Reference

Tektronix

2642A Analyzer

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Tektronix, Inc., P.O. Box 1000, Wilsonville, OR 97070–1000

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2642A Fourier Analyzer

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The German Postal Service was notified that the equipment is being marketed.

The German Postal Service has the right to re-test the series and to verify that it complies.

TEKTRONIX

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2642A Fourier Analyzer

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Preface

This *Reference Manual* explains how to install the Tektronix 2642A Analyzers, and describes its features.

A warranty card is furnished with this manual. The 2642A come with a one year hardware warranty. The Instrument Program software also comes with a warranty; see the *Instrument Program User's Guide* for futher information.

Your one year warranty begins when your analyzer is shipped to you. Completing and returning the warranty card insures that you are entered into our mailing list to receive information regarding the Tektronix analyzer users group, and future updates to the hardware and the Instrument Program software. The warranty card allows us to serve you better by targeting this information to the primary end user.

This manual contains information on the 2642 hardware only. For a tutorial and detailed information on the accompanying Instrument Program, see the *Instrument Program Tutorial*.

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Operator's Safety Summary

1 Introduction

Operator's Safety Summary

The general safety information in this part of the manual is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply and do not appear in this summary.

Terms in this Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

Terms Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the markings, or a hazard to property, including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

Symbols in this Manual

WARNING

This symbol indicates where applicable cautionary or other information is to be found. For maximum input voltage see Section 1.

To assure operator protection, do not exceed ±300 mA peak or ±1.2V relative to chassis ground or any other inputs, into the outside shell of the BNC connectors. Exceeding this current/voltage could cause damage to the instrument and create a potential operator hazard. See Section 1.

Symbols as Marked on Equipment

DANGER–High Voltage

Protective ground (earth) terminal

ATTENTION–Refer to manual

Power Source

This product is intended to operate from a power source that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising from Loss of Ground

Upon loss of the protective ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electrical shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

Use the Proper Fuse

To avoid fire hazard, use only a fuse of the correct type, voltage rating, and current rating as listed under "Specifications" in Section 1 of this manual.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

1 Introduction

This manual covers the installation and features of the Tektronix 2642A Analyzer.

The 2642A Analyzer

The 2642A is high performance analog data acquisition and signal processing peripheral for personal computers. The 2642A interfaces with an IBM PC, XT, AT, or PS/2 (referred to as the host computer) via the PC's serial port. It also operates on many IBM-compatible computers running MS-DOS. See Minimum System Requirements in Section 2 for a complete description of the compatibility requirements.

The 2642A acquires and processes two channels (four channels are optional) of analog input data. It can also generate one channel of analog output data.

Both the input and output subsystems process data at bandwidths starting from DC-to-5 Hz, up to 200 kHz. Thus the 2642A is useful for analysis and testing of mechanical systems, electro-mechanical systems, and low frequency electrical systems.

The 2642A uses digital low pass anti-aliasing filters as a major part of the data acquisition subsystem. The digital filters are preceded by a high quality 200 kHz analog low pass filter. Filter ripple and alias protection characteristics are guaranteed for the entire bandwidth.

The effective sample rate is 2.56 times the selected bandwidth. For example, when the bandwidth is set to 20 kHz, the effective sample rate is 51.2 kHz.

The following input system features are programmable:

- Bandwidth (effective sample rate)
- Gain and offset
- Triggering
- AC/DC coupling
- Accelerameter current source

The base unit analyzer includes two input channels (with zoom capability), and a built-in signal generator (analog output channel).

The following hardware options can be ordered:

- Integrated display device (option 33)
- Two additional input channels (option 1H)
- Extended performance configuration (16-bit A/D converter) option (option 16)
- Six extra megabytes of transient capture memory (option 6M)
- Digital Measurement Adapter (option 1D)

Front Panel

The front panel, shown in Figure 1-1, contains three indicators, four input connectors, a power switch, and an optional output connector. Note: if your analyzer is configured for two channels, the front panel will still contain four input connectors, but only the connectors labeled CH1 and CH2 will operate. (Four connectors are provided so that upgrading to a four channel system requires simply plugging in two new boards.)

Indicators

The three indicators show the current analyzer status, as follows:

Power — The analyzer is powered up.

Active — When lit steadily or intermittently, it indicates the analyzer is performing various operations. When flashing steadily at about once every two seconds, it indicates the analyzer is reset and waiting to be

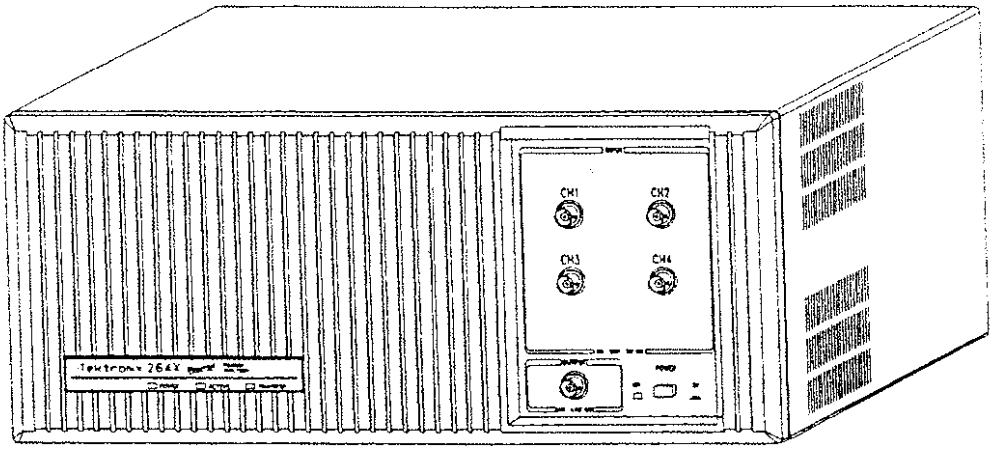

Figure 1-1. Front Panel

downloaded. When triggering is enabled, it indicates that the system is waiting for a trigger event.

Transfer	Indicates data is being transferred between the analyzer and the host computer.

Input Connectors

The 2642A is configured with either two or four inputs, depending on whether the four channel option is ordered with the system. If your analyzer is configured for two channels, the front panel will still contain four input connectors, but only the connectors labeled CH1 and CH2 will operate. Four connectors are provided so that upgrading to a four channel system requires simply plugging in two new boards.

The input connectors are analog input channels for electrical signals between -10 volts and +10 volts. They are normally connected to various electrical devices and transducers used in measurements, such as accelerometers, microphones, proximity probes, and seismometers.

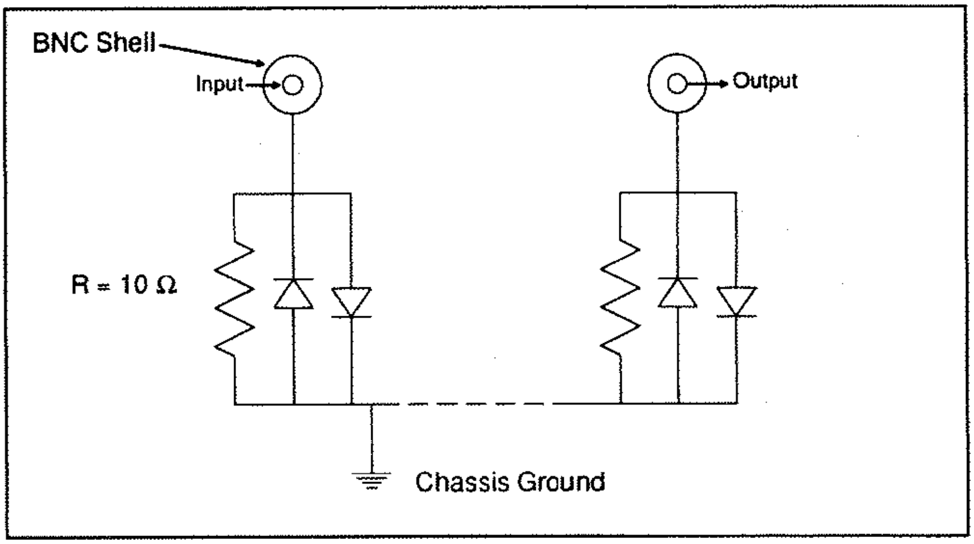

Figure 1-2.

