Service Guide

Publication Number 33220-90010 (*order as 33220-90100 manual set*)
Edition 1, February 2003

For Safety information, Warranties, and Regulatory information, see the pages following the Schematics.

Agilent 33220A
20 MHz Function / Arbitrary Waveform Generator

Agilent 33220A at a Glance

The Agilent Technologies 33220A is a 20 MHz synthesized function generator with built-in arbitrary waveform and pulse capabilities. Its combination of bench-top and system features makes this function generator a versatile solution for your testing requirements now and in the future.

Convenient bench-top features

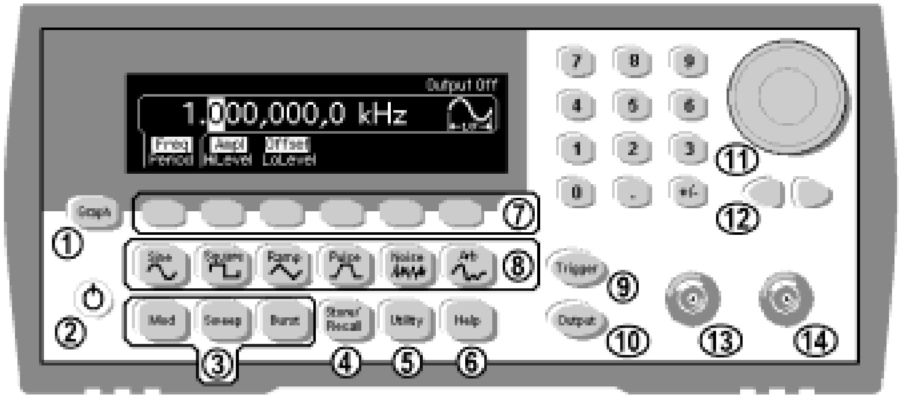
- 10 standard waveforms
- Built-in 14-bit 50 MSa/s arbitrary waveform capability
- Precise pulse waveform capabilities with adjustable edge time
- LCD display provides numeric and graphical views
- Easy-to-use knob and numeric keypad
- Instrument state storage with user-defined names
- Portable, ruggedized case with non-skid feet

Flexible system features

- Four downloadable 64K-point arbitrary waveform memories
- GPIB (IEEE-488), USB, and LAN remote interfaces are standard
- SCPI (Standard Commands for Programmable Instruments) compatibility

Note: *Unless otherwise indicated, this manual applies to all Serial Numbers.*

The Front Panel at a Glance

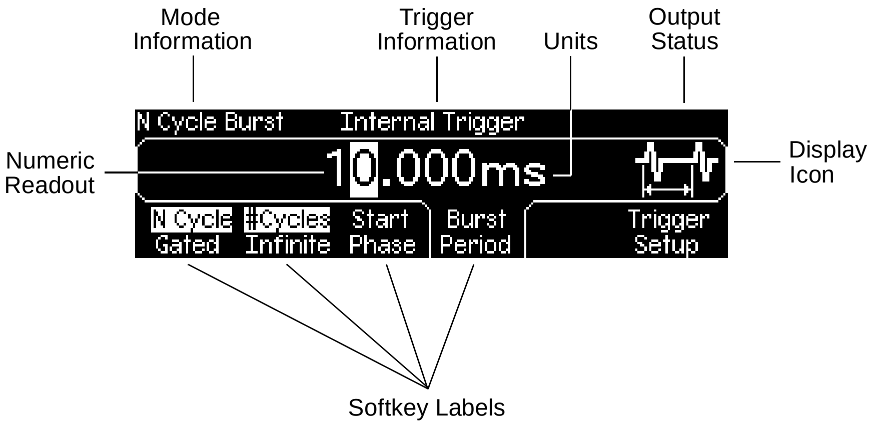


1 Graph Mode/Local Key
2 On/Off Switch
3 Modulation/Sweep/Burst Keys
4 State Storage Menu Key
5 Utility Menu Key
6 Help Menu Key
7 Menu Operation Softkeys
8 Waveform Selection Keys
9 Manual Trigger Key (*used for Sweep and Burst only*)
10 Output Enable/Disable Key
11 Knob
12 Cursor Keys
13 Sync Connector
14 Output Connector

Note: *To get context-sensitive help on any front-panel key or menu softkey, press and hold down that key.*

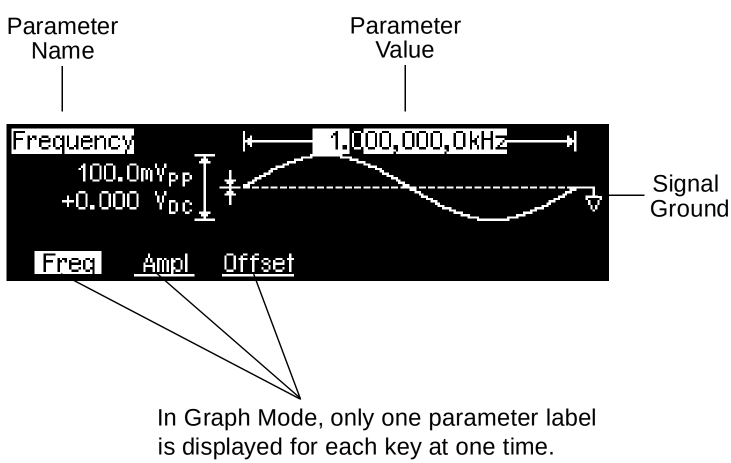
The Front-Panel Display at a Glance

Menu Mode



Graph Mode

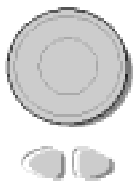
To enter or exit the Graph Mode, press the Graph *key.*



Front-Panel Number Entry

You can enter numbers from the front-panel using one of two methods.

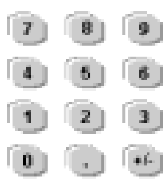
Use the knob and cursor keys to modify the displayed number.



1. Use the keys below the knob to move the cursor left or right

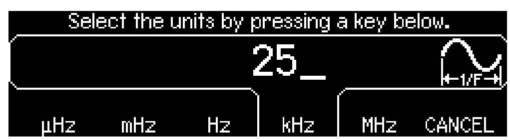
2. Rotate the knob to change a digit (clockwise to increase).

Use the keypad to enter numbers and the softkeys to select units.

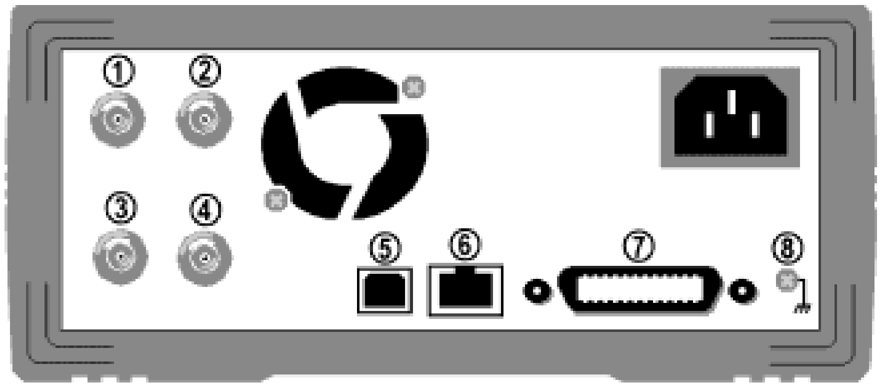


1. Key in a value as you would on a typical calculator.

2. Select a unit to enter the value.



The Rear Panel at a Glance



1 External 10 MHz Reference Input Terminal (Option 001 only).
2 Internal 10 MHz Reference Output Terminal (Option 001 only).
3 External Modulation Input Terminal
4 Input: External Trig/FSK/Burst Gate
Output: Trigger Output

5 USB Interface Connector
6 LAN Interface Connector
7 GPIB Interface Connector
8 Chassis Ground

Use the Utility **menu to:**

- Select the GPIB address (see chapter 3).
- Set the network parameters for the LAN interface (see chapter 3).
- Display the current network parameters (see chapter 3).

Note: *The External and Internal 10 MHz Reference Terminals (1 and 2, above) are present* ***only*** *if Option 001, External Timebase Reference, is installed. Otherwise, the holes for these connectors are plugged.*

WARNING

For protection from electrical shock, the power cord ground must not be defeated. If only a two-contact electrical outlet is available, connect the instrument's chassis ground screw (see above) to a good earth ground.

In This Book

Specifications Chapter 1 lists the function generator's specifications.

Quick Start Chapter 2 prepares the function generator for use and helps you get familiar with a few of its front-panel features.

Front-Panel Menu Operation Chapter 3 introduces you to the front-panel menu and describes some of the function generator's menu features.

Calibration Procedures Chapter 4 provides calibration, verification, and adjustment procedures for the function generator.

Theory of Operation Chapter 5 describes block and circuit level theory related to the operation of the function generator.

Service Chapter 6 provides guidelines for returning your function generator to Agilent Technologies for servicing, or for servicing it yourself.

Replaceable Parts Chapter 7 contains a detailed parts list of the function generator.

Backdating Chapter 8 describes the differences between this manual and older issues of this manual.

Schematics Chapter 9 contains the function generator's schematics and component locator drawings.

If you have questions relating to the operation of the Agilent 33220A, call **1-800-452-4844** in the United States, or contact your nearest Agilent Technologies Sales Office.

If your 33220A fails within three years of purchase, Agilent will either repair or replace it free of charge. Call **1-877-447-7278** in the United States (and ask for "Agilent Express") or contact your local Agilent Technologies Sales Office.

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Chapter 7 Replaceable Parts 139

Specifications

Waveforms

Standard: Sine, Square, Ramp, Triangle, Pulse, Noise, DC

Built-in Arbitrary: Exponential rise, Exponential fall, Negative ramp, Sin(x)/x, Cardiac.

Waveform Characteristics

Sine

Frequency Range: 1 µHz - 20 MHz

Amplitude Flatness: [1], [2]

	(Relative to 1 kHz)
< 100 kHz	0.1 dB
100 kHz to 5 MHz	0.15 dB
5 MHz to 20 MHz	0.3 dB

Harmonic Distortion: [2], [3]

	< 1 Vpp	≥ 1 Vpp
DC to 20 kHz	-70 dBc	-70 dBc
20 kHz to 100 kHz	-65 dBc	-60 dBc
100 kHz to 1 MHz	-50 dBc	-45 dBc
1 MHz to 20 MHz	-40 dBc	-35 dBc

Total Harmonic Distortion: [2], [3]
DC to 20 kHz 0.04%

Spurious (Non-Harmonic) Distortion: [2], [4]
DC to 1 MHz -70 dBc
1 MHz to 20 MHz -70 dBc +6 dB/octave

Phase Noise (10 kHz offset): -115 dBc / Hz, typical

Square

Frequency Range: 1 µHz to 20 MHz
Rise/Fall Time: < 13 ns
Overshoot: < 2%
Variable Duty Cycle: 20% - 80% (to 10 MHz) 40% - 60% (to 20 MHz)
Asymmetry (@ 50% Duty): 1% of period + 5 ns
Jitter: 300 ps + 100 ppm of period

Ramp, Triangle

Frequency Range: 1 µHz to 200 kHz
Linearity: < 0.1% of peak output
Variable Symmetry: 0.0% to 100.0%

Pulse

Frequency Range: 500 µHz to 5 MHz
Pulse Width (period ≤ 10 s): 20 ns minimum, 10 ns resolution

Variable Edge Time: < 13 ns to 100 ns
Overshoot: < 2%
Jitter: 300 ps + 0.1 ppm of period

Noise

Bandwidth (-3dB): 9 MHz, typical

Arbitrary

Frequency Range: 1 µHz to 6 MHz
Waveform Length: 2 to 64 K points
Amplitude Resolution: 14 bits (including sign)
Sample Rate: 50 MSa/s
Minimum Rise/Fall Time: 35 ns, typical
Linearity: < 0.1% of peak output
Settling Time: < 250 ns to 0.5% of final value
Jitter (RMS): 6 ns + 30 ppm
Non-volatile Memory: Four waveforms

Common Characteristics

Amplitude

Range:	
Into 50 Ω:	10 mVpp to 10 Vpp
Into open circuit:	20 mVpp to 20 Vpp
Accuracy (at 1 kHz): [1], [2]	± 1% of setting ± 1 mVpp
Units:	Vpp, Vrms, dBm
Resolution:	4 digits

