or the controller.
2. Toggle the power switch on the rear of the TXU-30 cabinet downwards.

To reset an EMERGENCY STOP button

- Turn the button clockwise as indicated by the arrows on the button face until the button pops outward.

Note  Pressing an EMERGENCY STOP button will trigger a fault indication. You will need to press the CLEAR or RESET button to resume transmitting after the emergency is over.

Powering the TXU-30 on and off

The power switch for the TXU-30 is located in the top right corner of the rear panel. (See Fig. 4-1.) The cooling fans will start running as soon as the TXU-30 is powered, but it will take about 30s for the system to boot up completely.

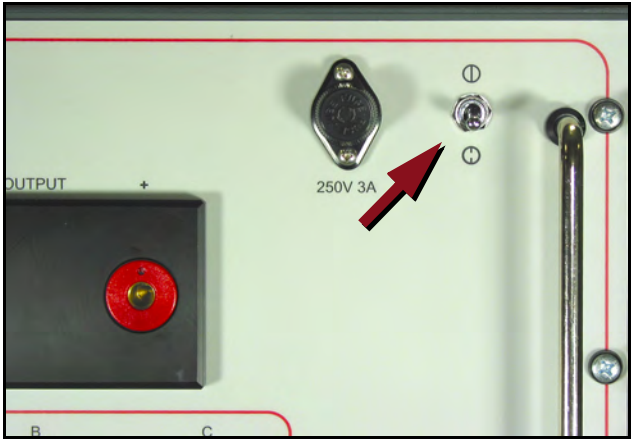


Fig. 4-1: Location of TXU-30 main power switch.

To power the TXU-30 on:

1. Start the motor generator (MG).
2. Toggle the power switch on the rear of the TXU-30 cabinet upwards.

   The fans start running immediately. If the controller is connected, then after about 15s the CONTROL lamp in the STATUS rectangle will light. If the controller is turned on, the LED colons in its STATUS rectangle will light. After approximately 30s, the SYSTEM and SYSTEM READY lamps will light.

To power the TXU-30 off:

1. Toggle the power switch on the rear of the TXU-30 cabinet downwards.

   If transmission was in progress, it stops immediately. The SYSTEM and SYSTEM READY lamps go out, and the FAULT lamp will light. After about 15s, the TXU-30 will shut down completely.

2. Optionally, turn off the MG.

Powering the controller on and off

The controller must be connected to the TXU-30 to operate, as it is powered by the TXU-30.

The controller is protected by a locking power switch that requires a key. Two copies of the key are shipped on a key ring with each controller. It is advisable to remove one of the the keys and keep it separately in case the other is lost.

To power the controller on:

- Insert the key and turn it one quarter turn clockwise.

  When the controller receives power from the TXU-30, it goes through its own boot up process. The LED colons in the STATUS rectangle light for about 15s, and then the time of day (from the CPU clock) is displayed. When both the controller and the TXU-30 finish booting up, the SETUP, OUTPUT, and STATUS rectangles will all display information about the system.

To power the controller off:

- Turn the key one quarter turn counterclockwise.

  The controller shuts down immediately.

Note The communication between the TXU-30 and the controller is over a serial link, which introduces a slight time delay. For this reason, you may notice an unsteadiness in the updating of the UTC display. This is also the reason that the controller HIGH VOLTAGE and DRIVE lamps do not indicate the frequency when transmitting at frequencies higher than 0.1Hz (10s period).

Setting the output voltage range

The TXU-30 has two output voltage ranges. The low range is from 25 to 500V (for up to 40A current); the high range is from 25 to 1000V (for up to 20A current).

The VOLTAGE RANGE toggle switch is the only transmitting control on the main cabinet of the TXU-30. (See Figure 4-2 on page 53.) All other controls are on the controller.

Fig. 4-2: Location of the VOLTAGE RANGE toggle switch.

To set the voltage range:

1. Ensure that the OUTPUT switch is toggled OFF.
2. Move the VOLTAGE RANGE toggle switch on the right front of the main cabinet to either the HIGH or LOW position.

Setting the parameters in manual modes

Except for setting the voltage range as just described, all operations are carried out on the controller.

To set the transmission parameters, you will press the SELECT button (see Fig. 4-3 on page 54) to move from one parameter to the next, and turn the adjustment knob in the CONTROL rectangle (see Fig. 4-4 on page 55) to change each parameter value.

When output is off, each press of the SELECT button advances the controller state through a circular list of five conditions.

Note Units with serial numbers less than 8042 may require a hardware and/or software upgrade to permit adjustable voltage.

The five conditions are:

- adjust mode (MODE display flashes)
- adjust frequency (FREQUENCY display flashes)
- adjust current (CURRENT display flashes)
- adjust voltage (VOLTAGE display flashes)
- ready (no indications)

Tip In controller software versions earlier than 3137B0, the adjustment knob is very sensitive. Only a very small turning movement is required to change to the next parameter value. The adjustment sensitivity is less in later software versions.

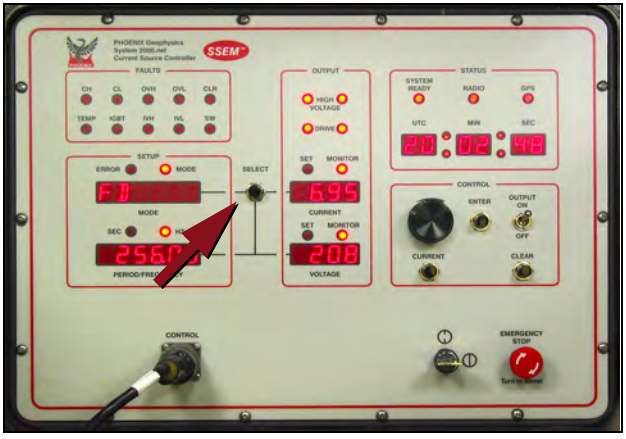


Fig. 4-3: Location of the SELECT button.

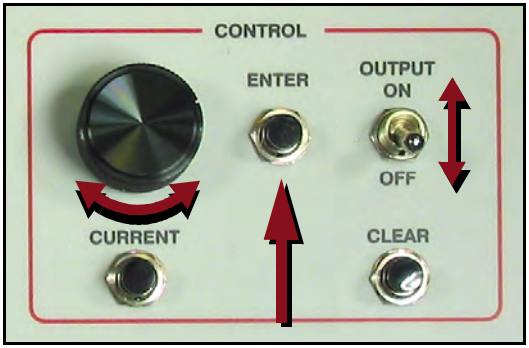


Fig. 4-4: Location of the adjustment knob, ENTER button, and OUTPUT toggle switch.

Setting the transmission mode

To set the transmission mode:

1. Press and release the SELECT button (Figure 4-3).

   In the SETUP rectangle, the MODE lamp lights and the MODE display starts flashing.

2. Turn the adjustment knob in the CONTROL rectangle (Figure 4-4) either way until the desired transmission mode is displayed. See Table 3-2 on page 27 for the meaning of the MODE displays.

Setting the period or frequency

To set the period or frequency:

1. Press and release the SELECT button again.

   In the SETUP rectangle, the MODE display stops flashing and the PERIOD/FREQUENCY display starts flashing.

2. Turn the adjustment knob in the CONTROL rectangle (Figure 4-4) either way until the desired period or frequency is displayed.

   See “TXU-30 Frequency Tables” on page 77 for the range of values available in time and frequency domains in manual modes.

Tip The digits displayed may represent either period in seconds or frequency in hertz. Ensure that the SEC or HZ lamp indicates your intention.

Setting the requested current

This section explains how to set the output current manually. A manual setting is appropriate when you want to keep the output current well below the maximum possible for a given set of conditions. If you want to maximize the output current, follow the instructions under “Auto-Limit: controlling output voltage automatically” on page 57.

To set the requested current before transmitting:

1. Press and release the SELECT button again.

   The PERIOD/FREQUENCY display stops flashing. In the OUTPUT rectangle, the SET lamps light and the CURRENT display starts flashing. (See Figure 4-5 on page 56.)

2. Turn the adjustment knob in the CONTROL rectangle either way until the desired current in amperes is displayed.
3. Press the ENTER button in the CONTROL rectangle (or the SELECT button again) to finish setting the parameters.

The CURRENT display stops flashing and the DRIVE “+” and “–” lamps in the OUTPUT rectangle light. The TXU-30 DRIVE lamps will flash if the frequency is ≤0.5Hz (2s); the controller DRIVE lamps will flash if the frequency is ≤0.1Hz (10s).