Schematic of Inputs and Outputs (Typical)

The maximum voltage the system can withstand is 30 volts. Under no circumstances should this ±30-volt limit be exceeded, as the analyzer will be damaged.

The 2642A inputs are differential with the outside shell of the BNC connectors returned through the circuitry shown in Figure 1-2 to the chassis ground. This assists in making low level measurements in situations where ground loops are present.

Signal Generator

The signal generator provides a convenient software-controlled source capable of a variety of pre-defined, as well as user-defined, signals. Some software programs require the signal generator for their operation, such as the swept sine analysis program.

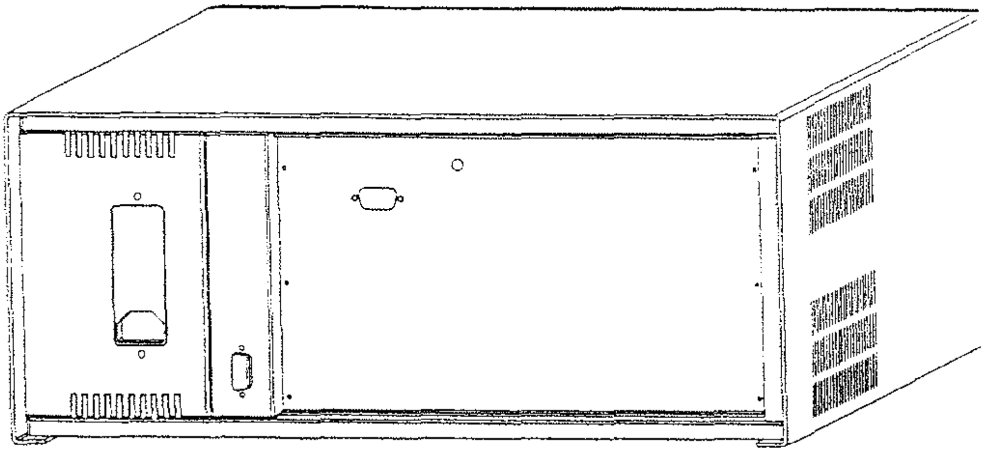

Figure 1-3. Rear Panel

The signal generator can be controlled by the Instrument Program or 2600 Application Library programs. It can generate these pre-defined waveforms:

- Sine
- Square
- Sawtooth
- Triangle
- Random
- Adjustable-random
- Impulse sequence
- Chirp

User-defined or previously-measured signals stored in a data file can also be output. See the Instrument Program User's Guide for details.

Rear Panel

The rear panel, shown in Figure 1-3, contains a system interconnect connector, a serial port connector, and a reset switch.

External Trigger/Sample (System Interconnect) Connector

The external trigger/sample connector on the channel controller board is a standard 9-pin male connector accessible from the rear of the unit. The pinouts are shown below.

Pin	Meaning
1	External triggering. A TTL-level signal input to the analyzer. This trigger source is selected in the Instrument Program TRIGGER menu. The trigger is generated at the trailing edge.
2	Trigger sense output. A TTL-level signal indicating trigger detection.
3	External clock input. A TTL-level signal for inputing a base, undivided sample clock (at 8 Mhz). Used for factory diagnostic purposes.
6, 7, 8	Signal ground
9	External sampling input. A TTL-level signal input to the analyzer at the desired A/D sampling rate. This clock source is selected in the Instrument Program INPUT menu.

Serial Port Connector

The 2642A is equipped with a serial port connector that links the analyzer to the host computer via a Tektronix-supplied serial interface cable.

You are supplied with two types of serial interface cables:

Host Computer	Host Computer Connector
IBM PC or XT	25-pin female (option 1B)
IBM AT or PS/2	9-pin female (option 2B)

The serial interface cable pin assignments are shown in the table on the next page. Connector pins 1, 2, 7, 8, and 9 are not used and should not be connected.

Analyzer connector 9 pin male		PC/XT connector 25 pin female	PC/AT connector 9 pin female
Pin Number	Signal	Pin Number	Pin Number
3	Ground	7	5
4			
5	Received Data	2	3
6	Transmitted Data	3	2

Note: The above wiring is matched to standard IBM PC and AT communications cable wiring. If you have trouble with the interface, verify that your computer serial port wiring matches the above diagram. Some multi-purpose cards have optional settings for the serial ports to allow them to be wired as either DTE or DCE. If your serial port is wired as DCE, you will have to reverse lines 2 and 3 (received data and transmitted data).

Reset Switch

The reset switch stops and resets the analyzer. The effect of pressing the switch is very similar to turning the analyzer off then on again. Do not press reset during normal operation, since all processing and displays will be terminated.

Power Entry Module

The power entry module contains the AC line fuse(s). For domestic (North American) installations, a single fuse is used; for European installations, two fuses are used. The power entry module also provides selection of 120v or 240v operation. The procedure for changing the operating voltage and fusing arrangement is described in Section 2 under Installing the 2642A.

See Specifications at the end of this section for the fuse ratings.

The System Simulator Box

A System Simulator Box is provided with the 2642A. It is used extensively in the Instrument Program Tutorial.

The System Simulator is an educational tool for first-time users learning to use the 2642A. It can also help experienced users expand their understanding of advanced measurements and get the most out of the analyzer.

The System Simulator Box is an active electronic analog circuit that simulates a mass-spring-damper mechanical system, as shown in Figure 1-4. The equivalent mechanical system has four equal masses, interconnected with four equal springs, and five equal dampers. There are four Force Inputs (F1 through F4) and four Displacement Outputs (Y1 through Y4). Any of the inputs can be excited and the outputs measured by the 2642A.

An additional input and output has been provided to allow for control systems experiments. A unity gain summer has been inserted in one of the internal feed-back paths. The two inputs to the summer are Y3 (an output from the System Simulator Box) and the Sum In input. The summer output is Sum Out.

The System Simulator Box also includes two uncorrelated noise sources: N1 and N2. These noise sources allow the box to be self-excited and also provide for corrupting noise sources to aid in various measurement technique experiments.

The System Simulator Box is shipped with a nine-volt AC adaptor. The AC adaptor has a negative tip and must provide a current of at least 50 mA. If you like, you may install a nine-volt battery by removing the back cover and inserting the battery into the battery clip. If you insert a battery, be sure to protect against corrosion by removing it when it is dead, or for long-term storage.