DC Offset

Range (peak AC + DC):	± 5 V into 50 Ω ±10 V into open circuit
Accuracy: [1], [2]	± 2% of offset setting ± 0.5% of ampl. ± 2 mV
Resolution:	4 digits

Main Output

Impedance:	50 Ω typical
Isolation:	42 Vpk maximum to earth
Protection:	Short-circuit protected, overload automatically disables main output

Internal Frequency Reference

Accuracy: [5]	± 10 ppm in 90 days, ± 20 ppm in 1 year

External Frequency Reference (Option 001)

Rear Panel Input:	
Lock Range:	10 MHz ± 500 Hz
Level:	100 mVpp to 5 Vpp
Impedance:	1 kΩ typical, AC coupled
Lock Time:	< 2 seconds
Rear Panel Output:	
Frequency:	10 MHz
Level:	632 mVpp (0 dBm), typical
Impedance:	50 Ω typical, AC coupled

Phase Offset:	
Range:	+360 to -360 degrees
Resolution:	0.001 degrees
Accuracy:	20 ns

Modulation

AM

Carrier Waveforms:	Sine, Square, Ramp, Arb
Source:	Internal/External
Internal Modulation:	Sine, Square, Ramp, Triangle, Noise, Arb (2 mHz to 20 kHz)
Depth:	0.0% to 120.0%

FM

Carrier Waveforms:	Sine, Square, Ramp, Arb
Source:	Internal/External
Internal Modulation:	Sine, Square, Ramp, Triangle, Noise, Arb (2 mHz to 20 kHz)
Deviation:	DC to 10 MHz

PM

Carrier Waveforms:	Sine, Square, Ramp, Arb
Source:	Internal/External
Internal Modulation:	Sine, Square, Ramp, Triangle, Noise, Arb (2 mHz to 20 kHz)
Deviation:	0.0 to 360.0 degrees

PWM

Carrier Waveforms:	Pulse
Source:	Internal/External
Internal Modulation:	Sine, Square, Ramp, Triangle, Noise, Arb (2 mHz to 20 kHz)
Deviation:	0% to 100% of pulse width

FSK

Carrier Waveforms:	Sine, Square, Ramp, Arb
Source:	Internal/External
Internal Modulation:	50% duty cycle square (2 mHz to 100 kHz)

External Modulation Input [6] (for AM, FM, PM, PWM)

Voltage Range:	± 5 V full scale
Input Resistance:	5 kΩ typical
Bandwidth:	DC to 20 kHz

Sweep

Waveforms:	Sine, Square, Ramp, Arb
Type:	Linear or Logarithmic
Direction:	Up or Down
Sweep Time:	1 ms to 500 s
Trigger:	Single, External or Internal
Marker	Falling edge of Sync signal (programmable frequency)

Burst [7]

Waveforms:	Sine, Square, Ramp, Triangle, Pulse, Noise, Arb
Type:	Counted (1 to 50,000 cycles), Infinite, Gated
Start/Stop Phase:	-360 to +360 degrees
Internal Period:	1 µs to 500 s
Gate Source:	External Trigger
Trigger Source:	Single, External, or Internal

Trigger Characteristics

Trigger Input:	
Input Level:	TTL compatible
Slope:	Rising or falling, selectable
Pulse Width:	> 100 ns
Input Impedance:	> 10 kΩ, DC coupled
Latency:	< 500 ns
Jitter (RMS)	6 ns (3.5 ns for Pulse)
Trigger Output:	
Level:	TTL compatible into ≥ 1 kΩ
Pulse Width:	> 400 ns
Output Impedance:	50 Ω, typical
Maximum Rate:	1 MHz

Programming Times (typical)

Configuration Times

	USB	LAN	GPIB
Function Change	99 ms	100 ms	99 ms
Frequency Change	3 ms	5 ms	2 ms
Amplitude Change	36 ms	36 ms	36 ms
Select User Arb	111 ms	112 ms	109 ms

Arb Download Times (binary transfer)

	USB	LAN	GPIB
64 K points	101 ms	250 ms	356 ms
16 K points	26 ms	62 ms	87 ms
4 K points	8 ms	20 ms	22 ms

Download times do not include setup or output time.

General

Power Supply:	CAT II 100 to 240 V @ 50/60 Hz (-5%, +10%) 100 to 120 V @ 400 Hz (± 10%)
Power Consumption:	50 VA maximum
Operating Environment:	IEC 61010 Pollution Degree 2 Indoor Location
Operating Temperature:	0 °C to 55 °C
Operating Humidity:	5% to 80% RH, non-condensing
Operating Altitude:	Up to 3000 meters
Storage Temperature:	-30 °C to 70 °C
State Storage Memory:	Power off state automatically saved. Four user-configurable stored states.
Interface:	GPIB, USB, and LAN standard
Language:	SCPI - 1993, IEEE-488.2
Dimensions (W x H x D):	
Bench Top:	261.1 mm by 103.8 mm by 303.2 mm
Rack Mount:	212.8 mm by 88.3 mm by 272.3 mm
Weight:	3.4 kg (7.5 lbs)
Safety Designed to:	UL-1244, CSA 1010, EN61010
EMC Tested to:	MIL-461C, EN55011, EN50082-1
Vibration and Shock:	MIL-T-28800, Type III, Class 5
Acoustic Noise:	30 dBa
Warm-up Time:	1 hour
Warranty:	3 years standard

Note: *Specifications are subject to change without notice. For the latest specifications, go to the Agilent 33220A product page and find the Product Datasheet.*

www.agilent.com/find/33220A

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

N10149

Footnotes:

1 Add 1/10th of output amplitude and offset specification per °C for operation outside the range of 18 °C to 28 °C.

2 Autorange enabled.

3 DC offset set to 0 V.

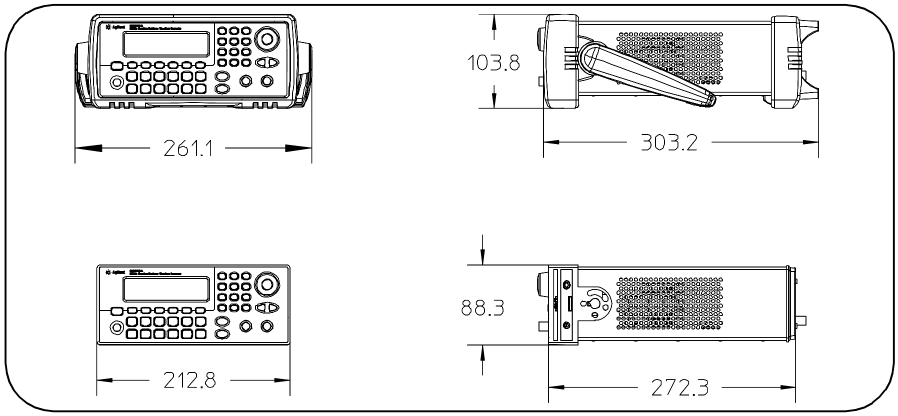
4 Spurious distortion at low amplitude is limited by -75 dBm typical.

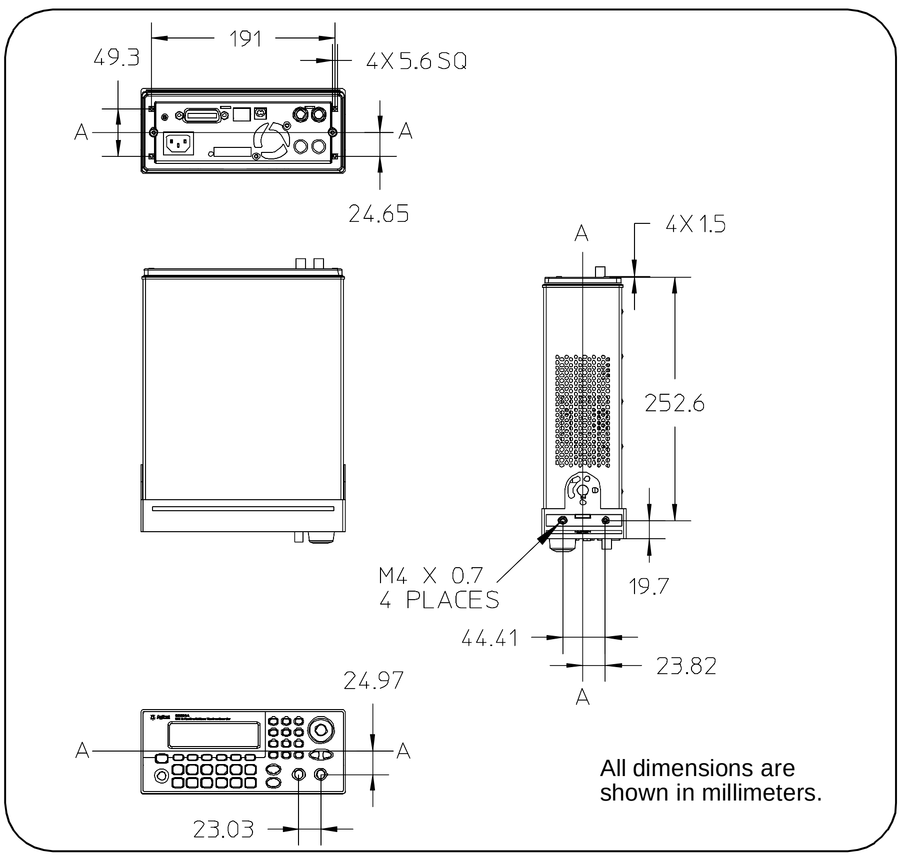
5 Add 1 ppm / °C (average) for operation outside the range 18 °C to 28 °C.

6 FSK uses trigger input (1 MHz maximum).

7 Sine and square waveforms above 6 MHz are allowed only with an “infinite” burst count.

Product Dimensions





Quick Start

Quick Start

One of the first things you will want to do with your function generator is to become acquainted with the front panel. We have written the exercises in this chapter to prepare the instrument for use and help you get familiar with some of its front-panel operations. This chapter is divided into the following sections:

2

To Prepare the Function Generator for Use

1 Check the list of supplied items.

Verify that you have received the following items with your instrument. If anything is missing, please contact your nearest Agilent Sales Office.

- ❑ One power cord.
- ❑ One *User's Guide*.
- ❑ This *Service Guide*.
- ❑ One folded *Quick Start Tutorial*.
- ❑ One folded *Quick Reference Guide*.
- ❑ Certificate of Calibration.
- ❑ Connectivity software on CD-ROM.

Power Switch

2 Connect the power cord and turn on the function generator.

The instrument runs a short power-on self test, which takes a few seconds. When the instrument is ready for use it displays a message about how to obtain help, along with the current GPIB address. The function generator powers up in the *sine wave* function at 1 kHz with an amplitude of 100 mV peak-to-peak (into a 50Ω termination). At power-on, the *Output* connector is disabled. To enable the *Output* connector, press the Output key.

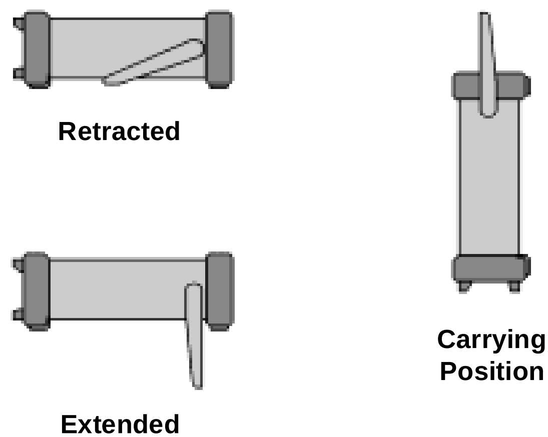
If the function generator *does not* turn on, verify that the power cord is firmly connected to the power receptacle on the rear panel (the power-line voltage is automatically sensed at power-on). You should also make sure that the function generator is connected to a power source that is energized. Then, verify that the function generator is turned on.

> If the power-on self test fails, “Self-Test Failed” is displayed along with an error code. See Chapter 6 for information on self-test error codes, and for instructions on returning the function generator to Agilent for service.

2

To Adjust the Carrying Handle

To adjust the position, grasp the handle by the sides and *pull outward*. Then, rotate the handle to the desired position.