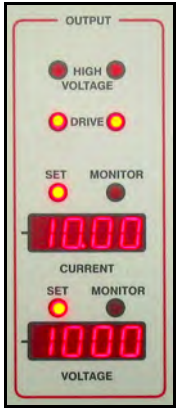


Fig. 4-5: SET lamp and CURRENT display.

Auto-Limit: controlling output voltage automatically

It is possible to request a current that is too high for conditions, causing the TXU-30 to stop transmitting because of an over-voltage fault.

The problem usually occurs with long dipoles or large loops consisting of several hundred metres of wire, where impedance increases with frequency. The TXU-30 compensates by increasing the output voltage. If you do not reduce the requested output current sufficiently, the output voltage may rise to an unsafe level, causing an over-voltage fault.

Beginning with transmitter and controller software releases 3136B0 and 3137B0 respectively, the TXU-30 can be set to automatically limit the output voltage to avoid overload fault conditions. This feature is activated when you set the output voltage to 90% or less of the chosen range. When you turn output on, the TXU-30 starts transmitting at a low current and gradually increases it. The output current stabilizes when either the requested current is reached, or the set maximum voltage is reached. This feature can be used in either manual or automatic modes. Units with serial numbers less than 8042 may require a hardware and/or software upgrade to permit adjustable voltage.

Note 
In Auto-Limit mode, you cannot select a voltage greater than 90% of the range chosen. Furthermore, if the high range is chosen, you cannot select exactly 500V. (This exception is intended to prevent users from mistaking low range without Auto-Limit for high range with Auto-Limit at 50%.)

To use Auto-Limit:

1. Make sure the OUTPUT switch is toggled OFF.
2. Prepare the TXU-30 for automatic or manual transmission as required.
3. On the remote panel, press and release the SELECT button repeatedly until the VOLTAGE display begins flashing.
4. Turn the adjustment knob until the voltage displayed is less than the output voltage range. (For the low voltage range, you can select 450V or less;

for the high voltage range, you can select 900V or less.)

5. Press ENTER.

   A decimal point appears after the last digit of the voltage display, indicating Auto-Limit is in effect. When you turn output on, the current and voltage displays will drop to near zero and gradually increase until either the requested voltage or the requested current is reached.

Transmitting in manual modes

With the parameters correctly set, you are ready to transmit, monitor voltage and current levels, and adjust the parameters if required. (See Figure 4-6 on page 59.)

Starting transmission

To start transmitting:

1. Ensure that the GPS lamp in the STATUS rectangle is lit. (If not, wait for the GPS lamp to light.)

Tip If the TXU-30 has been moved a great distance since it last achieved satellite lock, it can take up to 30 min to acquire satellite signals. Resetting the GPS receiver may help reduce that time. See “Resetting the GPS receiver” on page 75.

2. Move the OUTPUT toggle switch up to the ON position.

   In the OUTPUT rectangle:

   - The CURRENT and VOLTAGE displays will change as the MG produces the output current.
   - The DRIVE lamps continue to flash alternately at the rate set in the PERIOD/FREQUENCY display (low frequencies only).
   - At the start of the next pulse in the waveform, the HIGH VOLTAGE lamps will light in unison with the DRIVE lamps. (At very low frequencies in time domain methods, there may be a noticeable delay until the pulse begins and the HIGH VOLTAGE and DRIVE lamps synchronize.)

   The TXU-30 is now transmitting. (See Figure 4-7 on page 60.)

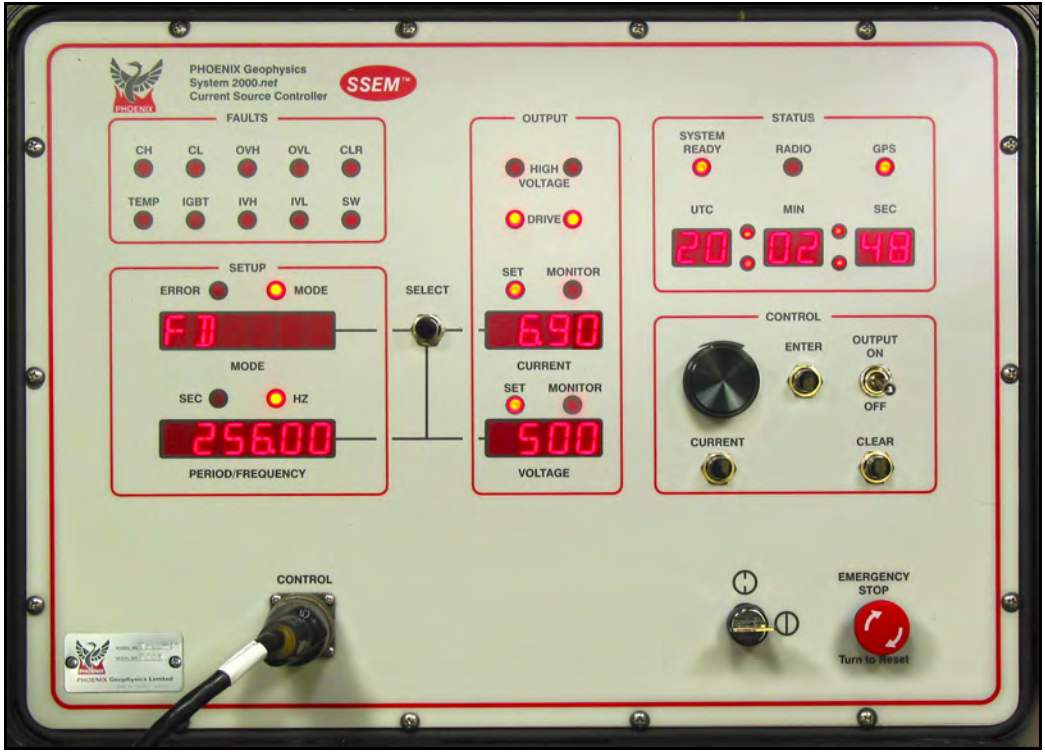


Fig. 4-6: Ready to transmit.

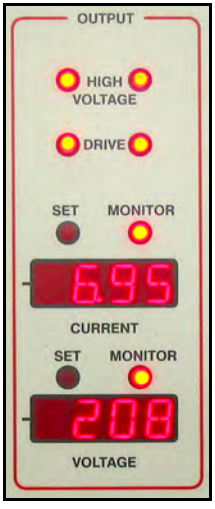


Fig. 4-7: Transmission in progress. The HIGH VOLTAGE and DRIVE lamps light in unison, CURRENT and VOLTAGE displays show the output levels, and the two MONITOR lamps are lit.

Adjusting the current while transmitting

The current can be changed while the OUTPUT toggle switch is in the ON position.

To adjust the current:

1. In the CONTROL rectangle, press and hold the CURRENT button (Figure 4-4).
2. Watch the CURRENT display and turn the adjustment knob until the desired current is displayed.
3. Release the CURRENT button.

Adjusting the frequency while transmitting

The frequency can be changed while the OUTPUT toggle switch is in the ON position.

To adjust the frequency:

1. Press and hold the SELECT button.

2. Watch the FREQUENCY display and turn the adjustment knob in the CONTROL rectangle until the desired frequency is displayed.
3. Release the SELECT button.

   The display returns momentarily to the previous frequency, then displays the new frequency.

Changing the Auto-Limit voltage or the transmission mode

Transmission must be interrupted to change the voltage when Auto-Limit is in effect, or to change the mode. (The period/frequency and the current can also be changed at this time.)

To re-adjust the mode and other parameters:

1. Move the OUTPUT toggle switch down to the OFF position to interrupt transmission.
2. Press and release the SELECT button once to change mode, twice to change period/frequency, three times to change current, or four times to change voltage.

   The affected parameter display starts flashing.
3. Turn the adjustment knob in the CONTROL rectangle to change the value.
4. Press the SELECT button to go to the next parameter, or press the ENTER button to complete the adjustments.
5. To resume transmission, move the OUTPUT toggle switch up to the ON position.

Transmitting using an external clock

The TXU-30 is designed to operate synchronously with other Phoenix products, using GPS signals. However, it can be controlled by legacy products such as the V5 (non-GPS) receiver, or by products from other manufacturers. (Some customization may be required.)

The TXU-30 has a multipin terminal to allow connection of an external clock.