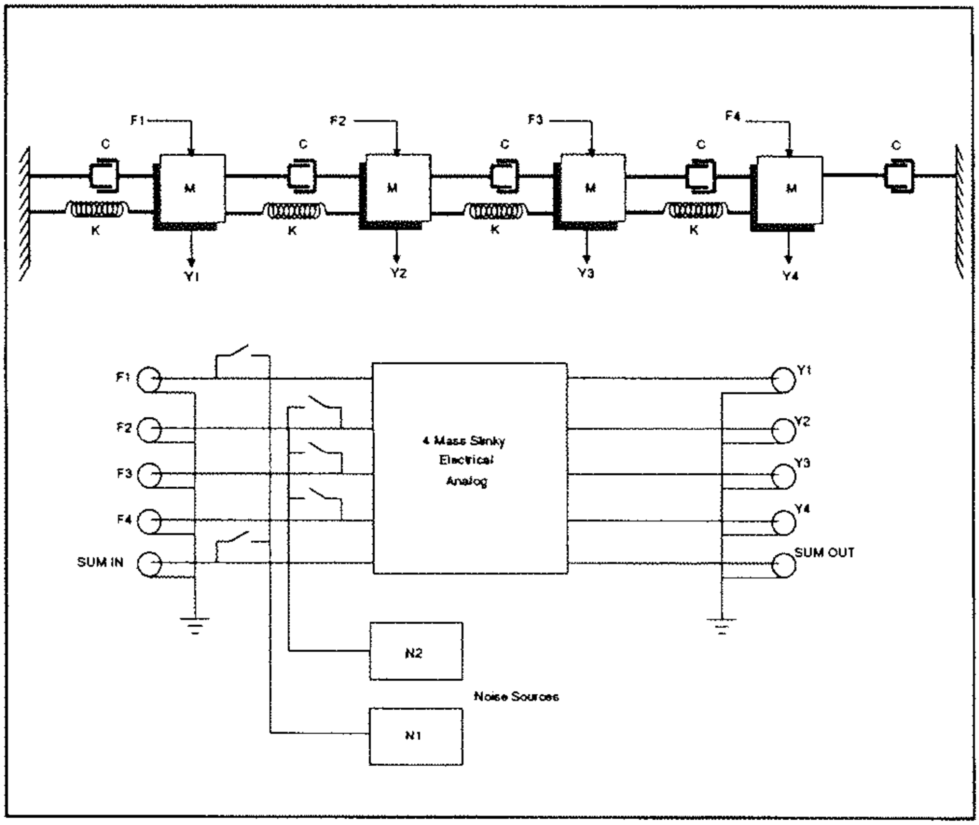

Figure 1-4. System Simulator Box Block Diagram

2642A Features

Measurement Functions

Time Domain	Frequency Domain
Time record	Auto power spectrum
X-Y (orbits)	Power spectral density
Auto correlation	Energy spectral density
Cross correlation	Cross power spectrum
Impulse response (calculated from transfer function)	Coherence
	Frequency response function (transfer function)

Averaging Functions

1 to 9,999 averages
Additive
Fast additive
Exponential
Time
Subtractive
Peak hold
0%, 50%, or maximum overlap

Selectable cross power terms
Start, stop, continue
Data reject modes:
- Auto on overload
- Manual
- Accept on trigger
- Double hit reject

Window Functions

Boxcar, Hanning, Hamming, Blackman-Harris, Blackman, Exact-Blackman, Flattop, Potter (200, 201, 210, 220, 310), Force (.1, .25), Exponential (.01, .05, .1)

Selectable amplitude or power correction

Inputs

Two input channels (four channels optional)
Manual or auto range setting
Simultaneous sampling on all channels
Analog and digital anti-alias filter bypass

Markers

One or both traces
Relative marker (ΔX and ΔY)
Search for peak
Search for minimum
Harmonic markers
RMS of displayed spectrum

Hardcopy

Print to printer
Print to file
Plot to HPGL compatible plotter
Plot to file

Data Storage

Store setups to file (includes storage of all data display parameters)

Store data to file (setups automatically stored with data)

Multiple functions per data file (e.g., transfer function and coherence stored to a single file)

File catalog

Display Types

Magnitude
Phase
Nyquist
Bode
Real
Imaginary
X-Y (orbit)
Coquad

Horizontal Axis

Selectable XMIN and XMAX (expand)
Scales: linear, log, dB
Units: Hz, seconds, CPM

Vertical Axis

Auto scale
Selectable YMIN and YMAX
Scales: linear, log, dB
Units: V, V2, V2/Hz, V2-sec/Hz, degrees, dB, Engineering Units

Display Formats

Single
Double (Upper/Lower)
Split grid for up to four single channel displays
Overlay trace from input or file

Signal Generator

Built-in signal generator with random, periodic and user-definable waveforms.

Zoom

Provides a selectable center frequency allowing high resolution measurements to be made anywhere within DC-200 kHz range.

2642A Specifications

Inputs

Channels

Two standard, four optional
Simultaneous sampling on all channels
12 bit ADC standard, 16 bit ADC optional

Analysis Bandwidths

Baseband: DC to 5 Hz up to DC to 200 kHz in 15 selections with a 1,2,5 sequence on all channels
Zoom: bandwidths ±5 Hz to ±100 kHz in 14 selections in a 1,2,5 sequence with a center frequency resolution of better than 0.5 Hz over the 200 kHz bandwidth

Sampling Frequency

Sampling frequency: 2.56 times analysis bandwidth (for instance, at 200 kHz bandwidth, sampling frequency is 512 kHz and sampling period is 1.953 µS)
Frame time: N times sampling period, where N=64,128,..., 4096 points
Accuracy : ±0.01%

Impedance

1 Meg. Ohm ±1%, shunted by 150 pF ±10%

Input Type

Differential with BNC shell returned to chassis through 10 Ohms and protection diodes

Common Mode Rejection

60 dB DC to 1 kHz

Maximum Input Level

Protected to ±30 volts, BNC center conductor to chassis or BNC shell
Protected to ±0.6 volts, BNC shell to chassis

Full Scale Ranges

20 ranges, ±14 mV to ±10 Volts (peak) full scale in 3 dB steps
Manual or auto ranging

Selectable DC Offset

Range: ±10 volts
Accuracy: 0.05% of setting, ±2 mV
Resolution: better than 10 mV

Coupling

AC: single pole RC, -3 dB @ 0.8 Hz ±10%
DC
Accel. bias: 2 mA ±10% ,+13 V Max
Output source: internal connection to 2642A output before output 50 Ohm source resistor

DC Offset

< 0.05% of full scale range ±0.5 mV
(after auto-calibration cycle, 50 Ohm source)

Anti-Alias Filtering

Type: fixed ninth order analog elliptic filter followed by real-time digital filtering providing 80 dB minimum alias protection over all analysis bands
Ripple: DC to 100 kHz ±0.15 dB; 100 kHz to 200 kHz ±0.2 dB

Channel-to-channel match:

	PHASE IN DEGREES	MAGNITUDE IN dB
3 mHz to 50 kHz	0.5	0.075
50 kHz to 100 kHz	1.0	0.125
100 kHz to 200 kHz	2.0	0.2
• Inputs DC coupled, same gain range • Correctable to better than 0.01 dB and 0.01 degrees with a simple MATH operation		

Bypass: Filters can be disabled for optimum time-domain fidelity

Transient Response

Rise time (10 to 90%): 1 sampling period
Overshoot: 0% (with anti-alias filters bypassed)

Trigger

Modes: free run (off), auto arm, manual arm, first frame (free run after first trigger)
Delay: pre-trigger up to 1 frame time, post-trigger up to 4 frame times
Source: channel 1, 2, 3, 4, external input (TTL), output generator synch
Filtering: selectable, before or after input digital filters
Level: - 83% to +83% of full scale in 27 steps
Slope: positive or negative
Hysteresis: 5% (low) or 15% (high) of full scale input range
Uncertainty: ±1 sample (digital triggering)

Interchannel Delay

Up to 65536 sampling periods of delay can be specified between input channels. Independent delays can be specified for each channel.