To Set the Output Frequency

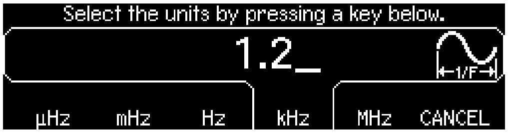
At power-on, the function generator outputs a sine wave at 1 kHz with an amplitude of 100 mV peak-to-peak (into a 50Ω termination).
The following steps show you how to change the frequency to 1.2 MHz.

1 Press the "Freq" softkey.

The displayed frequency is either the power-on value or the frequency previously selected. When you change functions, the same frequency is used if the present value is valid for the new function. To set the waveform *period* instead, press the **Freq** softkey again to toggle to the **Period** softkey (the current selection is highlighted).

2 Enter the magnitude of the desired frequency.

Using the numeric keypad, enter the value "1.2".



3 Select the desired units.

Press the softkey that corresponds to the desired units. When you select the units, the function generator outputs a waveform with the displayed frequency (if the output is enabled). For this example, press **MHz**.

Note: *You can also enter the desired value using the knob and cursor keys.*

To Set the Output Amplitude

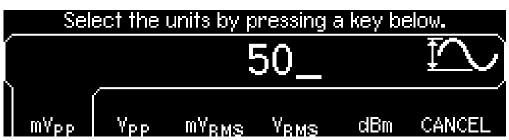
At power-on, the function generator outputs a sine wave with an amplitude of 100 mV peak-to-peak (into a 50Ω termination).
The following steps show you how to change the amplitude to 50 mVrms.

1 Press the "Ampl" softkey.

The displayed amplitude is either the power-on value or the amplitude previously selected. When you change functions, the same amplitude is used if the present value is valid for the new function. To set the amplitude using a *high level* and *low level*, press the **Ampl** softkey again to toggle to the **HiLevel** and **LoLevel** softkeys (the current selection is highlighted).

2 Enter the magnitude of the desired amplitude.

Using the numeric keypad, enter the value "50".



3 Select the desired units.

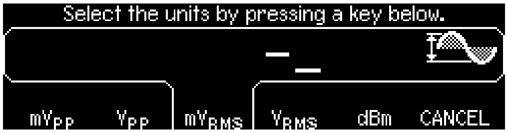
Press the softkey that corresponds to the desired units. When you select the units, the function generator outputs the waveform with the displayed amplitude (if the output is enabled). For this example, press **mV$_{RMS}$**.

Note: *You can also enter the desired value using the knob and cursor keys.*

You can easily convert the displayed amplitude from one unit to another. For example, the following steps show you how to convert the amplitude from Vrms to Vpp.

4 Enter the numeric entry mode.

Press the [+/-] key to enter the numeric entry mode.



5 Select the new units.

Press the softkey that corresponds to the desired units. The displayed value is converted to the new units. For this example, press the **Vpp** softkey to convert 50 mVrms to its equivalent in volts peak-to-peak.

To change the displayed amplitude by *decades*, press the right-cursor key to move the cursor to the units on the right side of the display. Then, rotate the knob to increase or decrease the displayed amplitude by decades.

To Set a DC Offset Voltage

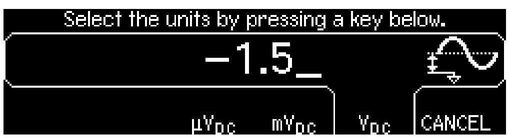
At power-on, the function generator outputs a sine wave with a dc offset of 0 volts (into a 50Ω termination). *The following steps show you how to change the offset to –1.5 mVdc.*

1 Press the “Offset” softkey.

The displayed offset voltage is either the power-on value or the offset previously selected. When you change functions, the same offset is used if the present value is valid for the new function.

2 Enter the magnitude of the desired offset.

Using the numeric keypad, enter the value “–1.5”.



3 Select the desired units.

Press the softkey that corresponds to the desired units. When you select the units, the function generator outputs the waveform with the displayed offset (if the output is enabled). For this example, press **mV$_{DC}$**.

Note: *You can also enter the desired value using the knob and cursor keys.*

To Set the High-Level and Low-Level Values

You can specify a signal by setting its amplitude and dc offset values, as described previously. Another way to set the limits of a signal is to specify its high-level (maximum) and low-level (minimum) values. This is typically convenient for digital applications. In the following example, let's set the high-level to 1.0 V and the low-level to 0.0 V.

1 Press the "Ampl" softkey to select "Ampl".

2 Press the softkey again to toggle to "HiLevel".

Note that both the **Ampl** and **Offset** softkeys toggle together, to **HiLevel** and **LoLevel**, respectively.

3 Set the "HiLevel" value.

Using the numeric keypad or the knob, select a value of "1.0 V". (If you are using the keypad, you will need to select the unit, "V", to enter the value.)

4 Press the "LoLevel" softkey and set the value.

Again, use the numeric keypad or the knob to enter a value of "0.0 V".

Note that these settings (high-level = "1.0 V" and low-level = "0.0 V") are equivalent to setting an amplitude of "1.0 Vpp" and an offset of "500 mVdc".

To Select “DC Volts”

You can select the "DC Volts" feature from the “Utility” menu, and then set a constant dc voltage as an "Offset" value. Let's set "DC Volts" = 1.0 Vdc.

1 Press Utility and then select the DC On softkey.

The **Offset** value becomes selected.

2 Enter the desired voltage level as an "Offset".

Enter 1.0 Vdc with the numeric keypad or knob.

You can enter any dc voltage from -5 Vdc to +5 Vdc.

To Set the Duty Cycle of a Square Wave

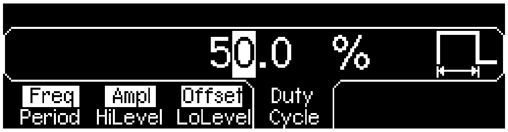
At power-on, the duty cycle for square waves is 50%. You can adjust the duty cycle from 20% to 80% for output frequencies up to 10 MHz. *The following steps show you how to change the duty cycle to 30%.*

1 Select the square wave function.

Press the Square key and then set the desired output frequency to any value up to 10 MHz.

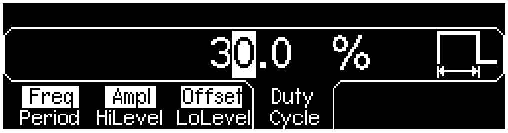
2 Press the "Duty Cycle" softkey.

The displayed duty cycle is either the power-on value or the percentage previously selected. The duty cycle represents the amount of time per cycle that the square wave is at a *high* level (note the icon on the right side of the display).



3 Enter the desired duty cycle.

Using the numeric keypad or the knob, select a duty cycle value of "30". The function generator adjusts the duty cycle immediately and outputs a square wave with the specified value (if the output is enabled).



2

To Configure a Pulse Waveform

You can configure the function generator to output a pulse waveform with variable pulse width and edge time. *The following steps show you how to configure a 500 ms pulse waveform with a pulse width of 10 ms and edge times of 50 ns.*

1 Select the pulse function.

Press the Pulse key to select the pulse function and output a pulse waveform with the default parameters.

2 Set the pulse period.

Press the **Period** softkey and then set the pulse period to 500 ms.

3 Set the pulse width.

Press the **Width** softkey and then set the pulse width to 10 ms. The pulse width represents the time from the 50% threshold of the rising edge to the 50% threshold of the next falling edge (note the display icon).

4 Set the edge time for both edges.

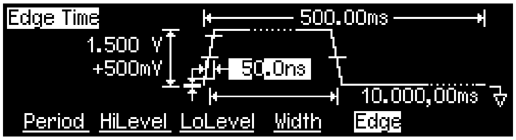
Press the **Edge Time** softkey and then set the edge time for *both* the rising and falling edges to 50 ns. The edge time represents the time from the 10% threshold to the 90% threshold of each edge (note the display icon).

To View a Waveform Graph

In the *Graph Mode*, you can view a graphical representation of the current waveform parameters. The softkeys are listed in the same order as in the normal display mode, and they perform the same functions. However, only one label (for example, **Freq** or **Period**) is displayed for each softkey at one time.

1 Enable the Graph Mode.

Press the [Graph] key to enable the Graph Mode. The name of the currently selected parameter, shown in the upper-left corner of the display, and the parameter's numeric value field are both highlighted.



2 Select the desired parameter.

To select a specific parameter, note the softkey labels at the bottom of the display. For example, to select period, press the **Period** softkey.

- As in the normal display mode, you can edit numbers using either the numeric keypad or the knob and cursor keys.
- Parameters which normally toggle when you press a key a second time also toggle in the Graph Mode. However, you can see only one label for each softkey at one time (for example, **Freq** or **Period).**
- To exit the Graph Mode, press [Graph] again.

> The [Graph] key also serves as a [Local] key to restore front-panel control after remote interface operations.

To Output a Stored Arbitrary Waveform

There are five built-in arbitrary waveforms stored in non-volatile memory. *The following steps show you how to output the built-in “exponential fall” waveform from the front panel.*

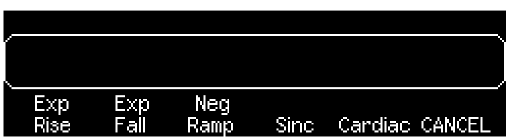
> For information on creating a custom arbitrary waveform, refer to “To Create and Store an Arbitrary Waveform” in the *User’s Guide*.

1 Select the arbitrary waveform function.

When you press the Arb key to select the arbitrary waveform function, a temporary message is displayed indicating which waveform is currently selected (the default is “exponential rise”).

2 Select the active waveform.

Press the **Select Wform** softkey and then press the **Built-In** softkey to select from the five built-in waveforms. Then press the **Exp Fall** softkey. The waveform is output using the present settings for frequency, amplitude, and offset unless you change them.



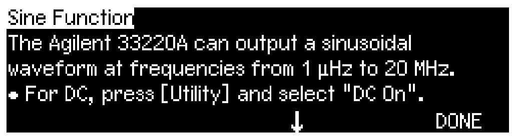
The selected waveform is now assigned to the Arb *key. Whenever you press this key, the selected arbitrary waveform is output. To quickly determine which arbitrary waveform is currently selected, press* Arb.

To Use the Built-In Help System

The built-in help system is designed to provide context-sensitive assistance on any front-panel key or menu softkey. A list of help topics is also available to assist you with several front-panel operations.

1 View the help information for a function key.

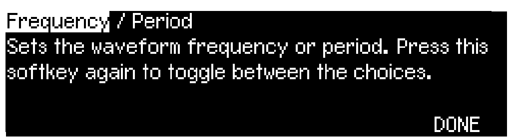
Press and hold down the Sine key. If the message contains more information than will fit on the display, press the ↓ softkey or turn the knob clockwise to view the remaining information.



Press **DONE** to exit Help.

2 View the help information for a menu softkey.

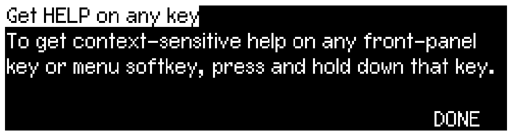
Press and hold down the **Freq** softkey. If the message contains more information than will fit on the display, press the ↓ softkey or rotate the knob clockwise to view the remaining information.



Press **DONE** to exit Help.

3 View the list of help topics.

Press the [Help] key to view the list of available help topics. To scroll through the list, press the ↑ or ↓ softkey or rotate the knob. Select the third topic "*Get HELP on any key*" and then press **SELECT**.

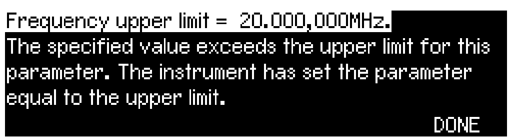


Press **DONE** to exit Help.

4 View the help information for displayed messages.

Whenever a limit is exceeded or any other invalid configuration is found, the function generator will display a message. For example, if you enter a value that exceeds the frequency limit for the selected function, a message will be displayed. The built-in help system provides additional information on the most recent message to be displayed.

Press the [Help] key, select the first topic "*View the last message displayed*", and then press **SELECT**.



Press **DONE** to exit Help.

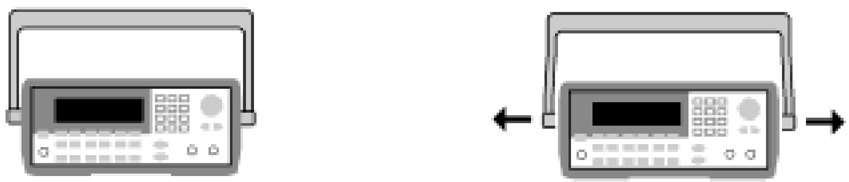
Local Language Help: The built-in help system in available in multiple languages. All messages, context-sensitive help, and help topics appear in the selected language. The menu softkey labels and status line messages are not translated.