Connecting an external clock

The external clock controller can be any of several devices. Use the same procedure to connect any of them.

To connect an external clock:

1. Remove the protective caps on the cable, on the clock output terminal and on the TXU-30 EXTERNAL DRIVE terminal.
2. Fit the cable to the transmitter and clock connectors and turn the locking rings clockwise until they lock.
3. Join the protective caps to keep them clean.

Transmitting under clock control

Under external clock control, only the current and voltage can be adjusted on the TXU-30 controller. External clocks do not control current on the TXU-30.

To transmit under external clock control:

1. Ensure that the TXU-30 HIGH VOLTAGE toggle switch is in the OFF position.
2. Turn on the external clock.
3. On the TXU-30 controller, press and release the SELECT button.
4. In the SETUP rectangle, the MODE display starts flashing.
5. Turn the adjustment knob in the CONTROL rectangle in either direction until *EXTCLK* appears in the display.
6. In the CONTROL rectangle, press ENTER.
7. Move the HIGH VOLTAGE toggle switch up to the ON position.

   Transmission is now under the control of the external clock. With GPS-synchronized clocks, there may be a significant delay before the first output.

8. If necessary, adjust the current and/or the voltage Auto-Limit. (See “Adjusting the current while transmitting” on page 60, or “Changing the Auto-Limit voltage or the transmission mode” on page 61.)

Transmitting using automatic frequency stepping

The Auto-1 through Auto-9 modes of the TXU-30 load user-created files stored on the CF card to control automatic frequency stepping, as explained in Chapter 3 on page 19.

Verifying the frequency table

You can view the contents of the frequency-stepping table on the TXU-30 controller.

Note If the mode display reads ------ when you expect to see the name of an Auto mode, then that mode has not been properly set up. Review the instructions in Chapter 3 on page 19.

To verify the frequency-stepping table:

1. On the TXU-30 controller, press and release the SELECT button.

   In the SETUP rectangle, the MODE lamp lights and the MODE display starts flashing.

2. Turn the adjustment knob in the CONTROL rectangle either way until AUTO-n is displayed, where n = 1 for parameter-based frequency stepping or n = 2–9 for file-based frequency stepping.
3. Press and release the SELECT button again.

   In the SETUP rectangle, the MODE display stops flashing and the PERIOD/FREQUENCY display starts flashing.

4. Turn the adjustment knob either way and watch the PERIOD/FREQUENCY display and the CURRENT display to see the frequency and current values in the frequency-stepping table.
5. When you are satisfied, press ENTER.

Note If you press SELECT instead of ENTER, the current display will flash as if you were about to set the current manually. However, the value cannot be changed. Press ENTER to stop the display from flashing.

Transmitting under Auto-n control

To begin transmitting on the Auto-n schedule:

1. Ensure that the GPS lamp in the STATUS rectangle is lit. (If not, wait for GPS synchronization to be achieved and the lamp to light.)
2. Select the AUTO-n mode you want to use.
3. Set the voltage range you want to use.
4. If desired, set the Auto-Limit voltage. (See “Auto-Limit: controlling output voltage automatically” on page 57.)
5. Move the OUTPUT switch up to the ON position.

   The TXU-30 synchronizes the table and phase to GPS and loads the presently scheduled frequency. There may be a slight delay before output begins, since transmission will not begin in the middle of a pulse.

Responding to faults and alarms

The transmitter software constantly monitors the state of the TXU-30 and will shut off high voltage transmission and light a fault lamp if any fault conditions arise.

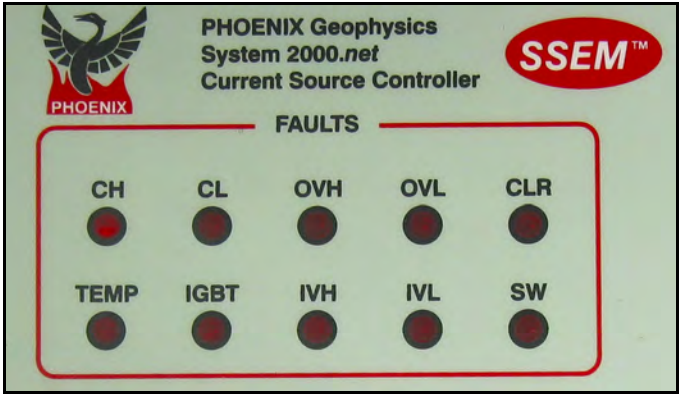


Fig. 4-8: Fault lamps.

Note Some fault conditions will reset the transmitter to the default parameters. You may need to set up your transmitting parameters again after clearing the fault condition.

Clearing fault conditions

To respond to a transmission fault:

1. Move the OUTPUT toggle switch down to the OFF position.

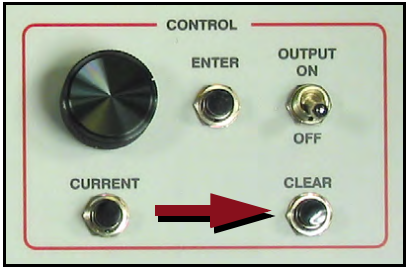


Fig. 4-9: Location of fault CLEAR button.

2. Consult Table 4-1 on page 66 and “Understanding and Clearing Faults” on page 69 for the meaning of the fault lamps and the means of resolving fault conditions.
3. Turn off the fault lamps by pressing the CLEAR button in the CONTROL rectangle (Figure 4-9) or the RESET button below the VOLTAGE RANGE toggle switch (Figure 4-10).

Fig. 4-10: Location of RESET button.

4. Correct the problem that caused the fault.
5. If necessary, change the transmission parameters and resume transmitting.

Table 4-1: Fault lamps

Lamp	Meaning
CH	Current High.
CL	Current Low.
OVH	Output Voltage High.
OVL	Output Voltage Low.
CLR	Reset required; press the Clear button.
TEMP	Temperature out of range.
IGBT	Isolated Gate Bipolar Transistor fault.
IVH	Input Voltage High.
IVL	Input Voltage Low.
SW	Software fault.

Stopping transmission and shutting down the TXU-30

At the end of a transmission session, you will need to stop transmitting and power off the TXU-30.

Stopping transmission

To stop transmission:

- Move the OUTPUT toggle switch down to the OFF position.

  In the OUTPUT rectangle:

  - The HIGH VOLTAGE lamps stop flashing.
  - The MONITOR lamps go out and the SET lamps light.
  - The VOLTAGE display shows the voltage range selected.

Shutting down the TXU-30

To shut down the TXU-30 completely:

1. Turn the controller key counterclockwise one-quarter turn.

   The controller lamps and displays all go out.

2. Toggle the main power switch on the rear of the TXU-30 cabinet down to the off position.

   The status lamps go out, any open files on the CF card are closed, and after a short delay, the fans turn off and TXU-30 shuts down completely.

Appendix A

Understanding and Clearing Faults

To protect personnel and equipment, the TXU-30 monitors its operation and automatically stops transmitting if an abnormal condition occurs. This appendix explains the meaning of the fault indicators and tells you how to correct faults.

In all cases when a fault occurs, toggle the OUTPUT switch OFF. In some cases, you may have to press the CLEAR button in the CONTROL rectangle or the RESET button below the VOLTAGE RANGE toggle switch on the TXU-30 before you can correct the fault. In the remaining cases, press the CLEAR or RESET button after correcting the fault.

Display	Associated FAULTS LED	Meaning	Resolution
ERR-01	CLR	Fault (one or more other fault conditions has occurred).	Toggle the OUTPUT switch OFF. Press the CLEAR or RESET button.
ERR-02	CLR	One or both EMERGENCY STOP buttons were pressed.	Toggle the OUTPUT switch OFF. Reset the EMERGENCY STOP button(s). Press the CLEAR or RESET button.
ERR-03	TEMP	TXU-30 temperature is too high or thermostat has malfunctioned.	Toggle the OUTPUT switch OFF. Ensure that ventilation openings are unobstructed and that all seven fans are operating. Press the CLEAR or RESET button. If error recurs, contact Phoenix.
ERR-04	CLR	Controller cable malfunction (hardware).	Toggle the OUTPUT switch OFF. Ensure that the cable between the TXU-30 and the controller is properly connected at both ends, and is not damaged. Press the CLEAR or RESET button.
ERR-05	SW	Software error.	Toggle the OUTPUT switch OFF. Press the CLEAR or RESET button.
ERR-06	CLR	The TXU-30 is under external clock control, but no controlling signal has been detected.	Toggle the OUTPUT switch OFF. Ensure the external clock cable is properly connected at both ends. Check the settings of the external clock control. Press the CLEAR or RESET button.
ERR-07	IGBT	Internal fault.	Turn off the TXU-30. Contact Phoenix.
ERR-08	IGBT	Internal fault.	Turn off the TXU-30. Contact Phoenix.