Noise Floor

0.1 - 5 kHz: -125 dbVrms
5 - 50 kHz: -120 dBVrms
50 - 200 kHz: -116 dBVrms
(Boxcar window, 50 Ohm source, 14 mV range, 2048 point frame)

Cross Talk

Better than 150 dB isolation between any two channels over entire DC to 200 kHz analysis range (50 Ohm source and input termination)

Absolute Accuracy (Spectrum Analysis)

The overall accuracy is the sum of the absolute accuracy, window flatness, and the noise floor.
For the 16 bit ADC option:
DC to 100 kHz ±0.15 dB ±0.003% of input range
100 to 200 kHz ±0.2 dB ±0.003% of input range
For the 12 bit ADC:
DC to 100 kHz ±0.15 dB ±0.0125% of input range
100 to 200 kHz ±0.2 dB ±0.0125% of input range

Measurement Range

Better than 150 dB (maximum input level to minimum detectable signal)

Dynamic Range

All harmonic and intermodulation distortion, and spurious responses will be below the full scale input by the table entry in dB:

16 Bit ADC				
	Frequency Range			
Full Scale V	DC to 20 kHz	DC to 50 kHz	DC to 100 kHz	DC to 200 kHz
0.014–0.055V	80 dB	80 dB	75 dB	70 dB
0.078–3.5V	90 dB	90 dB	85 dB	83 dB
5.00–10V	90 dB	85 dB	80 dB	78 dB

12 Bit ADC				
	Frequency Range			
Full Scale V	DC to 20 kHz	DC to 50 kHz	DC to 100 kHz	DC to 200 kHz
0.014–0.055V	75 dB	75 dB	75 dB	70 dB
0.078–3.5V	75 dB	75 dB	75 dB	75 dB
5.00–10V	75 dB	75 dB	75 dB	75 dB

(15 averages (ADD) , Hanning window, 2048 point frame, input @ 90% of full scale, 50 Ohm source)

Processing

Fourier Transform (FFT)

Numerical: full 32 bit floating point FFT (130 dB numerical dynamic range)
Speed: 3 mS for 1K real to complex transform with windowing and spectral accumulation
Frame sizes: selectable from 64 to 4096 points
Real time bandwidth: 100 kHz, single channel autospectrum (fast additive averaging (display off), 2048 point frame size)

Spectral Lines

Selectable from 25 to 1600 (equal to frame size/2.56)

Frequency Resolution

From 0.003 Hz to 8000 Hz (equal to bandwidth/spectral lines)

Window Functions

A selection of 17 including: Boxcar, Hanning, Hamming, Blackman-Harris, Blackman, Exact-Blackman, Flattop, Potter (200, 201, 210, 220, 310), Force (.1, .25), Exponential (.01, .05, .1)

Window Flatness

Boxcar: +0 -4.0 dB
Hanning: +0 -1.5 dB
Flattop: -0 +.01 dB

Transient Capture Memory

Record length: standard with 500 K samples of storage. Optional memory expansion provides up to 3.5 Mega samples of storage.
Throughput: 256 K samples per second continuous to memory (no gaps).
Processing: all standard functions (autospectra, crossspectra, transfer function, etc.)

Signal Generator

One output channel standard with instrument

Characteristics

Impedance: 50 Ohms ±2%
Protection: 20 V max center conductor to chassis, 0.6 V shell to chassis
Current: ±20 mA max
Stability: unconditional
Convertor: 16 bit D/A convertor

Full Scale

±10 Volts

Functions

Sine, square, sawtooth, triangle, impulse, random, adjustable random, chirp, arbitrary
Random: bandlimited spectral energy matches input analysis bandwidth
Adjustable random: center frequency and bandwidth user selectable
Chirp: spectral energy matches input analysis bandwidth and concentrated on spectral lines
Arbitrary (see below)

Frequency Accuracy

Within 0.01% of displayed setting

Frequency Resolution

Sine: .0002 Hz
Square, trangle, sawtooth: 10 mHz + 0.1% of setting
Adjustable random center frequency: 0.5 Hz
Arbitrary output center frequency: 0.5 Hz

Noise Floor

100-500 Hz: < -115 dBVrms (measured on 500 Hz BW, 2048 pt frame)
0.5-200 kHz: < -105 dBVrms (measured on 200 kHz BW, 2048 pt frame)

Dynamic Range

All harmonic and subharmonic distortion and spurious signals will be below the output level selected by the table entry in dB:

	Frequency Range	
Peak Output Level	DC to 20 kHz	DC to 200 kHz
0.07–0.2V	80 dB	80 dB
0.2–2.0V	90 dB	85 dB
2.0–8.5V	80 dB	75 dB

(Measured with a sine function output)

Smoothing Filter

Type: digital interpolation filter followed by an 9th order 200 kHz cutoff elliptic filter with sin(x)/x correction
Bypass: filters can be disabled for optimum time-domain fidelity

Amplitude Accuracy (Sine Function)

2 mHz to 100 kHz: ±0.1 dB ±0.005% of full scale
100 kHz to 200 kHz: ±0.2 dB ±0.005% of full scale

Arbitrary Output

Record length: any length from 16 to 4096 samples
Sampling rate: set to 2.56 times selected output bandwidth
Bandwidth: digital interpolating filters to select from 15 output bandwidths (identical to input bandwidths)
Center frequency: 0.5 to 200 kHz with 0.5 Hz resolution
Functions: software supports signal specification in time or frequency domains as well as replaying a measured signal

Burst Mode

Random: selectable on/off times, repeating or non repeating sequences
Adjustable random: selectable on/off times, repeating or non-repeating sequences
Chirp, arbitrary: selectable off time

Synchronization

A sync signal is generated for all functions that can be selected as a trigger for the input channels

Transient Response

Rise time (10 to 90%) : 1.2 µS
Overshoot: 0% (With output smoothing filters bypassed)

Residual DC Offset

0.01% of voltage setting ±1 mV

User Entered DC Offset

Range: ±10 Volts
Accuracy: 0.05% of setting, ±2 mV
Resolution: better than 10 mV resolution

General

Miscellaneous I/O (Back Panel)

External triggering: selected by trigger source menu, negative going TTL signal
Trigger sense: TTL output indicating trigger detection
External sampling: selected by input menu, TTL input (512 kHz max sampling rate) that drives the A/D sampling rate. Can be driven at 512 kHz by an external frequency standard for frequency accuracies beyond the ± 0.01% internal time reference or be used for variable frequency sampling.

Calibration

User invoked autocalibrate procedure corrects for input and output gain and offset errors by using an internal voltage standard. The analyzer will meet the above specifications after this calibration. The calibration factors are stored in non-volatile RAM. The calibration will hold over a 10 degree C. range and four hours of the last internal calibration.

Environment

Operating ambient temperature: 0 to 50 degrees C
Relative humidity: 90% at 40 degrees C (non-condensing)
Altitude: 15,000 ft

Power

95-126 VAC, 48-62 Hz
180-250 VAC, 48-62 Hz
175 Watts maximum

Weight

27 lbs (13.3 kg) without options
44 lbs (20 kg) with option 33 (Integrated System Controller)

Dimensions

16.75 in. (425 mm) wide 17.0 in. (431 mm) deep
7.0 in. (177 mm) high without options
9.5 in. (241 mm) high with option 33

2
Installation

This section describes the minimum host computer requirements for the 2642A, the supported options, and installation instructions.

Minimum System Requirements

To use the 2642A you must have the following minimum configuration:

- IBM PC, XT, AT, or PS/2 (or 100% compatible)
- DOS 3.3 or higher
- 640K bytes of RAM
- Floating point math coprocessor (8087, 80287, or 80387)
- One serial port
- One floppy disk drive (3.5" or 5.25")
- One hard drive or access to network storage
- IBM EGA or VGA compatible graphics card
- IBM Monochrome Monitor or IBM Enhanced Color Display (or equivalent).

Note: the Instrument Program also runs on the plasma displays found on the Compaq Portable III, Compaq Portable 386, or the Toshiba 3100.

In addition, the following are highly recommended:

- Second serial port
- Mouse

For more information on optional hardware supported by the Instrument Program, see the *Instrument Program User's Guide*.