To select the local language, press the [Utility] key, press the **System** softkey, and then press the **Help In** softkey. Select the desired language.

To Rack Mount the Function Generator

You can mount the Agilent 33220A in a standard 19-inch rack cabinet using one of two optional kits available. Instructions and mounting hardware are included with each rack-mounting kit. Any Agilent *System II* instrument of the same size can be rack-mounted beside the Agilent 33220A.

Note: *Remove the carrying handle, and the front and rear rubber bumpers, before rack-mounting the instrument.*

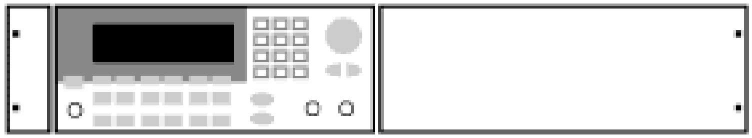


To remove the handle, rotate it to vertical and pull the ends outward.

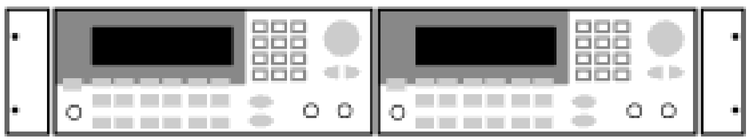
Front   Rear (bottom view)

To remove the rubber bumper, stretch a corner and then slide it off.

2



To rack mount a single instrument, order adapter kit 5063-9240.



To rack mount two instruments side-by-side, order lock-link kit 5061-9694 and flange kit 5063-9212. Be sure to use the support rails in the rack cabinet.

Note: *The lock-link kit works* ***only*** *for instruments of equal depth. If you want to mount an Agilent 33220A and an instrument of a different depth (for example, an Agilent 33250A) contact your Agilent Representative for further information.*

In order to prevent overheating, do not block the flow of air into or out of the instrument. Be sure to allow enough clearance at the rear, sides, and bottom of the instrument to permit adequate internal air flow.

3

Front-Panel Menu Operation

Front-Panel Menu Operation

This chapter introduces you to the front-panel keys and menu operation. This chapter does not give a detailed description of every front-panel key or menu operation. It does, however, give you an overview of the front-panel menus and many front-panel operations. Refer to the *Agilent 33220A User's Guide* for a complete discussion of the function generator's capabilities and operation.

Front-Panel Menu Reference

This section gives an overview of the front-panel menus. The remainder of this chapter contains examples of using the front-panel menus.

Mod	**Configure the modulation parameters for AM, FM, PM, FSK and PWM.**

- Select the modulation type.
- Select an internal or external modulation source.
- Specify AM modulation depth, modulating frequency, and modulation shape.
- Specify FM frequency deviation, modulating frequency, and modulation shape.
- Specify PM phase deviation, modulating frequency, and modulation shape.
- Specify FSK “hop” frequency and FSK rate.
- Specify PWM deviation, modulating frequency, and modulation shape.

Sweep	**Configure the parameters for frequency sweep.**

- Select linear or logarithmic sweeping.
- Select the start/stop frequencies <u>or</u> center/span frequencies.
- Select the time in seconds required to complete a sweep.
- Specify a marker frequency.
- Specify an internal or external trigger source for the sweep.
- Specify the slope (rising or falling edge) for an external trigger source.
- Specify the slope (rising or falling edge) of the “Trig Out” signal.

Burst	**Configure the parameters for burst.**

- Select the triggered (N Cycle) or externally-gated burst mode.
- Select the number of cycles per burst (1 to 50,000, or Infinite).
- Select the starting phase angle of the burst (-360° to +360°).
- Specify the time from the start of one burst to the start of the next burst.
- Specify an internal or external trigger source for the burst.
- Specify the slope (rising or falling edge) for an external trigger source.
- Specify the slope (rising or falling edge) of the “Trig Out” signal.

3

Store/Recall	**Store and recall instrument states.**

- Store up to four instrument states in non-volatile memory.
- Assign a custom name to each storage location.
- Recall stored instrument states.
- Restore all instrument settings to their factory default values.
- Select the instrument's power-on configuration (last or factory default).

Utility	**Configure system-related parameters.**

- Generate a dc-only voltage level.
- Enable/disable the Sync signal which is output from the "Sync" connector.
- Select the output termination (1Ω to 10 kΩ, or Infinite).
- Enable/disable amplitude autoranging.
- Select the waveform polarity (normal or inverted).
- Select the GPIB address.
- Specify the LAN configuration (IP address and network configuration).
- Select how periods and commas are used in numbers displayed on the front panel.
- Select the local language for front-panel messages and help text.
- Enable/disable the tone heard when an error is generated.
- Enable/disable the display bulb-saver mode.
- Adjust the contrast setting of the front-panel display.
- Perform an instrument self-test.
- Secure/unsecure the instrument for calibration and perform manual calibrations.
- Query the instrument's firmware revision codes.

Help	**View the list of Help topics.**

- View the last message displayed.
- View the remote command error queue.
- Get HELP on any key.
- How to generate a dc-only voltage level.
- How to generate a modulated waveform.
- How to create an arbitrary waveform.
- How to reset the instrument to its default state.
- How to view a waveform in the Graph Mode.
- How to synchronize multiple instruments.
- How to obtain AgilentTechnical Support.

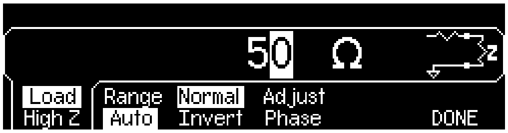
To Select the Output Termination

The Agilent 33220A has a fixed series output impedance of 50 ohms to the front-panel *Output* connector. If the actual load impedance is different than the value specified, the displayed amplitude and offset levels will be incorrect. The load impedance setting is simply provided as a convenience to ensure that the displayed voltage matches the expected load.

1 Press Utility .

2 Navigate the menu to set the output termination.

Press the **Output Setup** softkey and then select the **Load** softkey.



3 Select the desired output termination.

Use the knob or numeric keypad to select the desired load impedance or press the **Load** softkey again to choose “High Z”.

To Reset the Function Generator

To reset the instrument to its factory default state, press Store/Recall and then select the **Set to Defaults** softkey. Press **YES** to confirm the operation.

For a complete listing of the instrument’s power-on and reset conditions, see “Agilent 33220A Factory Default Settings” in the User’s Guide.

3

To Read the Calibration Information

You can access the instrument's calibration memory to read the calibration count and calibration message.

Calibration Count You can query the instrument to determine how many calibrations have been performed. Note that your instrument was calibrated before it left the factory. When you receive your instrument, read the count to determine its initial value. The count value increments by one for each calibration point, and a complete calibration may increase the value by many counts.

Calibration Message The instrument allows you to store one message in calibration memory. For example, you can store the date when the last calibration was performed, the date when the next calibration is due, the instrument's serial number, or even the name and phone number of the person to contact for a new calibration.

> You can **record** a calibration message only from the remote interface and only when the instrument is unsecured.
>
> You can **read** the message from either the front-panel or over the remote interface. You can read the calibration message whether the instrument is secured or unsecured.

1 Select the Cal Info interface.

Press [Utility] and then select the **Cal Info** softkey from the "Test/Cal" menu.

The first line in the display shows the calibration count.
The second line shows the calibration message.
The last line indicates the current version of the firmware.

The calibration information will time-out and disappear after a few seconds. Select the **Cal Info** softkey to show the information again.

2 Exit the menu.

Press the **DONE** softkey.

3

To Unsecure and Secure for Calibration

This feature allows you to enter a security code to prevent accidental or unauthorized adjustments of the instrument. When you first receive your instrument, it is secured. Before you can adjust the instrument, you must unsecure it by entering the correct security code.

- The security code is set to **AT33220A** when the instrument is shipped from the factory. The security code is stored in non-volatile memory, and does not change when power has been off, after a Factory Reset (`*RST` command), or after an Instrument Preset (`SYSTem:PRESet` command).
- The security code may contain up to 12 alphanumeric characters. The first character must be a letter, but the remaining characters can be letters, numbers, or an underscore (_). You do not have to use all 12 characters but the first character must always be a letter.

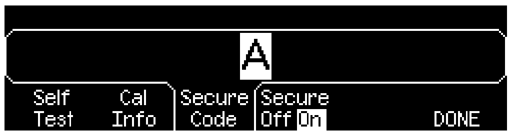
Note

If you forget your security code, you can disable the security feature by applying a temporary short inside the instrument as described in "To Unsecure the Instrument Without the Security Code" on page 74.

To Unsecure for Calibration

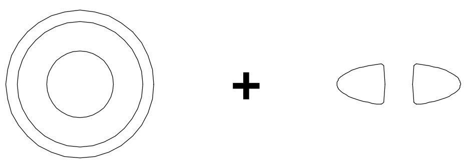
1 Select the Secure Code interface.

Press Utility and then select the **Test/Cal** softkey.



2 Enter the Secure Code.

Use the knob to change the displayed character. Use the arrow keys to move to the next character.



When the last character of the secure code is entered, the instrument will be unsecured.

3 Exit the menu.

Press the **DONE** softkey.

To Secure After Calibration

1 Select the Secure Code interface.

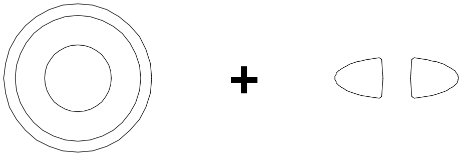
Press 

and then select the **Test/Cal** softkey.

2 Enter a Secure Code.

Enter up to 12 alphanumeric characters. The first character must be a letter.

Use the knob to change the displayed character. Use the arrow keys to move to the next character.



3 Secure the Instrument.

Select the **Secure** softkey.

4 Exit the menu.

Press the **DONE** softkey.

To Store the Instrument State

You can store the instrument state in one of four non-volatile storage locations. A fifth storage location automatically holds the power-down configuration of the instrument. When power is restored, the instrument can automatically return to its state before power-down.

1 Select the desired storage location.

Press Store/Recall and then select the **Store State** softkey.

2 Select a custom name for the selected location.

If desired, you can assign a custom name to each of the four locations.

- The name can contain up to 12 characters. The first character must be a letter but the remaining characters can be letters, numbers, or the underscore character ("_").
- To add additional characters, press the right-cursor key until the cursor is to the right of the existing name and then turn the knob.
- To delete all characters to the right of the cursor position, press +/- .
- To use numbers in the name, you can enter them directly from the numeric keypad. Use the decimal point from the numeric keypad to add the underscore character ("_") to the name.

3 Store the instrument state.

Press the **STORE STATE** softkey. The instrument stores the selected function, frequency, amplitude, dc offset, duty cycle, symmetry, as well as any modulation parameters in use. The instrument *does not* store volatile waveforms created in the arbitrary waveform function.

To Configure the Remote Interface

The Agilent 33220A supports remote interface communication using a choice of three interfaces: GPIB, USB, and LAN. All three interfaces are "live" at power up. The instructions that follow tell how to configure your remote interface from the instrument front panel.

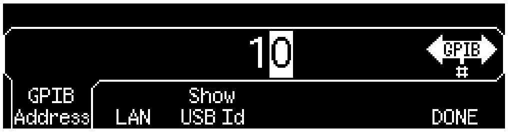
Note: *The CD-ROM provided with your instrument contains connectivity software to enable communications over these interfaces. Refer to the instructions provided on the CD-ROM to install this software on your PC.*

GPIB Configuration

You need only select a GPIB address.

1 Select the "I/O" menu.

Press Utility and then press the **I/O** softkey.



2 Select the GPIB address.

Use the knob and cursor keys or the numeric keypad to select a GPIB address in the range 0 through 30 (the factory default is "10").

The GPIB address is shown on the front-panel display at power-on.

3 Exit the menu.

Press the **DONE** softkey.

USB Configuration

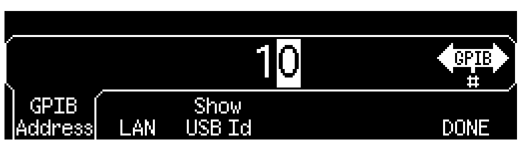
The USB interface requires no front panel configuration parameters. Just connect your Agilent 33220A to your PC using a standard USB cable and the interface will self configure. Press the **Show USB Id** softkey in the "I/O menu" to see the USB interface identification string.