Display	Associated FAULTS LED	Meaning	Resolution
ERR-09	IGBT	Internal fault.	Turn off the TXU-30. Contact Phoenix.
ERR-10	IGBT	Internal fault.	Turn off the TXU-30. Contact Phoenix.
ERR-11	—	Not used.	
ERR-12	—	Not used.	
ERR-13	—	Not used.	
ERR-14	—	Not used.	
ERR-15	IVH	Input voltage too high; probably a fault in 3-phase source.	Toggle the OUTPUT switch OFF. At the 3-phase power source, check the voltage across phases A-B and A-C. The values must be no greater than 240V.
ERR-16	IVL	Input voltage too low; probably a fault in 3-phase source.	Toggle the OUTPUT switch OFF. At the 3-phase power source, check the voltage across phases A-B and A-C. The values must be no less than 208V.
ERR-17	—	Not used.	
ERR-18	—	Not used.	

Display	Associated FAULTS LED	Meaning	Resolution
ERR-19	CH	Output current too high.	Toggle the OUTPUT switch OFF and press the CLEAR or RESET button. Then reduce the requested current, or increase the load impedance.
ERR-20	CL	Output current too low.	Toggle the OUTPUT switch OFF and press the CLEAR or RESET button. Then increase the requested current, or decrease the load impedance.
ERR-21	OVH	Output voltage too high (>550V or >1100V).	Toggle the OUTPUT switch OFF and press the CLEAR or RESET button. Then reduce the requested current.
ERR-22	OVL	Output voltage too low (<25V).	Toggle the OUTPUT switch OFF and press the CLEAR or RESET button. Then increase the requested current or increase the load impedance.
ERR-23	—	Not used.	
ERR-24	SW	Transmitter was powered on with the controller OUTPUT switch toggled ON.	Toggle the OUTPUT switch OFF and press the CLEAR or RESET button.

Display	Associated FAULTS LED	Meaning	Resolution
ERR-25	SW	Selected frequency is out of range for selected waveform.	Toggle the OUTPUT switch OFF and press the CLEAR or RESET button. Select an appropriate frequency. In auto modes, check the contents of the frequency table. In external clock mode, check the clock source and connections.
ERR-26	SW	VOLTAGE RANGE switch was changed while the OUTPUT switch was toggled ON.	Toggle the OUTPUT switch OFF and press the CLEAR or RESET button.
ERR-27	SW	Main power contacts inoperable. If this fault occurs during shutdown, the main power relay may have failed.	Toggle the OUTPUT switch OFF. At the 3-phase power source, check the voltage across phases A-B and A-C. The values must be between 208V and 240V. Press the CLEAR or RESET button. If the values are within range or the fault occurs during shutdown, contact Phoenix.
ERR-28	SW	Output power exceeds transmitter rating.	Toggle the OUTPUT switch OFF and press the CLEAR or RESET button. Then reduce the requested current.
ERR-29	—	Not used.	
ERR-30	—	Not used.	

Display	Associated FAULTS LED	Meaning	Resolution
ERR-31	CLR, CONTROL	Controller cannot communicate with TXU-30.	It is normal to see this error message briefly if the controller and the TXU-30 are both powered on at the same time. The controller finishes booting up before the TXU-30 does, and cannot communicate with it, triggering the fault indication. It is also normal to see this error message during a software update when the system reboots. If the error occurs under these conditions, it will clear itself when the TXU-30 finishes booting up and communication is established. If this fault occurs under other conditions, ensure that the cable between the TXU-30 and the controller is properly connected at both ends and is not damaged. Press the CLEAR or RESET button.

Troubleshooting GPS lock

Difficulty in achieving GPS lock can be caused by damaged equipment, poor antenna location, or long-distance transport of the TXU-30.

If you experience long delays in achieving GPS lock, the antenna or cable may be faulty; try using a different antenna or cable. Also, be sure that the antenna is positioned so that it is level, stable, and has unobstructed sight lines to as much of the sky as possible. If necessary, tape the antenna tripod to

another object (e.g., a stake, post, or larger tripod) so that it is raised above tall grass or shrubs.

Tip If you must stretch the cable in order to position the antenna, prevent damage to the connectors by providing strain relief at each cable end. Tape the cable to the tripod and to the TXU-30 chrome guard so that there is some slack at each connector.

Resetting the GPS receiver. If an instrument has been moved a great distance since it last achieved satellite lock, it can take up to 30 min to acquire satellite signals. This is normal, due to the nature of GPS.

Resetting the instrument's GPS receiver can significantly reduce the time it takes to achieve satellite lock in these conditions. The method for resetting the GPS receiver is to imitate a software upgrade, without any upgrade files present. For more information on software upgrades, see Appendix D on page 91.

To reset the GPS receiver:

1. Ensure that the TXU-30 and controller are fully booted up and that the OUTPUT switch is toggled OFF.
2. Disconnect the GPS antenna.
3. Press and hold simultaneously the CURRENT, ENTER, and CLEAR buttons on the controller.
4. Observe the MODE display.

   The display shows the TXU-30 serial number, then the TXU-30 software version, then the controller serial number, and then the controller software version. The display then begins a 10-second countdown from UPGR10 to UPGR00.

5. After the countdown reaches UPGR00, release the three buttons.

   With software versions before 3136A5 and 3137A3, the TXU-30 will reboot and the controller will report Error 31 (loss of communication with the TXU-30). After the TXU-30 finishes booting, Error 31 clears by itself.

   With software versions 3136A5 and 3137A3 and later, the TXU-30 does not reboot. The GPS receiver reset is complete when the MODE display no longer shows UPGR00.

6. Reconnect the GPS antenna.

The GPS receiver begins a fresh search for satellite signals, and should achieve lock in a few minutes.

Appendix B

TXU-30 Frequency Tables

This appendix provides tables of the frequencies that can be transmitted by the TXU-30. xref shows frequencies that can be selected manually using the controller. xref shows recommended frequencies that can be used in the automatic modes described in Chapter 3.

Table B-1: Selectable frequencies (Hz), frequency domain

9600.00	7680.00	6400.00		
4800.00	3840.00	3200.00	2844.44	
2400.00	1920.00	1600.00	1422.22	1200.00
1024.00	960.000	800.000	711.111	600.000
512.000	480.000	400.000	355.555	300.000
256.000	213.333	170.667	150.000	
128.000	106.667	85.3333	75.0000	
64.0000	53.3333	42.6667	37.5000	
32.0000	26.6667	21.3333	18.7500	
16.0000	13.3333	10.6667	9.37500	
8.00000	6.66667	5.33333	4.68750	
4.00000	3.33333	2.66667	2.34375	
2.00000	1.66667	1.33333	1.17188	
1.00000	0.833333	0.666667	0.600000	
0.500000	0.416667	0.333333	0.300000	

Table B-1: Selectable frequencies (Hz), frequency domain (continued)

0.250000	0.208333	0.166667	0.150000	
0.125000	0.1041667	0.0833333	0.0750000	0.0666667
0.0625000	0.0520833	0.0520833	0.0416667	0.0333333
0.0312500	0.0260417	0.0208333	0.0187500	0.0166667
0.0156250	0.0130208	0.0104167	0.0937500	0.00833333
0.00781250	0.00520833	0.00468750	0.00416667	
0.00390625				

Table B-2: Selectable frequencies (Hz), time domain

	30.0000	25.0000,
16.0000	10.0000	8.33333,
8.00000	5.00000,	
4.00000	2.50000,	
2.00000,		
1.00000,		
0.500000,		
0.250000,		
0.125000	0.0666667	
0.06250000	0.03333333	
0.03125000	0.0166667	
0.01562500	0.00833333	
0.00781250		