Installing the 2642A

Follow the steps in this section to unpack, connect, and power up the analyzer. Be sure to save the packing materials, since shipping the analyzer without the proper packaging may cause damage.

1. Check the contents of the shipping carton. The carton should contain:

   The 2642A analyzer
   The Instrument Program disks
   The System Simulator Box and AC adaptor
   An interconnect cable set with RCA-to-BNC adaptors
   Two serial communications cables (one 9-pin, one 25-pin)
   A power cable

   In addition, several publications are included with your shipment:

   2642A Hardware Reference Manual (this manual)
   Instrument Program User's Guide
   Instrument Program Tutorial
   2600 Application Library Introduction
   MATH User's Guide
   MEASURE User's Guide

   You may have additional manuals for any options you have received.

2. Remove the analyzer from the shipping carton and place it near the host computer.

You may place the analyzer on top of the host computer, but any suitable surface that allows about two inches clearance for the fan exhaust on the side is adequate. Do not place papers or other obstructions over the air flow openings.

3. Select the appropriate serial communications cable. We supply one cable with a 9-pin host connector, for use with the IBM AT, PS/2, or equivalent; and one with a 25-pin host connector, for the IBM PC, XT, or equivalent.

4. Connect the serial communications cable to the serial port connector on the host PC (COM1 or COM2) and to the primary serial port connector on the rear panel (we recommend COM1).

5. Check the AC voltage selection on the rear panel.

   If you have 95 to 126 volt AC power, make sure that the power entry module is set with the plastic tab pointing to 120V. The other three selections (100, 220, and 240) will not work and will damage the analyzer.

   If you have 180 to 250 volt AC power, make sure that the power entry module is set to 240V. The other selections (100 and 120) will not work and will damage the analyzer.

   If the selection is incorrect, continue with steps 6 through 14, below. If the selection is correct, skip to step 15.

6. **IMPORTANT: turn off the power and unplug the power cord.**

7. Use a small screwdriver to pry out the fuse holder from the power module. See Figure 2-1.

8. Remove the voltage selector card from the power module and rotate the voltage indicator pin 180 degrees. Figure 2-2 illustrates changing the card from 120v to 240v.

9. Replace the voltage selector card, with the small pointer toward the fuse.

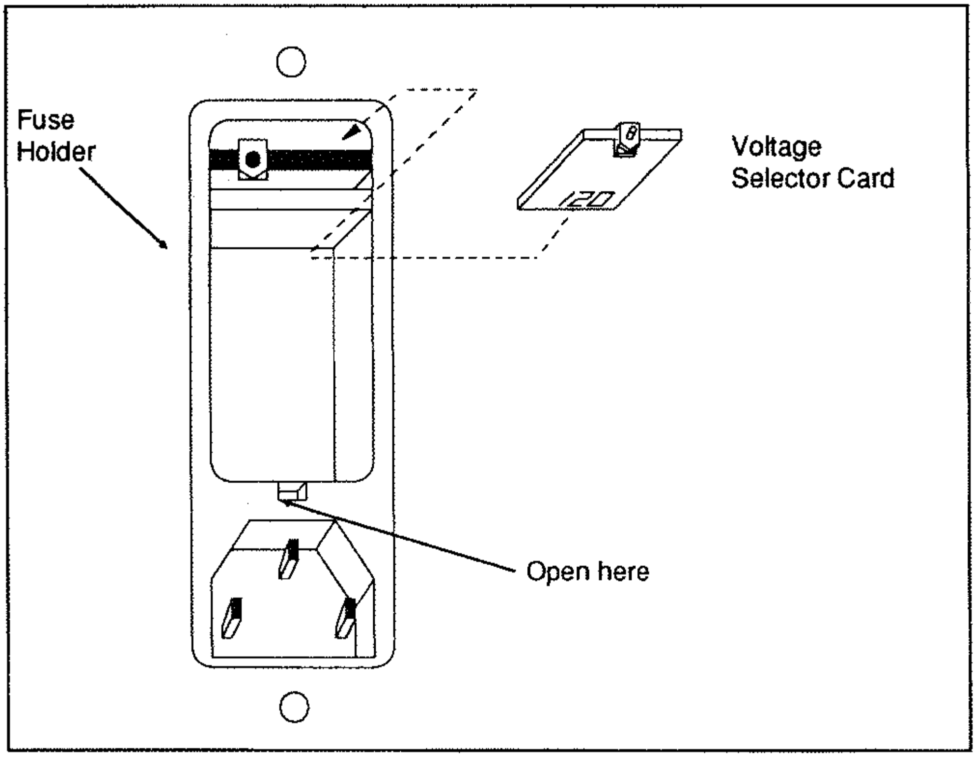

Figure 2-1. Removing the Fuseholder

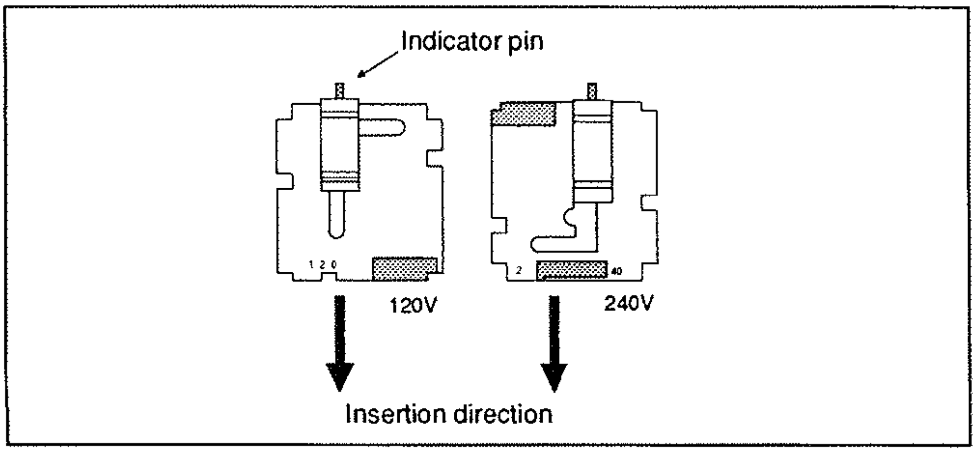

Figure 2-2. Voltage Selector Card

10. When changing from 120v to 240v, the voltage indicator pin should show through the 240-volt window. (To change from 240v to 120v, reverse the steps.)

NOTE: When changing the operating voltage, normally you must also change the fusing arrangement. North American operation on 120-volts uses only one fuse. European operation on 220-volts uses two fuses. The analyzer accommodates both arrangements. The following steps explain how to change the fusing arrangement.

11. Remove the fuse holder from the power module as described in steps 6 and 7.

12. Loosen the screw that holds the fuse block to the fuse holder cover and remove the fuse block. See Figure 2-3.

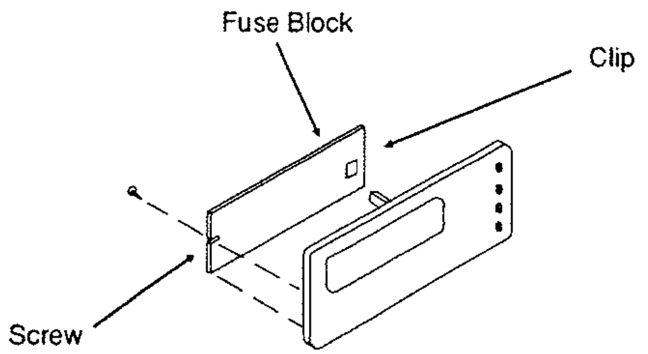

Figure 2-3.

Removing the Fuse Block from the Fuse Holder

13. Flip the fuse block over and reinstall it to the cover. See Figure 2-4.

14. Replace the fuse block and cover assembly in the power module.

15. Make sure the power switch is in the OFF position. The switch is on the rear panel next to the power cord receptacle.