LAN Configuration

There are several parameters that you may need to set to establish network communication using the LAN interface. Primarily, you will need to establish an IP address. You may need to contact your network administrator for help in establishing communication with the LAN interface.

1 Select the "I/O" menu.

Press Utility and then press the **I/O** softkey.



2 Select the "LAN" menu.

Press the **LAN** softkey.

From this menu, you can select **IP Setup** to set an IP address and related parameters, **DNS Setup** to configure DNS, or **Current Config** to view the current LAN configuration.

3 Establish an "IP Setup."

To use the Agilent 33220A on the network, you must first establish an IP setup, including an IP address, and possibly a subnet mask and gateway address. Press the **IP Setup** softkey. By default, **DHCP** is set to **On**.

With **DHCP On**, an IP address will automatically be set by DHCP (Dynamic Host Configuration Protocol) when you connect the Agilent 33220A to the network, provided the DHCP server is found and is able to do so. DHCP also automatically deals with the subnet mask and gateway address, if required. *This is typically the easiest way to establish LAN communication for your instrument. All you need to do is leave* **DHCP On**.

However, if you cannot establish communication by means of DHCP, you will need to manually set an IP address, and a subnet mask and gateway address if they are in use. Follow these steps:

a. **Set the "IP Address."** Press the softkey to select **DHCP Off**. The manual selection softkeys appear and the current IP address is displayed:

Contact your network administrator for the IP address to use. All IP addresses take the form "nnn.nnn.nnn.nnn" where each "nnn" is a byte value in the range 000 through 255. You can enter a new IP address using the numeric keypad (not the knob). Just type in the numbers and the period delimiters using the keypad. Use the left cursor key as a backspace key.

b. **Set the "Subnet Mask."** The subnet mask is required if your network has been divided into subnets. Ask your network administrator whether a subnet mask is needed, and for the correct mask. Press the **Subnet Mask** softkey and enter the subnet mask in the IP address format (using the keypad).

c. **Set the "Default Gateway."** The gateway address is the address of a gateway, which is a device that connects two networks. Ask your network administrator whether a gateway is in use and for the correct address. Press the **Default Gateway** softkey and enter the gateway address in the IP address format (using the keypad).

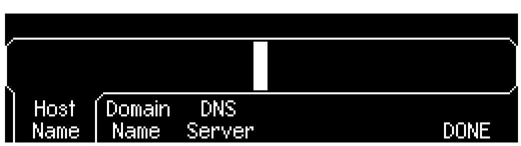
d. **Exit the "IP Setup" menu.** Press **DONE** to return to the "LAN" menu.

4 Configure the "DNS Setup" (optional).

DNS (Domain Name Service) is an Internet service that translates domain names into IP addresses. Ask your network administrator whether DNS is in use, and if it is, for the host name, domain name, and DNS server address to use.

Start at the "LAN" menu.

Press the **DNS Setup** softkey to display the "Host Name" field.



a. **Set the "Host Name."** Enter the host name. The host name is the host portion of the domain name, which is translated into an IP address. The host name is entered as a string using the knob and cursor keys to select and change characters. The host name may include letters, numbers, and dashes ("-"). You can use the keypad for the numeric characters only.

Press [+/-] to delete all characters to the right of the cursor position.

b. **Set the "Domain Name."** Press the **Domain Name** softkey and enter the domain name. The domain name is translated into an IP address. The domain name is entered as a string using the knob and cursor keys to select and change characters. The domain name may include letters, numbers, dashes ("-"), and periods ("."). You can use the keypad for the numeric characters only.

Press [+/-] to delete all characters to the right of the cursor position.

c. **Set the "DNS Server" address.** Press the **DNS Server** softkey and enter the address of the DNS server in the IP address format (using the keypad).

d. **Exit the "DNS Setup" menu.** Press **DONE** to return to the "LAN" menu.

5 View the current LAN configuration.

Press the **Current Config** softkey to view the current LAN configuration. To scroll through the configuration, use the ↑ and ↓ softkeys or rotate the knob. Press **DONE** to return to the "LAN" menu.

6 Exit the menu.

Press **DONE** to exit each menu in turn, or press [Utility] to exit the "Utility" menu directly.

3

3

Calibration Procedures

Calibration Procedures

This chapter contains procedures for verification of the instrument's performance and adjustment (calibration). The chapter is divided into the following sections:

Closed-Case Electronic Calibration The instrument features closed-case electronic calibration. No internal mechanical adjustments are required. The instrument calculates correction factors based upon the input reference value you set. The new correction factors are stored in non-volatile memory until the next calibration adjustment is performed. Non-volatile EEPROM calibration memory does not change when power has been off or after a remote interface reset.

Agilent Technologies Calibration Services

When your instrument is due for calibration, contact your local Agilent Technologies Service Center for a low-cost recalibration. The Agilent 33220A is supported on automated calibration systems which allow Agilent to provide this service at competitive prices.

Calibration Interval

The instrument should be calibrated on a regular interval determined by the measurement accuracy requirements of your application. A 1-year interval is adequate for most applications. Accuracy specifications are warranted only if adjustment is made at regular calibration intervals. Accuracy specifications are not warranted beyond the 1-year calibration interval. Agilent Technologies does not recommend extending calibration intervals beyond 2 years for any application.

Adjustment is Recommended

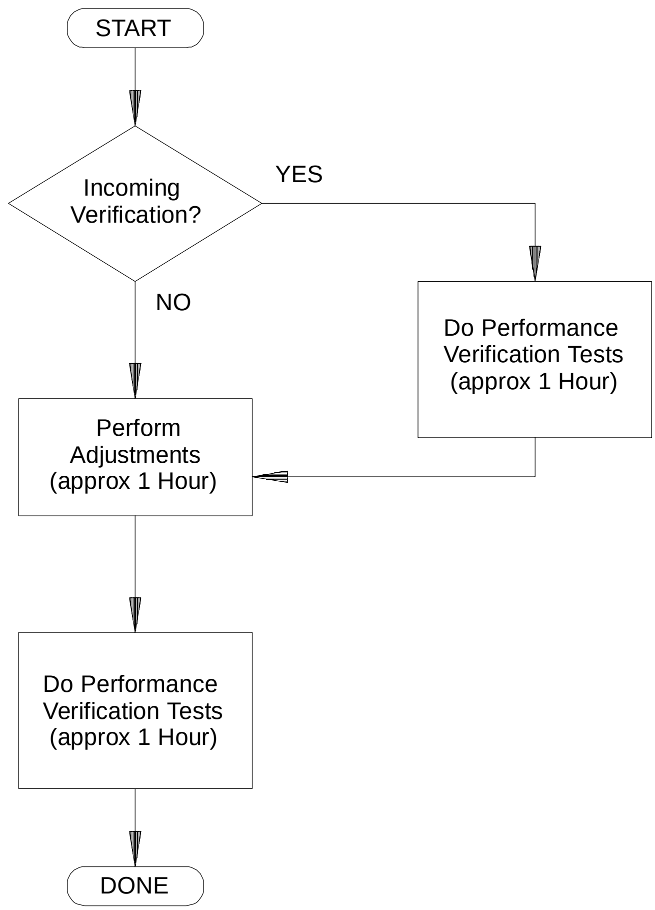
Whatever calibration interval you select, Agilent Technologies recommends that complete re-adjustment should always be performed at the calibration interval. This will assure that the Agilent 33220A will remain within specification for the next calibration interval. This criteria for re-adjustment provides the best long-term stability. Performance data measured using this method can be used to extend future calibration intervals.

Use the Calibration Count (see page 75) to verify that all adjustments have been performed.

4

Time Required for Calibration

The Agilent 33220A can be automatically calibrated under computer control. With computer control you can perform the complete calibration procedure and performance verification tests in approximately 30 minutes once the instrument is warmed-up (see “Test Considerations” on page 59). Manual adjustments and verifications, using the recommended test equipment, will take approximately 2 hours.



Automating Calibration Procedures

You can automate the complete verification and adjustment procedures outlined in this chapter if you have access to programmable test equipment. You can program the instrument configurations specified for each test over the remote interface. You can then enter read-back verification data into a test program and compare the results to the appropriate test limit values.

You can also adjust the instrument from the remote interface. Remote adjustment is similar to the local front-panel procedure. You can use a computer to perform the adjustment by first selecting the required function and range. The calibration value is sent to the instrument and then the calibration is initiated over the remote interface. The instrument must be unsecured prior to initiating the calibration procedure.

For further information on programming the instrument, see chapters 3 and 4 in the *Agilent 33220A User's Guide*.

4

Recommended Test Equipment

The test equipment recommended for the performance verification and adjustment procedures is listed below. If the exact instrument is not available, substitute calibration standards of equivalent accuracy.

Instrument	Requirements	Recommended Model	Use*
Digital Multimeter (DMM)	ac volts, true rms, ac coupled accuracy: ±0.02% to 1 MHz dc volts accuracy: 50 ppm resolution: 100 µV Resistance Offset-compensated accuracy: ±0.1Ω	Agilent 3458A	Q, P, T
Power Meter	100 kHz to 100 MHz 1 µW to 100 mW (–30 dBm to +20 dBm) accuracy: 0.02 dB resolution: 0.01 dB	Agilent E4418B	Q, P, T
Power Head	100 kHz to 100 MHz 1 µW to 100 mW (–30 dBm to +20 dBm)	Agilent 8482A	Q, P, T
Attenuator	–20 dB	HP 8491C Opt 020	Q, P, T
Frequency Meter	accuracy: 0.1 ppm	Agilent 53131A Opt 010 (high stability)	Q, P, T
Oscilloscope	500 MHz 2 Gs/second 50Ω input termination	Agilent 54825A	T
Adapter	BNC (m) to dual-banana (f)	Agilent 11001-60001	Q, P, T
Adapter	N type (m) to BNC (m)	Agilent E9623A	Q, P, T
Cable (2 required)	Dual banana (m) to dual banana (m)	Agilent 11000-60000	Q, P, T
Cable	RG58, BNC (m) to dual banana	Agilent 11001-60001	Q, P, T
Cable	RG58, BNC (m) to BNC (m)	Agilent 11170C	Q, P, T

* Q = Quick Verification   P = Performance Verification   T = Troubleshooting

Test Considerations

For optimum performance, all procedures should comply with the following recommendations:

- Assure that the calibration ambient temperature is stable and between 18 °C and 28 °C. Ideally, the calibration should be performed at 23 °C ±1 °C.
- Assure ambient relative humidity is less than 80%.
- Allow a 1-hour warm-up period before verification or adjustment.
- Keep the measurement cables as short as possible, consistent with the impedance requirements.
- Use only RG-58 or equivalent 50Ω cable.

Performance Verification Tests

Use the Performance Verification Tests to verify the measurement performance of the instrument. The performance verification tests use the instrument's specifications listed in the "Specifications" chapter beginning on page 13.

You can perform three different levels of performance verification tests:

- **Self-Test** A series of internal verification tests that give high confidence that the instrument is operational.
- **Quick Verification** A combination of the internal self-tests and selected verification tests.
- **Performance Verification Tests** An extensive set of tests that are recommended as an acceptance test when you first receive the instrument or after performing adjustments.

Self-Test

A brief power-on self-test occurs automatically whenever you turn on the instrument. This limited test assures that the instrument is operational.

To perform a complete self-test:

1 Press [Utility] on the front panel.

2 Select the **Self Test** softkey from the “Test/Cal” menu.

A complete description of the self-tests can be found in chapter 6. The instrument will automatically perform the complete self-test procedure when you release the key. The self-test will complete in approximately 15 seconds.

- If the self-test is successful, “Self Test Passed” is displayed on the front panel.
- If the self-test fails, “Self Test Failed” and an error number are displayed.
  If repair is required, see chapter 6, “Service,” for further details.

Quick Performance Check

The quick performance check is a combination of internal self-test and an abbreviated performance test (specified by the letter **Q** in the performance verification tests). This test provides a simple method to achieve high confidence in the instrument's ability to functionally operate and meet specifications. These tests represent the absolute minimum set of performance checks recommended following any service activity. Auditing the instrument’s performance for the quick check points (designated by a **Q**) verifies performance for normal accuracy drift mechanisms. This test does not check for abnormal component failures.