Table B-3: Recommended frequencies for automatic frequency stepping

Frequency (Hz)									
				1024.0000	512.0000	256.0000	128.0000	64.00000	32.00000
								61.44000	30.72000
	7680.000	3840.000	1920.000	960.0000	480.0000	240.0000	120.0000	60.00000	30.00000
				948.1481	474.0741	237.0370	118.5185	59.25926	29.62963
								56.88889	28.44444
			1706.667	853.3333	426.6667	213.3333	106.6667	53.33333	26.66667
								51.20000	25.60000
	6400.000	3200.000	1600.000	800.0000	400.0000	200.0000	100.0000	50.00000	25.00000
		3072.000	1536.000	768.0000	384.0000	192.0000	96.0000	48.00000	24.00000
								47.40741	23.70370
		2844.444	1422.222	711.1111	355.5556	177.7778	88.8889	44.44444	22.22222
					341.3333	170.6667	85.3333	42.66667	21.33333
	5120.000	2560.000	1280.000	640.0000	320.0000	160.0000	80.0000	40.00000	20.00000
				614.4000	307.2000	153.6000	76.8000	38.40000	19.20000
9600.000	4800.000	2400.000	1200.000	600.0000	300.0000	150.0000	75.0000	37.50000	18.75000
				568.8889	284.4444	142.2222	71.1111	35.55556	17.77778
								34.13333	17.06667
8533.333	4266.667	2133.333	1066.667	533.3333	266.6667	133.3333	66.6667	33.33333	16.66667

Table B-3: Recommended frequencies for automatic frequency stepping (continued)

Frequency (Hz)					Period (s)	Frequency	Period (s)	Frequency	Period (s)
16.00000	8.000000	4.000000	2.000000	1.000000	*1.000000*	0.500000	*2.000000*	0.250000	*4.000000*
15.36000	7.680000	3.840000	1.920000	0.960000	*1.041667*	0.480000	*2.083333*		
15.00000	7.500000	3.750000	1.875000	0.937500	*1.066667*	0.468750	*2.133333*	0.234375	*4.266667*
14.81481	7.407407	3.703704	1.851852	0.925926	*1.080000*	0.462963	*2.160000*		
14.22222	7.111111	3.555556	1.777778	0.888889	*1.125000*	0.444444	*2.250000*		
13.33333	6.666667	3.333333	1.666667	0.833333	*1.200000*	0.416667	*2.400000*	0.208333	*4.800001*
12.80000	6.400000	3.200000	1.600000	0.800000	*1.250000*	0.400000	*2.500000*	0.200000	*5.000000*
12.50000	6.250000	3.125000	1.562500	0.781250	*1.280000*	0.390625	*2.560000*		
12.00000	6.000000	3.000000	1.500000	0.750000	*1.333333*	0.375000	*2.666667*	0.187500	*5.333333*
11.85185	5.925926	2.962963	1.481481	0.740741	*1.350000*	0.370370	*2.700000*	0.185185	*5.400000*
11.11111	5.555556	2.777778	1.388889	0.694444	*1.440000*	0.347222	*2.880000*		
10.66667	5.333333	2.666667	1.333333	0.666667	*1.500000*	0.333333	*3.000000*	0.166667	*5.999999*
10.00000	5.000000	2.500000	1.250000	0.625000	*1.600000*	0.312500	*3.200000*	0.156250	*6.400000*
9.60000	4.800000	2.400000	1.200000	0.600000	*1.666667*	0.300000	*3.333333*	0.150000	*6.666667*
9.37500	4.687500	2.343750	1.171875	0.585938	*1.706667*				
8.88889	4.444444	2.222222	1.111111	0.555556	*1.800000*	0.277778	*3.600000*	0.138889	*7.199999*
8.53333	4.266667	2.133333	1.066667	0.533333	*1.875000*	0.266667	*3.750000*		
8.33333	4.166667	2.083333	1.041667	0.520833	*1.920000*	0.260417	*3.840000*		

Table B-3: Recommended frequencies for automatic frequency stepping (continued)

Frequency	Period (s)	Frequency	Period (s)	Frequency	Period (s)	Frequency	Period (s)	Frequency	Period (s)
0.1250000	*8.00000*	0.0625000	*16.00000*	0.0312500	*32.00000*	0.01562500	*64.0000*	0.00781250	*128.000*
0.1200000	*8.33333*	0.0600000	*16.66667*	0.0300000	*33.33333*	0.01500000	*66.6667*	0.00750000	*133.333*
0.1171875	*8.53333*								
0.1111111	*9.00000*	0.0555556	*18.00000*	0.0277778	*36.00000*	0.01388889	*72.0000*	0.00694444	*144.000*
0.1041667	*9.60000*	0.0520833	*19.20000*	0.0260417	*38.40000*	0.01302083	*76.8000*		
0.1000000	*10.00000*	0.0500000	*20.00000*	0.0250000	*40.00000*	0.01250000	*80.0000*	0.00625000	*160.000*
0.0937500	*10.66667*	0.0468750	*21.33333*	0.0234375	*42.66667*				
0.0925926	*10.80000*	0.0462963	*21.60000*	0.0231482	*43.20000*	0.01157407	*86.4000*	0.00578704	*172.800*
0.0833333	*12.00000*	0.0416667	*24.00000*	0.0208333	*48.00001*	0.01041667	*96.0000*	0.00520833	*192.000*
0.0781250	*12.80000*	0.0390625	*25.60000*						
0.0750000	*13.33333*	0.0375000	*26.66667*	0.0187500	*53.33333*	0.00937500	*106.6667*	0.00468750	*213.333*
0.0694444	*14.40000*	0.0347222	*28.80000*	0.0173611	*57.60000*	0.00868056	*115.2000*	0.00434028	*230.400*
0.0666667	*15.00000*	0.0333333	*30.00000*	0.0166667	*59.99999*	0.00833333	*120.0000*	0.00416667	*240.000*
								0.00390625	*256.000*