16. Connect the power cable to the rear panel receptacle and to a suitable AC power outlet.

The analyzer's power consumption is about 115 watts. The analyzer operates in any environment suitable for a PC.

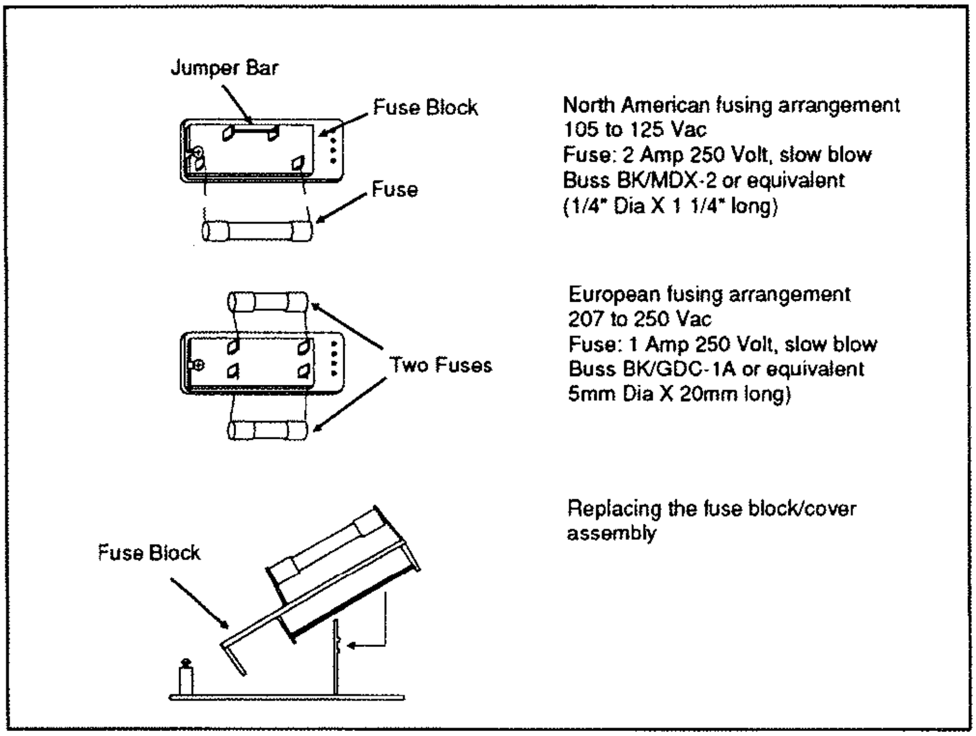

Figure 2-4. Changing the Fusing Arrangement

17. Turn on the power switch on the rear panel.

The **Power** indicator on the front panel should light and the fan should be operating.

a. If the Power indicator does not come on, check the power cord connections.

b. If the power cord is okay, ***unplug the power cord*** and check the fuse (or fuses) in the power module on the rear panel. There is one fuse for 120-volt operation and two fuses for European 220-volt operation. Inspect the fuse (or fuses) and, if necessary, replace with the appropriate size fuse, as indicated under *Specifications* in Section 1.

c. If this still does not work and all power connections appear to be okay, call Tektronix for further assistance.

3
Calibration

This section describes procedures for calibrating the 2642A's input channels and signal generator. The calibration is performed using the internal calibration signal.

Discussion of Calibration Operations

The 2642A is calibrated at the factory. The calibration procedure generates a set of calibration factors that are stored in non-volatile memory (EEROM) in the analyzer.

The stored calibration factors consist of gain and offset factors for all the system input channels and optional signal generator. The offset factors are used to automatically remove internal hardware offsets resulting from production tolerances in components. They are not intended for use in removing DC offsets of input signals. The input channel calibration offsets are determined by setting a switch under software control that shorts the channel inputs. Sets of 32-point frames are acquired, and the mean value of these frames is used to determine the offset value. Offset values for each of the 20 gain ranges for both AC and DC coupling are determined and stored for each channel as signed integers.

The input gain factors are determined by applying a square wave with a 3.1 volt amplitude at 1000 Hz to each input channel. The square wave is generated using the internal calibration signal. A set of 128 data points are acquired, and the FFT computed, to obtain an estimated amplitude for the 1000 Hz component.

Measurements are made at the 10V, 7.1V, 5V, and 2.5V gain ranges. This permits determination of all levels relative to the 10 volt range. A final measurement is made with a 5 volt square wave at the 10V gain setting to obtain the absolute gain factors for each of the 20 gain ranges. These gain factors are stored as floating point numbers in the range of 0.91 to 1.09. The calibration fails if the gain factors fall outside this range. In this case, the factors are ignored and values of exactly 1.0 are used. If any of the gain factors for an input channel are exactly 1.0, the calibration most likely has failed, and the unit may require repair. Contact your local Tektronix office.

The analog signal generator offset is determined at 32 points. There are 4096 possible combinations in-between. The final offset corrections are determined by linearly interpolating between these levels. The signal generator is nulled using the input channel 55-millivolt gain range at a 20 kHz bandwidth. Thirty-two offset values (in the range of -128 to 127) are determined and stored.

The analog signal generator gain is determined by applying a sine wave with a 9 volt amplitude at 1000 Hz to the first input channel. A set of 1024 data points are acquired, and the FFT computed, to obtain an estimated amplitude for the 1000 Hz component. The measurement is made at the 10V range, and then compared to a theoretical gain. The ratio between them is the analog signal generator gain, and must be in the range 0.95 to 1.05.

Auto-Calibration

The auto-calibration procedure uses the Instrument Program software package. For information on running the Instrument Program, see the *Instrument Program User's Guide*.

1. From within the Instrument Program, press Q. This menu appears:

```
Type:
 C = Continue
 E = Exit to DOS
 S = Suspend. Type EXIT to resume IP.
 A = Auto-calibrate
 L = List calibration factors
 W = Write auto.set
```

2. Press A to run the auto-calibration procedure.

Auto-calibration takes 30 to 40 seconds. Upon completion, the gain and offset factors are stored in non-volatile memory in the analyzer and printed out on the screen.

If any of the gain factors for a given channel are exactly 1.0, then the calibration has probably failed, and the analyzer may be in need of repair.

4
Troubleshooting

The TOMON (TO MONitor) program is part of the Tektronix-supplied software package (included with the Instrument Program) that communicates with the analyzer over the host computer serial interface. The TOMON program can be used as a terminal emulator to troubleshoot serial interface problems, run a system health test, and run a memory exerciser.

TOMON's primary function is to communicate with the monitor program that resides in the analyzer, and to download programs to the analyzer. The messages that TOMON prints out during normal and abnormal downloading operations are explained in Appendix A.

Serial Line Tests

If the startup procedure described in the Instrument Program User's Guide does not work, you should suspect the serial port pin assignments or the serial port cable. If you use the Tektronix communications cable supplied with your analyzer, it is highly likely that the cable is OK, but the serial interface may still be suspect. You can make simple checks of the interface with the TOMON program. Perform the following tests.

Test 1: Test Serial Link from Host to Analyzer

With the analyzer connected to the host computer:

1. Press the Reset switch on the back panel.

2. At the DOS prompt, type one of the following commands and press Return:

`TOMON -k`	(to use the COM1 serial port)
`TOMON -p 2 -k`	(to use the COM2 serial port)

A message of several lines appears on the screen explaining some aspects of TOMON.

3. Press Return. You should see the following message:

```
R Tektronix 2642A Monitor vx.xx
```

where x.xx is the Monitor Program version number.

If this test is successful, the serial port is probably operating properly, at least at low baud rates. Proceed to System Health Tests.