To perform the quick performance check, do the following:

1 Perform a complete self-test. A procedure is given on page 61.

2 Perform only the performance verification tests indicated with the letter **Q**.

3 If the instrument fails the quick performance check, adjustment or repair is required.

Performance Verification Tests

The performance verification tests are recommended as acceptance tests when you first receive the instrument. The acceptance test results should be compared against the specifications given in chapter 1. After acceptance, you should repeat the performance verification tests at every calibration interval.

If the instrument fails performance verification, adjustment or repair is required.

Adjustment is recommended at every calibration interval. If adjustment is not made, you must guard band, using no more than 80% of the specifications listed in chapter 1, as the verification limits.

Special Note:
Amplitude and Flatness Verification Procedures

Measurements made during the AC Amplitude (high-impedance) Verification procedure (see page 66) are used as reference measurements in the flatness verification procedures (beginning on page 67). Additional reference measurements and calculated references are used in the flatness verification procedures. Photo-copy and use the table on page 64 to record these reference measurements and perform the calculations.

The flatness verification procedures use both a DMM and a Power Meter to make the measurements. To correct the difference between the DMM and Power Meter measurements, the Power Meter reference measurement level is adjusted to set the 0.00 dB level to the DMM measurement made at 1 kHz. The flatness error of the DMM at 100 KHz is used to set the required 0.00 dB reference.

The instrument internally corrects the difference between the high-Z input of the DMM and the 50 Ω input of the Power Meter when setting the output level.

The reference measurements must also be converted from Vrms (made by the DMM) to dBm (made by the Power Meter).

The equation used for the conversion from Vrms (High-Z) to dBm (at 50 Ω) is as follows:

$$\text{Power (dBm)} = 10 \log(5.0 * V_{rms}^2)$$

Flatness measurements for the –10 db, –20d B, and –30 dB attenuator ranges are verified as a part of the 0 dB verification procedure. No separate verification procedure is given for these ranges.

4

4

Amplitude and Flatness Verification Worksheet

1. Enter the following measurements (from procedure on page 66).

1kHz_0dB_reference = ___________________________ Vrms

1kHz_10dB_reference = ___________________________ Vrms

1kHz_20dB_reference = ___________________________ Vrms

2. Calculate the dBm value of the rms voltages.

1kHz_0dB_reference_dBm = 10 * log(5.0 * $1kHz\_0dB\_reference^2$)

= ___________________________ dBm

1kHz_10dB_reference_dBm = 10 * log(5.0 * $1kHz\_10dB\_reference^2$)

= ___________________________ dBm

1kHz_20dB_reference_dBm = 10 * log(5.0 * $1kHz\_20dB\_reference^2$)

= ___________________________ dBm

3. Enter the following measurements (from the procedure on page 67).

100kHz_0dB_reference = ___________________________ Vrms

100kHz_10dB_reference = ___________________________ Vrms

100kHz_20dB_reference = ___________________________ Vrms

4. Calculate the dBm value of the rms voltages.

100kHz_0dB_reference_dBm = 10 * log(5.0 * $100kHz\_0dB\_reference^2$)

= ___________________________ dBm

100kHz_10dB_reference_dBm = 10 * log(5.0 * $100kHz\_10dB\_reference^2$)

= ___________________________ dBm

100kHz_20dB_reference_dBm = 10 * log(5.0 * $100kHz\_20dB\_reference^2$)

= ___________________________ dBm

5. Calculate the offset values.

100kHz_0dB_offset = *100kHz_0dB_reference_dBm – 1kHz_0dB_reference_dBm*

= ___________________________ dBm (use on page 68)

100kHz_10dB_offset = *100kHz_10dB_reference_dBm – 1kHz_10dB_reference_dBm*

= ___________________________ dBm (use on page 70)

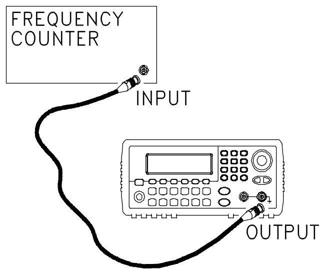
100kHz_20dB_offset = *100kHz_20dB_reference_dBm – 1kHz_20dB_reference_dBm*

= ___________________________ dBm (use on page 71)

Internal Timebase Verification

This test verifies the output frequency accuracy of the instrument. All output frequencies are derived from a single generated frequency.

1 Connect a frequency counter as shown below (the frequency counter input should be terminated at 50 Ω).



2 Set the instrument to the output described in the table below and measure the output frequency. *Be sure the instrument output is enabled*.

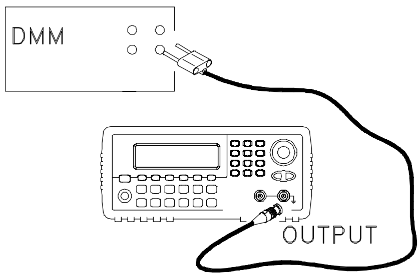
	Agilent 33220A			Measurement	
	Function	Amplitude	Frequency	Nominal	Error
Q	Sine Wave	1.00 Vpp	10.000,000,0 MHz	10.000 MHz	**± 10 Hz**

3 Compare the measured frequency to the test limits shown in the table.

AC Amplitude (high-impedance) Verification

This procedure checks the ac amplitude output accuracy at a frequency of 1 kHz, and establishes reference measurements for the higher frequency flatness verification procedures.

1 Set the DMM to measure Vrms Volts. Connect the DMM as shown below.



2 Set the instrument to each output described in the table below and measure the output voltage with the DMM. *Press* [Utility] *to set the output impedance to High–Z. Be sure the output is enabled.*

	Agilent 33220A				Measurement	
	Output Setup	Function	Frequency	Amplitude	Nominal	Error*
Q	High Z	Sine Wave	1.000 kHz	20.0 mVrms	0.020 Vrms	**± 0.00091 Vrms**
Q	High Z	Sine Wave	1.000 kHz	67.0 mVrms	0.067 Vrms	**± 0.00138 Vrms**
Q	High Z	Sine Wave	1.000 kHz	200.0 mVrms	0.200 Vrms	**± 0.00271 Vrms**
Q	High Z	Sine Wave	1.000 kHz	670.0 mVrms	0.670 Vrms [1]	**± 0.00741 Vrms**
Q	High Z	Sine Wave	1.000 kHz	2.000 Vrms	2.0000 Vrms [2]	**± 0.0207 Vrms**
Q	High Z	Sine Wave	1.000 kHz	7.000 Vrms	7.000 Vrms [3]	**± 0.0707 Vrms**
Q	High Z	Square Wave [4]	1.000 kHz	900.0 mVrms	0.900 Vrms	**± 0.0100 Vrms**

* Based upon 1% of setting ±1 mVpp (50 Ω); converted to Vrms for High–Z.
[1] Enter the measured value on the worksheet (page 64) as *1kHz_0dB_reference*.
[2] Enter the measured value on the worksheet (page 64) as *1kHz_10dB_reference*.
[3] Enter the measured value on the worksheet (page 64) as *1kHz_20dB_reference*.
[4] Square wave amplitude accuracy is not specified. This measurement and error may be used as a guideline for typical operation.

3 Compare the measured voltage to the test limits shown in the table.

Low Frequency Flatness Verification

This procedure checks the AC amplitude flatness at 100 kHz using the reference measurements recorded in the Amplitude and Flatness Verification Worksheet. These measurements also establish an error value used to set the power meter reference. The transfer measurements are made at a frequency of 100 kHz using both the DMM and the power meter.

1 Set the DMM to measure ac Volts. Connect the DMM as shown in the figure on page 66.

2 Set the instrument to each output described in the table below and measure the output voltage with the DMM. *Press* Utility *to set the output impedance to High-Z. Be sure the output is enabled.*

	Agilent 33220A				Measurement	
	Output Setup	Function	Frequency	Amplitude	Nominal	Error
Q	High Z	Sine Wave	100.000 kHz	670.0 mVrms	0.670 Vrms [1]	**± 0.0067 Vrms**
Q	High Z	Sine Wave	100.000 kHz	2.000 Vrms	2.000 Vrms [2]	**± 0.020 Vrms**
Q	High Z	Sine Wave	100.000 kHz	7.000 Vrms	7.000 Vrms [3]	**± 0.070 Vrms**

[1] Enter the measured value on the worksheet (page 64) as *100kHz_0dB_reference.*

[2] Enter the measured value on the worksheet (page 64) as *1k00Hz_10dB_reference.*

[3] Enter the measured value on the worksheet (page 64) as *100kHz_20dB_reference.*

3 Compare the measured voltage to the test limits shown in the table.

4 You have now recorded all the required measurements on the worksheet (page 64). Complete the worksheet by making all the indicated calculations.

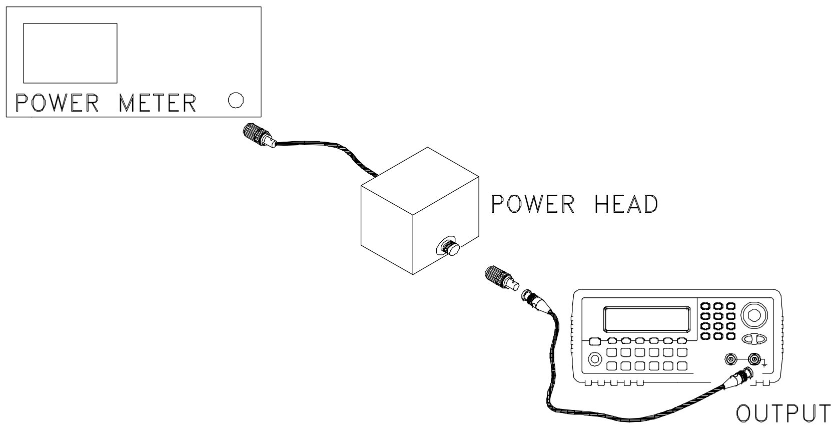
4

4

0 dB Range Flatness Verification

This procedure checks the high frequency ac amplitude flatness above 100 kHz on the 0dB attenuator range.

1 Connect as power meter to measure the output amplitude of the instrument as shown below.



2 Set the power meter reference level to equal *100kHz_0dB_offset*. This sets the power meter to directly read the flatness error specification. *100kHz_0dB_offset* is calculated on the Amplitude and Flatness Verification Worksheet.

3 Set the instrument to each output described in the table below and measure the output amplitude with the power meter. *Press* Utility *to set the output impedance to 50 Ω. Be sure the output is enabled.*

	Agilent 33220A				Measurement	
	Output Setup	Function	Amplitude	Frequency	Nominal	Error
Q	50 Ω	Sine Wave	+3.51 dBm	100.000 kHz	0 dBm	**± 0.1 dB**
	50 Ω	Sine Wave	+3.51 dBm	200.000 kHz	0 dBm	**± 0.15 dB**
	50 Ω	Sine Wave	+3.51 dBm	500.000 kHz	0 dBm	**± 0.15 dB**
	50 Ω	Sine Wave	+3.51 dBm	2.000 MHz	0 dBm	**± 0.15 dB**
	50 Ω	Sine Wave	+3.51 dBm	3.000 MHz	0 dBm	**± 0.3 dB**
Q	50 Ω	Sine Wave	+3.51 dBm	4.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+3.51 dBm	5.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+3.51 dBm	8.000 MHz	0 dBm	**± 0.3 dB**
Q	50 Ω	Sine Wave	+3.51 dBm	10.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+3.51 dBm	12.500 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+3.51 dBm	14.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+3.51 dBm	16.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+3.51 dBm	17.500 MHz	0 dBm	**± 0.3 dB**
Q	50 Ω	Sine Wave	+3.51 dBm	20.000 MHz	0 dBm	**± 0.3 dB**

4 Compare the measured output to the test limits shown in the table.

+10 dB Range Flatness Verification

This procedure checks the high frequency ac amplitude flatness above 100 kHz on the +10dB attenuator range.

1 Connect as power meter to measure the output amplitude of the instrument as shown on page 68.

2 Set the power meter reference level to equal to the calculated *100kHz_10dB_offset* value. This sets the power meter to directly read the flatness error specification. *100kHz_10dB_offset* is calculated on the Amplitude and Flatness Verification Worksheet.