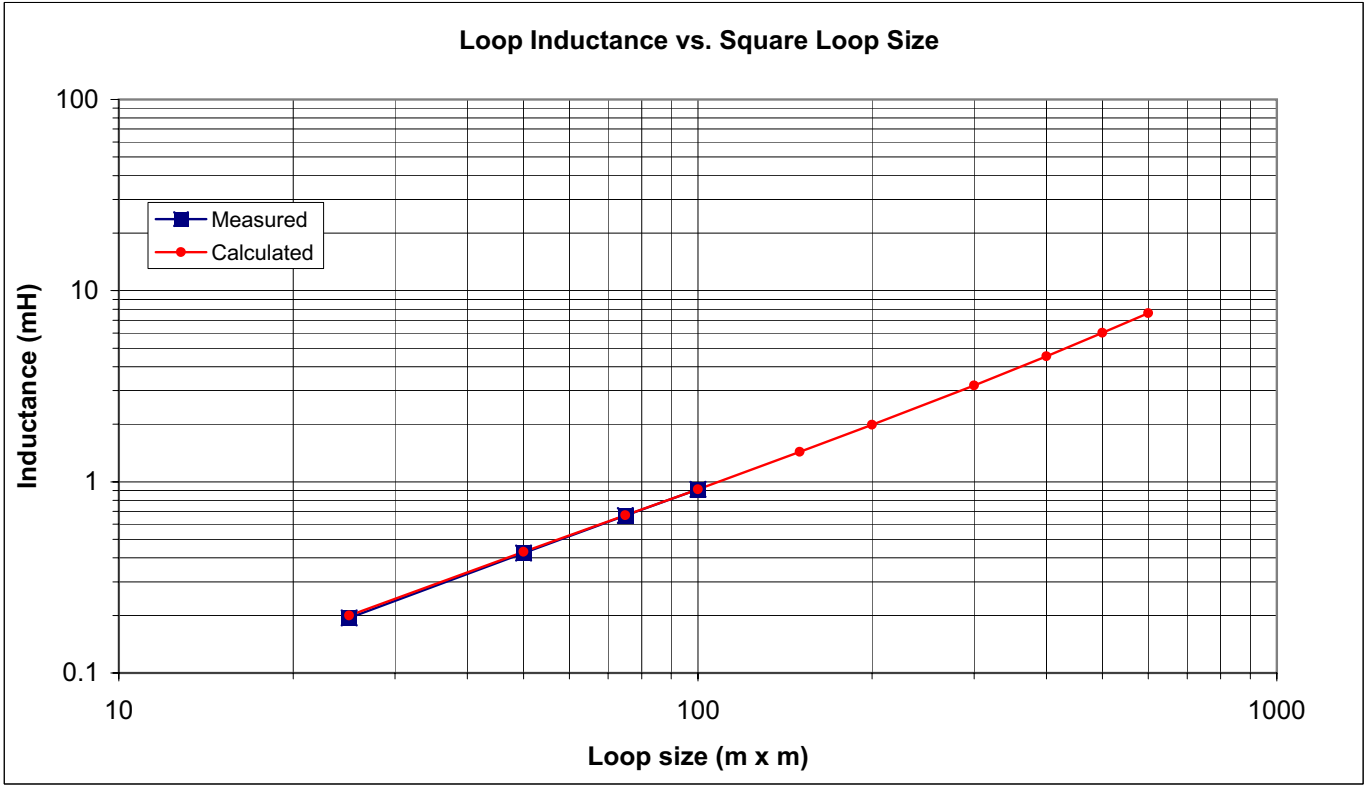
Appendix C

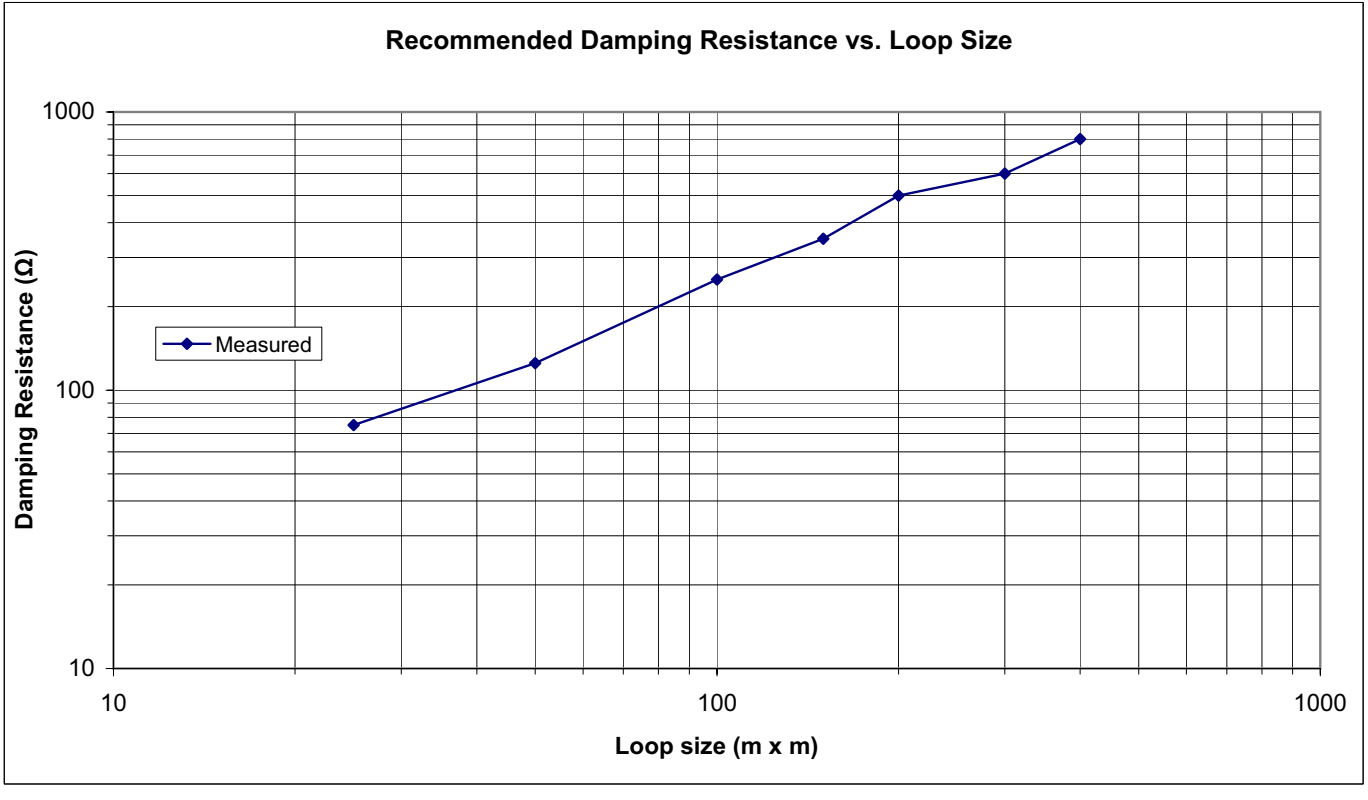
Transmitting Loop Characteristics

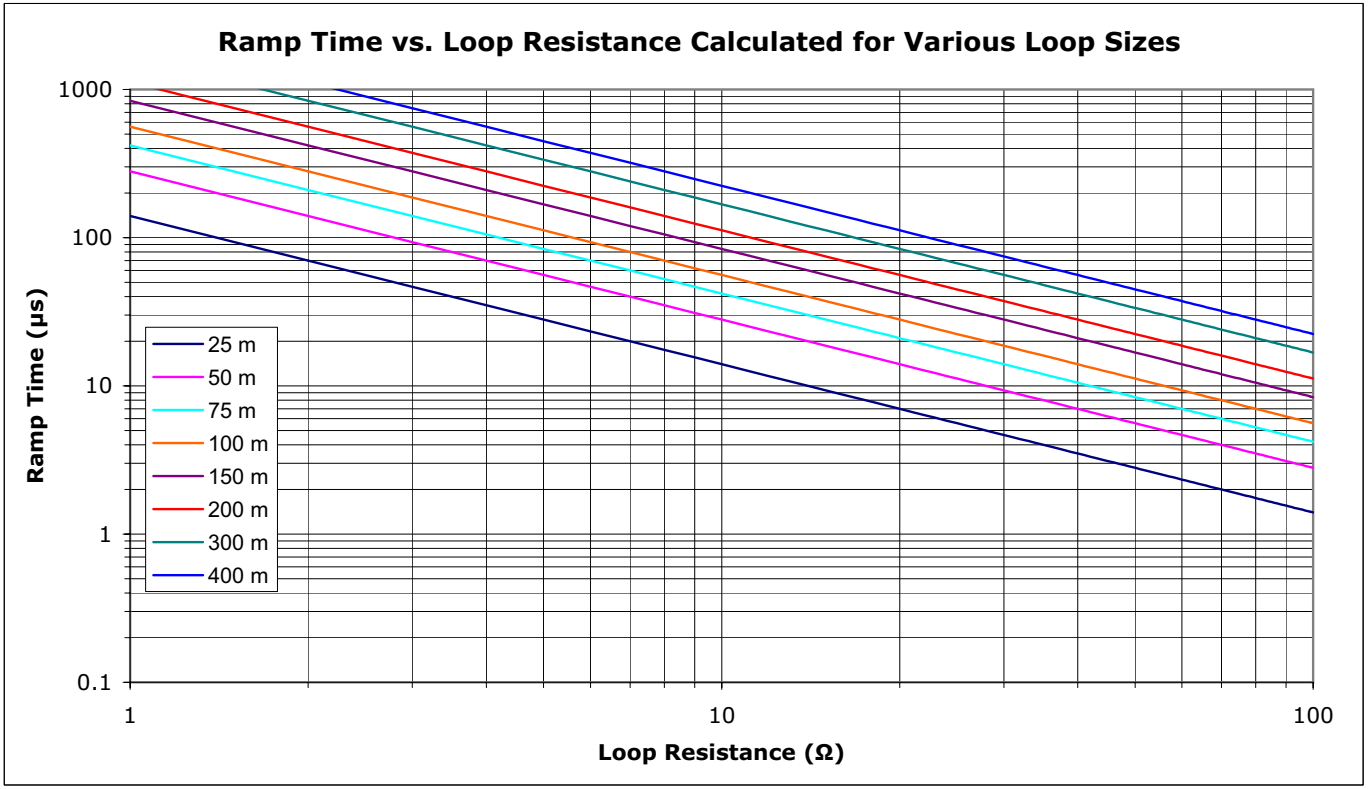
This appendix provides log-log graphs of various characteristics of loops used to transmit with a TXU-30.