If this test is not successful, the serial link cable is suspect and you should proceed to Test 2.

Test 2: Test Host Serial Port (COM1 or COM2)

This test requires a serial wrap plug or break-out box. The wrap plug connects line 2 to line 3 and routes the output line back to the input line. If you use a break-out box, connect a lead between pins 2 and 3 in the break-out box or directly on the connector. This connection causes transmitted commands to be echoed back and appear on the terminal screen.

1. Unplug the interface cable from the host computer serial port.

2. Attach a serial wrap plug or break-out box to the host computer serial port connector.

3. At the DOS prompt, type one of the following commands and press Return:

`TOMON -k`	(to use the COM1 serial port)
`TOMON -p 2 -k`	(to use the COM2 serial port)

Anything you type at this point should echo back to the screen (without line feeds) if the serial port is operating.

If this test is successful, proceed to Test 3.

If this test is not successful, verify that the connection has been made to the proper port, COM1 or COM2. If the test still does not work, the host computer serial port is probably defective.

Test 3: Test Communication Cable

This test requires a wrap-plug or break-out box.

1. Attach the communications cable to the serial port on the host computer.

2. Attach the break-out box to the other end of the cable.

3. On the break-out box, make a connection between lines 5 and 6 on the 9-pin DB connector. Line 5 is Received Data and line 6 is Transmitted Data at this end.

4. At the DOS prompt, enter one of the following commands and press Return:

`TOMON -k`	(for the COM1 serial port)
`TOMON -p 2 -k`	(for the COM2 serial port)

Anything you type at this point should echo back to the host screen.

If the characters do not echo back, there is a problem in the cable wiring or connections. The cable must be repaired before any further tests can be made. See Appendix A for information on the wiring of the Tektronix communications cable.

If the characters echo back properly, proceed to Test 4.

Test 4: Test for DCE- or DTE-Wired Serial Port

This test requires a null modem cable.

1. Attach the communications cable to the analyzer.

2. If the system is not already in the terminal mode, then type one of the following commands at the DOS prompt, and press Return:

`TOMON -k`	(for the COM1 serial port)
`TOMON -p 2 -k`	(for the COM2 serial port)

   Anything you type at this point should echo back to the host screen. If the characters do not echo back, proceed to step 3. If the characters do echo back, proceed to System Health Test.

3. Connect a null modem cable between the host serial port connector and the Tektronix communications cable. A null modem cable reverses the transmit and receive lines (lines 2 and 3). Line 7 on the PC and line 5 on the AT is signal ground, which must be connected straight through.

4. Once again check that characters typed on the keyboard echo back to the host screen.

If typed characters echo back, the host serial port is wired DCE instead of the standard DTE. A break-out box with LED indicators on the various lines can be useful in verifying this. The transmit line from the host computer lights when TOMON transmits to the analyzer.

If the connection is verified at this time, try the start up procedure again. If the analyzer still does not respond, call Tektronix.

System Health Test

If Test 1 is successful, you can proceed with the following health test. The system health test checks many of the registers in the different analyzer subsystems and checks the memory size and optional input and output channels.

Procedure

1. In the TOMON monitor, press "@" and Return to put the monitor into the command mode.

2. Press Return again. A "*" should appear followed by a carriage return–line feed.

3. Type "xq" to initiate the system health test. You should get one or more of the following messages:

   `Memory ends at x00000`
   (If the address printed is not a multiple of 200000, then there is probably a memory problem)

   `FPA 64 kb Memory ends at 610000`
   (This message indicates that the Floating Point Accelerator memory is okay)

   `DFE 200khz Input CardPresent @xxxxxx`
   (This message is repeated for each input channel installed–either 2 or 4)

   `DBE Output Card Present @xxxxxx`
   (This appears if the optional analog signal generator is installed)

   `Serial Number : yyyyy`
   (where yyyyy is the last five digits of the system serial number)

Health Test Error Messages

If there is a problem with your analyzer, you may see one of the following error messages indicating the probable error. Many of the messages include the address of the memory location or register at which the error was detected (in the form @xxxxxx). Please note the address printed when reporting the problem.

`FPU (Floating Pt. Unit) Error : Status Rd Fail`
Unable to read the status register of the floating point coprocessor. Note that if the FPU is not installed, or is completely dead, the processor is hung, and no messages appear after the "Memory Ends At xxxxxx" message. It is necessary to reset the analyzer.

`FPU (Floating Pt. Unit) Error : Invalid Result`
The FPU generated an incorrect result in a simple addition and multiplication operation.

```
FPA (Floating Point Accelerator) : Register R/W un-
able to read the DSP32C registers
```

```
FPA (Floating Point Accelerator) : Memory R/W FPA
memory error
```

```
DFE Channel Controller  Error : CC_MAIN     R/W   @ef0000
DFE Channel Controller  Error : CC_TRIG     R/W   @ef0002
DFE Channel Controller  Error : CC_CHEN     R/W   @ef0004
DFE Channel Controller  Error : CC_TRIGCNT  R/W   @ef0006
DFE Channel Controller  Error : CC_TRIGLEV  R/W   @ef0008
DFE Channel Controller  Error : CC_ZMLoINC  R/W   @ef000a
DFE Channel Controller  Error : CC_ZMHiINC  R/W   @ef000c
DFE Channel Controller  Error : CC_SCD      R/W   @ef000e
```

All of these errors occur if the input channel controller is not installed or is not responding. Each message indicates a failure to read or write a particular register.

```
DFE 200khz Input Card Error : Register R/W @xxxxxx
```

Unable to read or write a register on card.

```
DBE Output Card Error : WCS1 Memory @xxxxxx
DBE Output Card Error : WCS2 Memory @xxxxxx
```

Read or write error in the writeable control store of the optional analog signal generator. There are two writable control stores.

```
DBE Output Card Error : ArbOut Memory @xxxxxx
```

Read or write error in the data memory of the analog signal generator. This memory is used for the arbitrary output and chirp functions.

```
Config/Calibration EEROM Error : Not Initialized
```

The EEROM is either not installed, defective, or not properly programmed.

```
DMA Error : Register R/W
```

Unable to read or write a DMA control register.

```
DMA Error : Time Out on Move @xxxxxx
DMA Error : Blk Move Failed  @xxxxxx
```

These messages indicate a failure of a DMA transfer. If the DMA controller is defective, a number of these messages occur, since 16 byte moves are attempted to a variety of locations.

Memory Exerciser

The memory exerciser reads and writes random patterns to the analyzer memory to test for faults. This is a more complete test than the one performed by the XQ command discussed earlier in this section.

1. In the TOMON monitor, press "@" and Return to put the monitor into the command mode.

2. Press Return again. A "*" should appear followed by a carriage return–line feed.

3. Type the following command to initiate the memory exerciser:

```
XM <start stop count>
```

where

`start` is the starting memory address in hexadecimal.

`stop` is the ending memory address in hexadecimal.

`count` is the number of passes through the test. If no count is given, the exerciser loops continuously. If a count of zero is given, the exercisor also loops continuously but error messages are suppressed to allow troubleshooting.

If you don't provide any arguments, the exerciser tests system memory from address 8400H to the top of memory (approximately 200000H). If you provide start and stop addresses, the exerciser tests from the start address up to, but not including, the stop address.

4. If errors are detected, a printout is generated. The printout gives the data written, the incorrect value read back, and the memory location in question.