3 Set the instrument to each output described in the table below and measure the output amplitude with the power meter. *Press* Utility *to set the output impedance to 50 Ω. Be sure the output is enabled.*

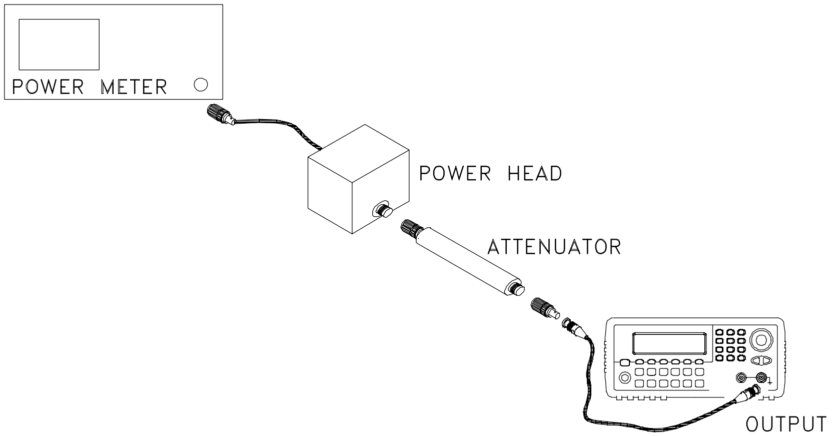
	Agilent 33220A				Measurement	
	Output Setup	Function	Amplitude	Frequency	Nominal	Error
Q	50 Ω	Sine Wave	+13.00 dBm	100.000 kHz	0 dBm	**± 0.1 dB**
	50 Ω	Sine Wave	+13.00 dBm	200.000 kHz	0 dBm	**± 0.15 dB**
	50 Ω	Sine Wave	+13.00 dBm	500.000 kHz	0 dBm	**± 0.15 dB**
	50 Ω	Sine Wave	+13.00 dBm	2.000 MHz	0 dBm	**± 0.15 dB**
	50 Ω	Sine Wave	+13.00 dBm	3.000 MHz	0 dBm	**± 0.3 dB**
Q	50 Ω	Sine Wave	+13.00 dBm	4.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+13.00 dBm	5.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+13.00 dBm	8.000 MHz	0 dBm	**± 0.3 dB**
Q	50 Ω	Sine Wave	+13.00 dBm	10.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+13.00 dBm	12.500 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+13.00 dBm	14.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+13.00 dBm	16.000 MHz	0 dBm	**± 0.423 dB**
	50 Ω	Sine Wave	+13.00 dBm	17.500 MHz	0 dBm	**± 0.423 dB**
Q	50 Ω	Sine Wave	+13.00 dBm	20.000 MHz	0 dBm	**± 0.423 dB**

4 Compare the measured output to the test limits shown in the table.

+20 dB Range Flatness Verification

This procedure checks the high frequency ac amplitude flatness above 100 kHz on the +20dB attenuator range.

1 Connect as power meter to measure the output voltage of the instrument as shown below.



2 Set the power meter reference level to equal to the calculated *100kHz_20dB_offset* value. This sets the power meter to directly read the flatness error specification. *100kHz_20dB_offset* is calculated on the Amplitude and Flatness Verification Worksheet.

Caution *Most power meters will require an attenuator or special power head to measure the +20 dB output.*

3 Set the instrument to each output described in the table below and measure the output amplitude with the power meter. *Press* [Utility] *to set the output impedance to 50 Ω. Be sure the output is enabled*

	Agilent 33220A				Measurement	
	Output Setup	Function	Amplitude	Frequency	Nominal	Error
Q	50 Ω	Sine Wave	+23.90 dBm	100.000 kHz	0 dBm	**± 0.1 dB**
	50 Ω	Sine Wave	+23.90 dBm	200.000 kHz	0 dBm	**± 0.15 dB**
	50 Ω	Sine Wave	+23.90 dBm	500.000 kHz	0 dBm	**± 0.15 dB**
	50 Ω	Sine Wave	+23.90 dBm	2.000 MHz	0 dBm	**± 0.15 dB**
	50 Ω	Sine Wave	+23.90 dBm	3.000 MHz	0 dBm	**± 0.3 dB**
Q	50 Ω	Sine Wave	+23.90 dBm	4.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+23.90 dBm	5.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+23.90 dBm	8.000 MHz	0 dBm	**± 0.3 dB**
Q	50 Ω	Sine Wave	+23.90 dBm	10.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+23.90 dBm	12.500 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+23.90 dBm	14.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+23.90 dBm	16.000 MHz	0 dBm	**± 0.3 dB**
	50 Ω	Sine Wave	+23.90 dBm	17.500 MHz	0 dBm	**± 0.3 dB**
Q	50 Ω	Sine Wave	+23.90 dBm	20.000 MHz	0 dBm	**± 0.3 dB**

4 Compare the measured output to the test limits shown in the table.

Calibration Security

This feature allows you to enter a security code to prevent accidental or unauthorized adjustments of the instrument. When you first receive your instrument, it is secured. Before you can adjust the instrument, you must unsecure it by entering the correct security code.

See "To Unsecure and Secure for Calibration", on page 43 for a procedure to enter the security code from the front panel. *Use the* CAL:SEC:STAT ON *command to enter the security code using the remote interface.*

- The security code is set to **AT33220A** when the instrument is shipped from the factory. The security code is stored in non-volatile memory, and does not change when power has been off, after a Factory Reset (*RST command), or after an Instrument Preset (SYSTem:PRESet command).
- The security code may contain up to 12 alphanumeric characters. The first character must be a letter, but the remaining characters can be letters, numbers, or an underscore (_). You do not have to use all 12 characters but the first character must always be a letter.

Note

If you forget your security code, you can disable the security feature by applying a temporary short inside the instrument as described on the following page.

4

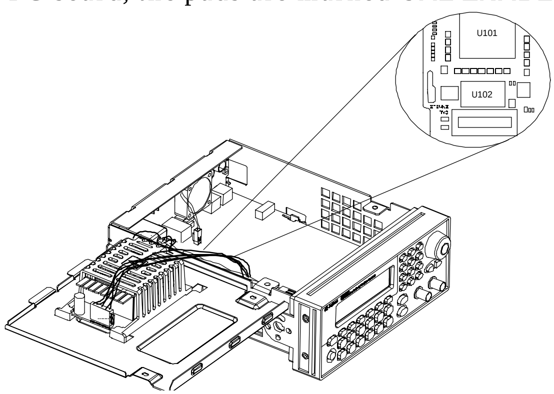
To Unsecure the Instrument Without the Security Code

To unsecure the instrument without the correct security code, follow the steps below. See “To Unsecure and Secure for Calibration” on page 43. See “Electrostatic Discharge (ESD) Precautions” on page 121 before beginning this procedure.

1 Disconnect the power cord and all input connections.

2 Disassemble the instrument using the “General Disassembly Procedure” on page 128.

3 Apply a temporary short between the two exposed metal pads on the A1 assembly. The general location is shown in the figure below. On the PC board, the pads are marked **CAL ENABLE**.



4 Apply power and turn on the instrument.

WARNING *Be careful not to touch the power line connections or high voltages on the power supply module. Power is present even if the instrument is turned off.*

5 The display will show the message “Calibration security has been disabled”. The instrument is now unsecured.

6 Turn off the instrument and remove the power cord.

7 Reassemble the instrument.

Now you can enter a new security code, see “To Unsecure and Secure for Calibration”, on page 43. Be sure you record the new security code.

Calibration Message

The instrument allows you to store one message in calibration memory. For example, you can store the date when the last calibration was performed, the date when the next calibration is due, the instrument's serial number, or even the name and phone number of the person to contact for a new calibration.

You can **record** a calibration message only from the remote interface and only when the instrument is unsecured. Use the CAL:STRING <*message*> command.

You can **read** the message from either the front-panel or over the remote interface. You can read the calibration message whether the instrument is secured or unsecured. Reading the calibration message from the front panel is described on "To Read the Calibration Information", on page 42. Use the CAL:STRING? query to read the message over the remote interface.

Calibration Count

You can query the instrument to determine how many calibrations have been performed. Note that your instrument was calibrated before it left the factory. When you receive your instrument, read the count to determine its initial value. The count value increments by one for each calibration point, and a complete calibration may increase the value by many counts. See "To Read the Calibration Information", on page 42. Use the CAL:COUNT? query to read the count over the remote interface.

General Calibration/Adjustment Procedure

The following procedure is the recommended method to complete an instrument calibration. This procedure is an overview of the steps required for a complete calibration. Additional details for each step in this procedure are given in the appropriate sections of this chapter.

1 Read “Test Considerations” on page 59.

2 Unsecure the instrument for calibration (see page 73).

3 Perform the verification tests, beginning on page page 60, to characterize the instrument (incoming data).

4 Press Utility on the front panel.

5 Select the “Test / Cal” menu.

6 Select **Perform Cal**.

7 Enter the **Setup Number** for the procedure being performed. The default setup number is “1” and, from the front panel, the number will increment as the procedures are performed.

8 Select **BEGIN**.

9 For setups that require an input, adjust the value shown in the display to the measured value and select **ENTER VALUE**.

10 The setup will automatically advance to the next required value.

Note To cancel the adjustment procedure, select **CANCEL STEP**. The display will return to the setup number entry.

11 When finished, select **END CAL**.

12 Secure the instrument against calibration.

13 Note the new security code and calibration count in the instrument’s maintenance records.

Aborting a Calibration in Progress

Sometimes it may be necessary to abort a calibration after the procedure has already been initiated. You can abort a calibration at any time by turning off the power. When performing a calibration from the remote interface, you can abort a calibration by issuing a remote interface device clear message followed by a *RST.

The instrument stores calibration constants at the end of each adjustment procedure. If you lose power, or otherwise abort an adjustment in progress, you will only need to perform the interrupted adjustment procedure again.

Caution *If power is lost when the instrument is attempting to write new calibration constants to EEPROM, you may lose all calibration constants for the function. Typically, upon re-applying power, the instrument will report error "-313, Calibration Memory Lost".*

Sequence of Adjustments

The adjustment sequence shown in the following sections of this chapter is recommended to minimize the number of test equipment set-up and connection changes.

You may perform individual adjustments as necessary. Setups 1 through 7 **must** be performed in order and **must** be performed **before** any other setup procedure.

4

Self-Test

Self-Test is performed as the first step to ensure the instrument is in working order before beginning any additional adjustments.

Note Be sure to follow the requirements listed in “Test Considerations” on page 59 before beginning any adjustments.

1 Press [Utility] on the front panel. Select **Perform Cal** on the “Test / Cal” menu. Enter setup number “1” and select **BEGIN**.

Setup	
1	Performs the Self-test. The Main Output is disabled during test.

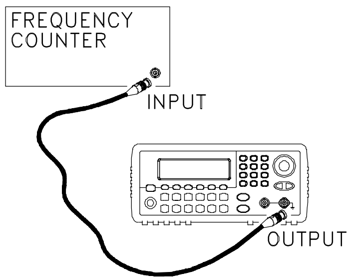
2 If the instrument fails any self-test, you must repair the instrument before continuing the adjustment procedures.

Note The self-test procedure takes approximately 15 seconds to complete.

Frequency (Internal Timebase) Adjustment

The function generator stores a calibration constant that sets the VCXO to output exactly 10MHz.

1 Set the frequency counter resolution to better than 0.1 ppm and the input termination to 50 Ω (if your frequency counter does not have a 50 Ω input termination, you must provide an external termination). Make the connections shown below.



2 Use a frequency counter to measure the output frequency for each setup in the following table.

	Nominal Signal		
Setup	Frequency	Amplitude	
2	<10 MHz	1 Vpp	Output frequency is slightly less than 10MHz
3	>10 MHz	1 Vpp	Output frequency is slightly more than 10MHz
4	~10 MHz	1 Vpp	Output frequency should be near 10MHz
5*	10 MHz	1 Vpp	Output frequency should be 10MHz ±1ppm

* Constants are stored after completing this setup.

3 Using the numerical keypad or knob, adjust the displayed frequency at each setup to match the measured frequency. Select **ENTER VALUE**.

4 After performing setup 5:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform “Internal Timebase Verification”, on page 65.