Table C-1: Properties of stranded copper wire

Gauge (AWG#)	Diameter (mm)	Cross-section (mm^2)	Resistance (Ω/Km)	Weight (Kg/Km)
10	2.555	5.261	3.277	46.77
12	2.052	3.309	5.210	29.42
14	1.628	2.081	8.285	18.50
16	1.291	1.309	13.17	11.63
18	1.014	0.823	20.95	7.317
20	0.881	0.518	33.31	4.602


Loop Inductance vs. Square Loop Size
100
10
1
0.1
Inductance (mH)
Measured
Calculated
10
100
1000
Loop size (m x m)


Recommended Damping Resistance vs. Loop Size
1000
100
10
Damping Resistance (Ω)
Measured
10
100
1000
Loop size (m x m)


Ramp Time vs. Loop Resistance Calculated for Various Loop Sizes
Ramp Time (µs)
1000
100
10
1
0.1
1
10
100
Loop Resistance (Ω)
25 m
50 m
75 m
100 m
150 m
200 m
300 m
400 m

Appendix D

This Appendix explains how to verify the version of software currently installed in a TXU-30 or controller and how to upgrade the software.

Upgrading Instrument software

Overview

TXU-30 operating software is stored on two internal CompactFlash cards, one in the transmitter and one in the controller.

With version 3137A1 software installed, the controller cabinet must be opened in order to upgrade the software. TXU-30 software can be upgraded without opening the cabinet.

With software versions later than 3136A4 (TXU-30) and 3137A1 (controller) installed, upgrades can be performed without opening the controller cabinet.

Verifying the software version

Follow this procedure to determine the software version currently installed on the TXU-30 and controller.

Warning!  If the TXU-30 software is version 3136A4 or earlier, the transmitter software ***must*** be upgraded *before* the controller software is upgraded.

To verify the software version:

1. Ensure that the TXU-30 and controller are fully booted up and that the OUTPUT toggle switch is in the OFF position.
2. Press and hold simultaneously the CURRENT, ENTER, and CLEAR buttons on the controller.
3. Observe the MODE display.

   The display shows the TXU-30 serial number, then the TXU-30 software version, then the controller serial number, and then the controller software version.

   The display then begins a 10-second countdown from UPGR10 to UPGR00.

4. Release the CURRENT, ENTER, and CLEAR buttons *before* the countdown reaches UPGR00.

Upgrading TXU-30 software from versions 3136A4 and earlier

If your TXU-30 requires a software upgrade, Phoenix technical support will provide you with a file named TX30an.upg (where “an” represents the new software version designation). Using this file, you can upgrade the TXU-30 in only a few minutes.

Keep the original .upg file on your PC in case you want to use it more than once. Although you will copy the .upg file to a CompactFlash (CF) card to begin the upgrade, the process deletes that copy at the end of the upgrade.

Warning  Be sure that the power source for the TXU-30 is stable and will not be interrupted during the upgrade process. If power is lost during an upgrade, the TXU-30 may have to be returned for factory service.

To upgrade TXU-30 software:

1. Copy the upgrade file (TX30an.upg) provided by Phoenix to the \DATA directory of a CompactFlash card.
2. Delete all other files in the \DATA directory.
3. Ensure that the TXU-30 is powered off.
4. Insert the CF card into the TXU-30 card slot.
5. Power on the TXU-30 and controller and wait until they have finished booting up. (You do not need to wait for GPS synchronization.)
6. Press and hold simultaneously the CURRENT, ENTER, and CLEAR buttons on the controller.
7. Observe the MODE display.

   The display shows the TXU-30 serial number, then the TXU-30 software version, then the controller serial number, and then the controller software version.

   The display then begins a 10-second countdown from UPGR10 to UPGR00.
8. After the display reaches UPGR00, release the three buttons.

After a short delay, the controller will report Error 31 (loss of communication with the TXU-30), because the TXU-30 is rebooting using the new software.

After a short delay, Error 31 clears by itself.

9. When the error condition clears, verify the software version as described on page 92. The controller should report the new software version for the TXU-30.

Note  The procedure just described can also be used without a .upg file, to reset the GPS receiver. See “Resetting the GPS receiver” on page 75.

Upgrading controller software from version 3137A1

If your TXU-30 controller requires a software upgrade, Phoenix technical support will provide you with a file named TXRPan.upg (where “an” represents the new software version designation). Using this file, you can upgrade your controller in a few minutes.

Keep the original .upg file on your PC in case you want to use it more than once. Although you will copy the .upg file to a CompactFlash (CF) card to begin the upgrade, the process deletes that copy at the end of the upgrade.

Preparing to upgrade from version 3137A1

Upgrading controller software version 3137A1 is slightly more complicated than upgrading the TXU-30, because the controller does not have an external CF card. The process is similar to upgrading the TXU-30, but the controller panel must be removed from the case first to access the CF card.

Warning  Be sure that the power source for the TXU-30 is stable and will not be interrupted during the upgrade process. If power is lost during an upgrade, the TXU-30 may have to be returned for factory service.

To prepare for the upgrade of controller software:

1. Ensure that the TXU-30 and controller are powered off.
2. If necessary, disconnect the controller cable from the controller panel.
3. Remove the 14 screws from the perimeter of the controller panel.
4. Carefully turn the controller panel upside down and locate the CF card in the centre of the panel. (See Figure D-1.)
5. Note how the lacing cord that holds the CF card in place is tied. You will have to install a new lacing cord later.
6. Cut away the lacing cord and gently slide the card downward, away from the terminal pins. *Do not bend the terminal pins.*
7. Use a PC to copy the upgrade file (TXRPan.upg) provided by Phoenix to the \DATA directory of the CF card.
8. Delete all other files in the \DATA directory.
9. Replace the CF card in the controller, taking care not to bend the terminal pins. Do not replace the lacing cord yet.
10. Turn the controller panel right side up and rest it in the case. Do not replace the panel screws yet.

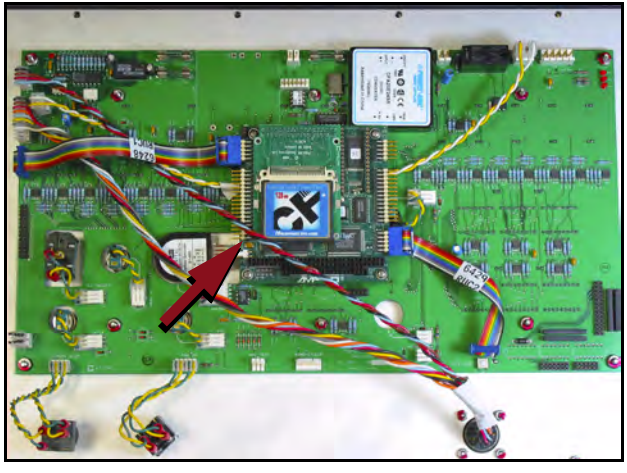


Fig. D-1: Location of the CF card on the underside of the controller panel (lacing cord removed).

Upgrading from version 3137A1

Once the controller's CF card is prepared as just described, the process for upgrading the controller is identical to that for upgrading the TXU-30.

To upgrade the controller software:

1. Reconnect the cable between the TXU-30 and the controller.
2. Power on the TXU-30 and controller and wait until they finish booting up completely.
3. Press and hold simultaneously the CURRENT, ENTER, and CLEAR buttons on the controller.
4. Observe the MODE display.

   The display shows the TXU-30 serial number, then the TXU-30 software version, then the controller serial number, and then the controller software version.

   The display then begins a 10-second countdown from UPGR10 to UPGR00.

5. After the display reaches UPGR00, release the three buttons.

   After a short delay, the TXU-30 CONTROL lamp will go out (indicating loss of communication with the controller), because the controller is loading and booting from the new software.

   After about 20 seconds, the TXU-30 CONTROL lamp will light again and the controller will have booted normally.

6. When the CONTROL lamp lights, verify the software version as described on page 92. The controller should report its new software version.
7. Power the TXU-30 and controller off.
8. Disconnect the controller cable.
9. Turn the controller panel over and tie the CF card in place with a new lacing cord.
10. Turn the controller panel right side up and replace the 14 perimeter screws.
11. Repeat the software verification process to ensure that the controller is operating correctly.

Upgrading from versions 3136A5, 3137A2, and later

With software version 3136A5 (TXU-30) and 3137A2 (controller) installed, the upgrade process is simplified. It is not necessary to remove the controller panel from the case.

If your TXU-30 requires a software upgrade, Phoenix technical support will provide you with a file named TX30an.upg (where “an” represents the new software version designation).

If your TXU-30 controller requires a software upgrade, Phoenix technical support will provide you with a file named TXRPan.upg (where “an” represents the new software version designation).

Using one or both of these files, you can upgrade in only a few minutes. Upgrading a controller takes a little more than two minutes. Upgrading a TXU-30 takes less than two minutes.