Note: to test the memory in the DBE WCS type:

```
XM E14000 E18000 1
```

A
TOMON Program

The TOMON program is used primarily to download code to the analyzer, and to initiate the execution of that code. The TOMON program syntax is as follows:

```
TOMON [-b n] [-B n] [-D] [-e] [-g] [-G] [-i] [-k] [-l]
[-p n] [-q] [-r] [-s] [-v] [file1 .. filen] [-c file]
```

where

-b n sets the baud rate for downloading code to the analyzer, as follows:

n=	For baud rate
0	1.2k
1	2.4k
2	4.8k
3	9.6k
4	19.2k
5	38.4k
6	57.6k
7	115.2k

If you do not specify this switch, TOMON defaults to 115.2k baud.

-B n sets the baud rate at which the analyzer normally communicates with the host computer. The baud rate codes used are the same as those for the -b switch. If you do not specify this switch, TOMON defaults to 38.4k baud. You should not specify n=6 or n=7.

Note that is you select a non-standard baud rate here, then you must modify the P20 command line to include "b n", where n is the same value as specified here. See the Instrument Program User's Guide for a description of the P20 program.

-D generates an error abort if the analyzer does not have the optional signal generator.

-e echos all monitor commands and responses.

-g causes a "G" command (go) to be issued to the analyzer after the download.

-G causes the startup sequence to be issued, which is needed to start the Instrument Program.

-i causes TOMON to exit immediately if the analyzer is already running the Instrument Program.

-k invokes the terminal mode (used for debugging).

-l specifies that a 2642A analyzer is the destination.

-p n selects the host serial port to be used for downloading, as follows:

n = 1 selects Com1
n = 2 selects Com2

If you do not specify this switch, TOMON defaults to COM1.

-q suppresses status messages.

-r reboots the analyzer (this only works if the analyzer is running).

-s suppresses the loading of code (that is, loads data areas only).

-v displays the TOMON version number.

file downloads the specified file to the analyzer. If you omit the extension, TOMON defaults to ".out".

-c file specifies a file containing commands to be executed by the monitor.

TOMON sets the return status to 0 if the downloading is successful, and to 1 if the downloading is unsuccessful. Invalid responses to commands in a command file (-c option) do not affect the return status.

TOMON Error and Status Messages

TOMON displays various status messages during normal downloading operations, and displays error messages when things go astray. These messages are explained below.

Status Messages

`Analyzer S/W already loaded and running`

This message is displayed if the -i switch has been specified, and the analyzer software is loaded.

`Loading xxx.out ...`

This indicates that TOMON is downloading file xxx.out to the analyzer. Each "." indicates a block being transferred. If a block transfer fails, an "e" is displayed, and the block is retransmitted. If the block cannot be transmitted in three attempts, TOMON aborts.

`Transfer complete-Retry count = xx`

This message appears upon successful completion of downloading. The retry count is normally 0. Values other than 0 may indicate a problem with the serial interface to the analyzer.

Error Messages

```
Analyzer boot monitor not responding -- Retry or
RESET
```

This is the most common error message. It indicates that the analyzer is not running its monitor program, or the serial port cable is not properly connected. Sometimes you can simply rerun TOMON, and the monitor responds. Normally you must either press the Reset button on the back of the analyzer, or turn the power off and then on. If the error recurs after turning the power off and on, the cable may not be properly connected. Make sure it is connected to the primary serial port connector on the analyzer, and to the COM1 (default) port on the host. (If using COM2–after specifying "-p 2" on the TOMON command line–make sure the serial port cable is connected to COM2 on the host.)

```
Block transfer failed : errortype error at address
[memorytype] - better RESET
```

where

errortype is one of the following: handshake, timeout, line status, checksum, or memory verify

address is the starting address of the memory block for which the transfer failed

memorytype is one of the following: main memory, FXP data memory, FXP writeable control store, DBE writeable control store, or ???

All errors except memory verify are probably due to communications problems. Memory verify errors on the writeable control stores may be due to the processors not being fully reset. If this occurs, it may be necessary to turn off the analyzer, and then turn it back on. If the memory verify error persists after turning the power off and on, then a hardware failure may have occured. If this happens, we suggest that you run the system health and memory exerciser test (see Section 4, Troubleshooting).

`tomon : can't open input file : xxx.out`

TOMON cannot find the file xxx.out. Most likely the file is not in the current directory, or the filename or path was mistyped. This can occur if the Instrument Program batch file (IP or IP2) is run from a directory other than \IP. (Placing the \IP directory on the DOS path will not solve this problem.) You can either change the current directory to \IP using the DOS CD command, or by editing the IP.BAT (or IP2.BAT) to explicitly list the path in which the downloadable files are to be found. For instance: `TOMON -i D:\IP\UCODE20.OUT D:\IP\SP.OUT -G`

`tomon : error reading 1st block, status = xx`

TOMON was able to open the file, but could not read the first 1024 words of the file. Presumably this is not a downloadable file, or it has been corrupted.

`tomon : Not a downloadable file. (xxx)`

The file is not of the proper format for downloading.

`tomon : File read error. Status = xx - ABORT`

An error was encountered reading the data file. The file has been corrupted or truncated.

B

Integrated Display Option

This appendix covers installation instructions for option 33, the integrated system controller that can be attached to your analyzer. The integrated system controller consists of a 386SX notebook computer (manufactured by AST), retaining brackets to hold the notebook to the 2642A, and a hinged top cover to protect the notebook when it is not in use.

The information given here covers opening the top cover, removing the notebook from the analyzer, re-attaching it, and plugging in the cables.

Opening the Top Cover

The AST notebook computer is shipped already attached to your 2642A analyzer. The top cover is shipped locked; inside the AST notebook soft carry case you will find the key for the top cover (as well as the battery for the AST computer). You must unlock the cover before opening.

The magnetic catches holding the cover closed are very strong; you may need both hands to open them.

Remove the four foam inserts that surround the computer. IMPORTANT: retain the foam inserts; you may need them should it ever be necessary to ship your analyzer. DO NOT attempt to ship the analyzer and integrated display without the foam inserts; damage from shipment may occur!

For information on installing the AST's battery, consult your AST manual.

Removing the AST Computer

To remove the AST, follow these steps:

1. Unplug the power cord from the 2642A.

2. Disconnect all cables from the back of the computer.

3. Using a flathead screwdriver, loosen the two thumbscrews that fasten the RIGHT bracket to the top of the analyzer. (You may be able to remove the thumbscrews with your fingers instead of a screwdriver.)

4. Remove the right bracket.

5. Gently lift up on the right side of the computer. Slide it out from under the left bracket, and lift it off of the analyzer.

6. Immediately re-attach the right bracket, for safekeeping.

Reattaching the AST Computer

There are two methods of reattacing the AST computer to the top of your analyzer. The first is to simply reverse the directions given above under *Removing The AST Computer*. Remove the right bracket, slide the computer under the left bracket and seat it properly in place, and replace the right bracket.

To replace the AST without removing a bracket, follow these steps:

1. Loosen the thumbscrews on both brackets. Do not remove the brackets. Notice the "play" produced by loosening the thumbscrews.

2. Push the brackets apart.

3. Place the AST on top of the analyzer, between the brackets.

4. Right the brackets, hooking them over the edges of the AST's keyboard to clamp it in place.

5. Tighten all four thumbscrews.

Installing the Cables

Important: before installing the cables, you must unplug the 2642A power cord. This is important because the AC recepticle used for the AST battery charger is unswitched, meaning that it has power even when the 2642A is off.

After attaching the AST to the top of your analyzer, you must properly install these three cables:

- The serial cable, connecting the AST's serial port to the analyzer's serial port
- The power supply, connecting the AST to the battery charger
- The trackball cable (note: the trackball is velcro-attached to the side of the AST, for easy removal)

Exercise care when plugging in the cables: line the pins up first, making sure that the arrow on the connector faces up. Then apply steady, light pressure to push the connecor in. DO NOT force the connector in; it is possible, though unlikely, to bend the pins, particularly if you have inadvertantly swapped the locations of the trackball and battery charger cables.

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