Keep the original .upg file on your PC in case you want to use it more than once. Although you will copy the .upg file to a CompactFlash (CF) card to begin the upgrade, the process deletes that copy at the end of the upgrade.

If both the TXU-30 and the controller need to be upgraded, you will have to give the upgrade command twice. The first time, the command upgrades the controller and then deletes the TXRPan.upg file; the second time, the command upgrades the TXU-30 and then deletes the TX30an.upg file.

Warning  Be sure that the power source for the TXU-30 is stable and will not be interrupted during the upgrade process. If power is lost during an upgrade, the TXU-30 may have to be returned for factory service.

To upgrade software:

1. Copy the .upg file(s) provided by Phoenix Technical Support to the \DATA directory of the CF card of the TXU-30.
2. Install the CF card in the TXU-30 card slot.

3. Power on the TXU-30 and controller and wait until they finish booting up completely.
4. Press and hold simultaneously the CURRENT, ENTER, and CLEAR buttons on the controller.
5. Observe the MODE display.

   The display shows the TXU-30 serial number, then the TXU-30 software version, then the controller serial number, and then the controller software version.

   The display then begins a 10-second countdown from UPGR10 to UPGR00.

6. After the display reaches UPGR00, release the three buttons.

   If a TXRPan.upg file exists on the CF card, the display shows UPGRRP while the controller software is upgraded. After a few minutes, the TXU-30 CONTROL lamp will go out (indicating loss of communication with the controller), because the controller is rebooting using the new software.

   If only a TX30an.upg file exists on the CF, then the display shows UPGRTX while the TXU-30 is upgraded. After a short delay, the controller will report Error 31 (loss of communication with the TXU-30), because the TXU-30 is rebooting using the new software.

   After a short delay, Error 31 clears by itself.

7. If the display showed UPGRRP during the previous step, then only the controller was upgraded. Repeat Steps 4–6 to upgrade the TXU-30.

   The display shows UPGRTX while the TXU-30 is upgraded. After a short delay, the controller will report Error 31 (loss of communication with the TXU-30), because the TXU-30 is rebooting using the new software.

   After a short delay, Error 31 clears by itself.

8. Verify the software version as described on page 92, to ensure that both the controller and the TXU-30 have been successfully upgraded.

Upgrading to versions 3136B and 3137B

Versions 3136B0 and 3137B0 and later include the Auto-Limit feature, and may require a hardware upgrade. Contact Phoenix for assistance.

Appendix E

Specifications

Dimensions
Transmitter: 52cm W x 44.5 cm H x 60 cm D.
Controller: 47cm W x 15cm H x 36.5cm D.

Weight
Transmitter: 52.5kg.
Controller: 6.5kg.

Environmental
Operating: –20°C to 45°C
Storage: –35°C TO 50°C

Input Power
50Hz, 60Hz, or 400Hz three-phase 200–240V AC motor-generator or electrical mains.

Output Current
0.5–20A at 1000V.
0.5–40A at 500V.

Output Voltage
Minimum 25V.
Maximum 1000V or 500V, selectable.

Output Power
Maximum 20kW at 25°C, sea level.

Frequency Domain Waveforms
Bipolar square wave selectable from:
- continuous (100% duty cycle); frequency range: 256s to 9600Hz.
- fundamental plus 9th harmonic (ON/OFF ratio of 10:8; 55.55% duty cycle); frequency range: to 8Hz.

Time Domain Waveforms
Bipolar or unipolar square wave with duty cycles selectable from:
- 50% (ON/OFF ratio of 1:1).
- 33.3% (ON/OFF ratio of 1:2).
- 25% (ON/OFF ratio of 1:3).

Frequency range: 128s to 30Hz.

Turn-off time
Linear ramp better than 5µs/ampere.

GPS synchronization

±0.5µs

Controls

Microprocessor-based controller with GPS display.

Indicators

Mode, Frequency/Period, Current, Voltage, Output Polarity, GPS Time (UTC), Faults.

Integrated Safety Features

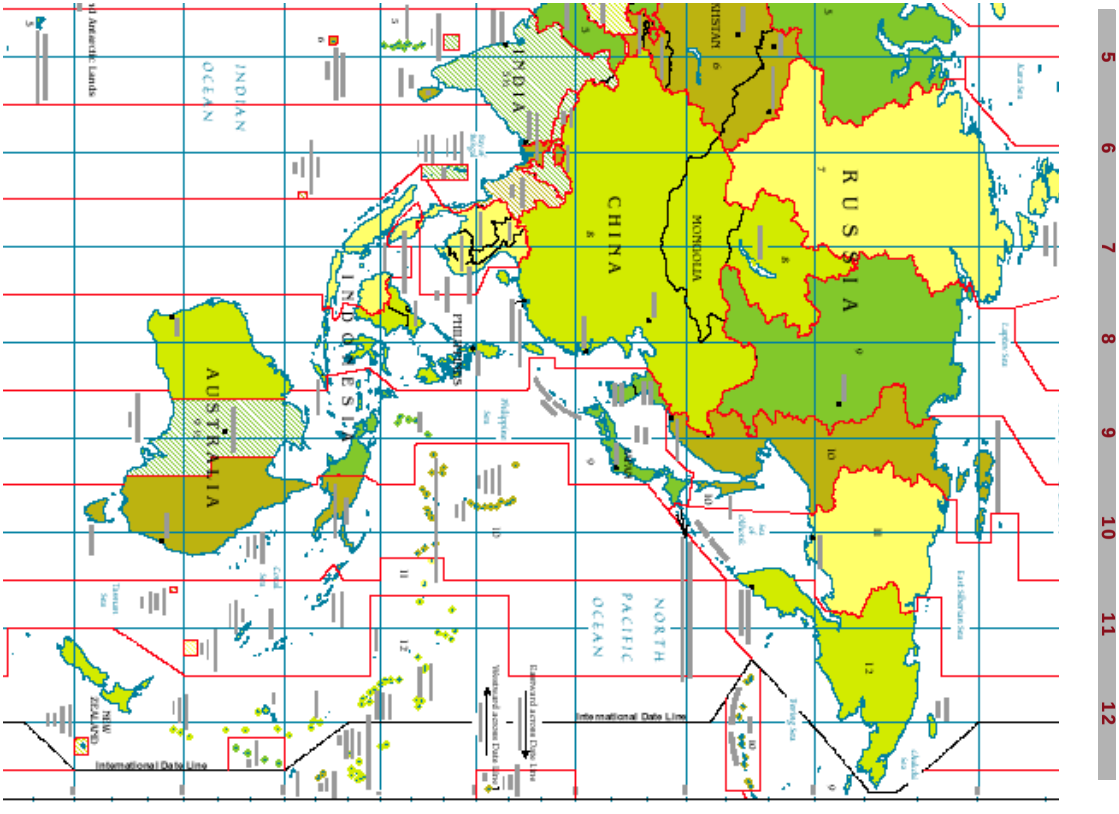
Fault detection, emergency stop buttons, system power key.

Appendix F

Time Zone Map


11 10 9 8 7 6 5 4 3
ARCTIC OCEAN
Greenla
(DENMARK)
U.S.
CANADA
UNITED STATES
MEXICO
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
SOUTH PACIFIC OCEAN
COLOMBIA
PERU
BRAZIL
BOLIVIA
ARGENTINA
CHILE
French Polynesia
Scale 1:85,000,000 at 0°
Miller Cylindrical Projection


2
1
0
1
2
3
4
5
Greenland Sea
Barents Sea
Kara Sea
Norwegian Sea
Denmark Strait
NORWAY
SWEDEN
FINLAND
North Sea
KAZAKHSTAN
Black Sea
TURKEY
Mediterranean Sea
IRAN
3%
ALGERIA
LIBYA
EGYPT
SAUDI ARABIA
INDIA
5%
Arabian Sea
MALI
NIGER
CHAD
SUDAN
DEM. REP. OF THE CONGO
ANGOLA
SOUTH ATLANTIC OCEAN
INDIAN OCEAN
SOUTH AFRICA
French Southern and Antarctic Lands
Coordinated Universal Time (UTC)
formerly


INDIA
CHINA
RUSSIA
MONGOLIA
AUSTRALIA
INDONESIA
PHILIPPINES
INDIAN OCEAN
NORTH PACIFIC OCEAN
NEW ZEALAND
International Date Line
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