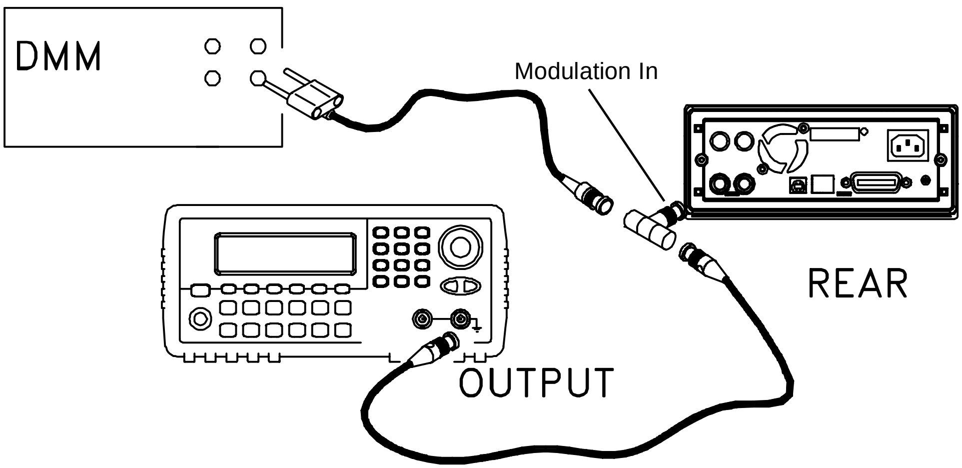
b. If you are making all the adjustments and then verifying the instrument’s performance, continue with the next procedure in this chapter.

4

Internal ADC Adjustment

The function generator stores calibration constants related to the gain and offset of the internal ADC. Setup 6 **must** always be performed **before** any other adjustments are attempted. The internal ADC is then used as a source for the calibration constants generated in setup 7.

1 Make the connections as shown below.



2 Set the DMM to display 5 1/2 digits and measure the dc value. Record the measurement.

3 Enter the following setup and use the numeric keypad or knob to enter the measured value of the dc source.

	Nominal Signal	
Setup	DC level	
6*	~1.1 Vdc ±10%	Calibrates the internal ADC.

* Constants are stored after completing this setup.

Note This setup requires approximately 15 seconds to complete.

4 Disconnect all cables from the rear panel Modulation In connector.

5 Enter and begin the following setup.

Setup	
7*	Self-calibration. The output is disabled.

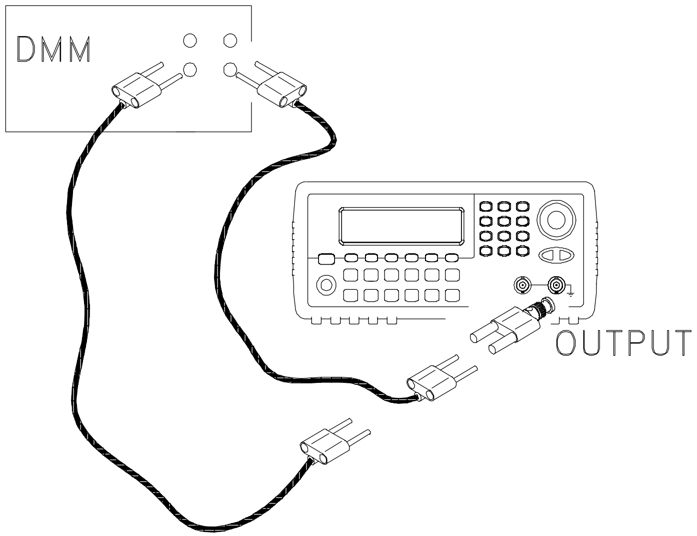
* Constants are stored after completing this setup.

6 There are no specific operational verification tests for setups 6 and 7 since the constants generated affect almost all behavior of the instrument. Continue with the next adjustment procedure in this chapter.

Output Impedance Adjustment

The function generator stores calibration constants for the output impedance. The output impedance constants are generated with and without the distortion filter and using all five attenuator paths.

1 Set the DMM to measure offset-compensated, four-wire Ohms. Set the DMM to use 100 NPLC integration. Make the connections as shown below.



2 Use the DMM to make a resistance measurement at the front panel Output connector for each setup in the following table. The expected measured value is approximately 50 Ω.

Setup	
8*	-30dB range
9*	-20dB range
10*	-10dB range
11*	0dB range
12*	+10dB range

* Constants are stored after completing this setup.

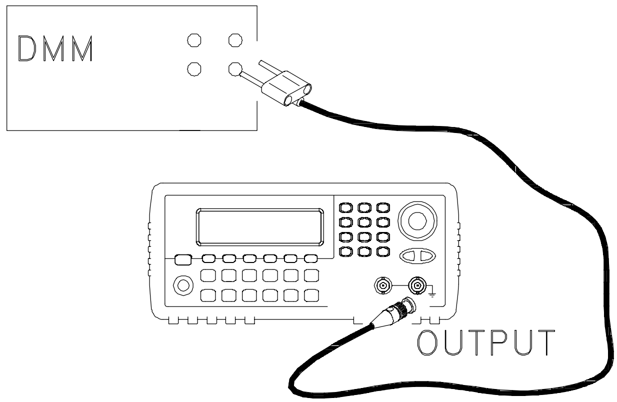
3 Using the numeric keypad or knob, adjust the displayed impedance at each setup to match the measured impedance. Select **ENTER VALUE**.

4 There are no specific operational verification tests for Output Impedance. Continue with the next adjustment procedure in this chapter.

AC Amplitude (high-impedance) Adjustment

The function generator stores a calibration constant for each high-impedance attenuator path. The gain coefficient of each path is calculated using two measurements; one with the waveform DAC at + output and one with waveform DAC at – output. The setups, therefore, must be performed in pairs.

1 Connect the DMM as shown below.



2 Use the DMM to measure the dc voltage at the front-panel Output connector for each setup in the following table.

	Nominal Signal	
Setup	DC level	
13	+0.015 V	Output of -30dB range
14*	-0.015 V	Output of -30dB range
15	+0.05 V	Output of -20dB range
16*	-0.05 V	Output of -20dB range
17	+0.15 V	Output of -10dB range
18*	-0.15 V	Output of -10dB range
19	+0.50 V	Output of 0dB range
20*	-0.50 V	Output of 0dB range
21	+0.15 V	Output of -10dB range (Amplifier In)
22*	-0.15 V	Output of -10dB range (Amplifier In)
23	+0.50 V	Output of 0dB range (Amplifier In)
24*	-0.50 V	Output of 0dB range (Amplifier In)
25	+1.5 V	Output of +10dB range (Amplifier In)
26*	-1.5 V	Output of +10dB range (Amplifier In)
27	+5 V	Output of +20dB range (Amplifier In)
28*	-5 V	Output of +20dB range (Amplifier In)

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**. (Entered values are rounded to the nearest 100 μV).

4 After performing setup 28:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform “AC Amplitude (high-impedance) Verification”, on page 66.

b. If you are making all the adjustments and then verifying the instrument’s performance, continue with the next procedure in this chapter.

4

Low Frequency Flatness Adjustment

The Low Frequency Flatness adjustment calculates the flatness response of 3 attenuator paths with the Elliptical filter and 2attenuator paths with the Linear Phase filter.

1 Set the DMM to measure Vrms. Make the connections shown on page 83.

2 Use the DMM to measure the output voltage for each of the setups in the table below.

	Nominal Signal		
Setup	Frequency	Amplitude	
29*	1 kHz	0.56 Vrms	Flatness for 0dB, Elliptical Filter
30*	100 kHz	0.56 Vrms	Flatness for 0dB, Elliptical Filter
31*	1 kHz	0.56 Vrms	Flatness for 0dB, Linear Phase Filter
32*	100 kHz	0.56 Vrms	Flatness for 0dB, Linear Phase Filter
33*	1 kHz	1.7 Vrms	Flatness for +10dB, Elliptical Filter
34*	100 kHz	1.7 Vrms	Flatness for +10dB, Elliptical Filter
35*	1 kHz	5.6 Vrms	Flatness for +20dB, Elliptical Filter
36*	100 kHz	5.6 Vrms	Flatness for +20dB, Elliptical Filter
37*	1 kHz	5.6 Vrms	Flatness for +20dB, Linear Phase Filter
38*	100 kHz	5.6 Vrms	Flatness for +20dB, Linear Phase Filter

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.

4 After performing setup 38:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform “Low Frequency Flatness Verification”, on page 67.

b. If you are making all the adjustments and then verifying the instrument’s performance, continue with the next procedure in this chapter.

4

0 dB Range Flatness Adjustments

1 Connect the power meter as shown on page 88.

2 Use the power meter to measure the output amplitude for each of the setups in the table below.

Note Setup 39 establishes the power meter reference for all the remaining setups in this table. You must always perform setup 39 before any of the following setups.

	Nominal Signal			
Setup	Frequency	Amplitude		
39*	100 kHz	0.28 Vrms	2 dBm	Power Meter Reference for 0dB Range
40*	200 kHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
41*	500 kHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
42*	1.5 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
43*	3 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
44*	4 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
45*	6 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
46*	8 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
47*	10.1 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
48*	12.5 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
49*	14.1 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
50*	16.1 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
51*	17.5 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter
52*	19.9 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Elliptical Filter

* Constants are stored after completing this setup.

This table is continued on the next page.

	Nominal Signal			
Setup	Frequency	Amplitude		
53*	200 kHz	0.28 Vrms	2 dBm	Flatness for 0dB, Linear Phase Filter
54*	500 kHz	0.28 Vrms	2 dBm	Flatness for 0dB, Linear Phase Filter
55*	1.5 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Linear Phase Filter
56*	3.0 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Linear Phase Filter
57*	4 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Linear Phase Filter
58*	6 MHz	0.28 Vrms	2 dBm	Flatness for 0dB, Linear Phase Filter
59			0 dBm	*Setup not used for this instrument*
60*			0 dBm	*Setup not used for this instrument*

* Constants are stored after completing this setup.

Note

Setups 59 and 60 are not used in this instrument. From the front panel, press the Enter softkey to advance the setup from 59 to 61. No number entry is required.

3 Using the numeric keypad or knob, adjust the displayed amplitude at each setup to match the measured amplitude (in dBm).
Select **ENTER VALUE**.

4 After performing setup 58:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform "0 dB Range Flatness Verification", on page 68.

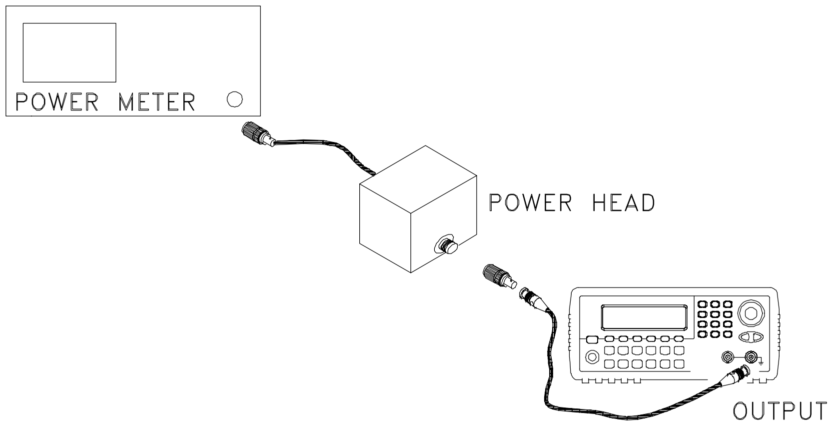
b. If you are making all the adjustments and then verifying the instrument's performance, continue with the next procedure in this chapter.

4

+10 dB Range Flatness Adjustments

Note The Linear Phase path is not adjusted. It is approximated using the other path's values.

1 Connect the power meter as shown below.



2 Use a power meter to measure the output amplitude for each of the setups in the table on the next page.

Note Setup 61 establishes the power meter reference for all the remaining setups in this table. You must always perform setup 61 before any of the following setups.

	Nominal Signal			
Setup	Frequency	Amplitude		
61*	100 kHz	0.9 Vrms	12 dBm	Power Meter Reference for +10dB Range
62*	200 kHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
63*	500 kHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
64*	1.5 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
65*	3 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
66*	4 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
67*	6 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
68*	8 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
69*	10.1 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
70*	12.5 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
71*	14.1 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
72*	16.1 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
73*	17.5 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter
74*	19.9 MHz	0.9 Vrms	12 dBm	Flatness for +10dB, Elliptical Filter

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed amplitude at each setup to match the measured amplitude (in dBm). Select **ENTER VALUE**.

4 After performing setup 74:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform "+10 dB Range Flatness Verification", on page 70.

b. If you are making all the adjustments and then verifying the instrument's performance, continue with the next procedure in this chapter.

4

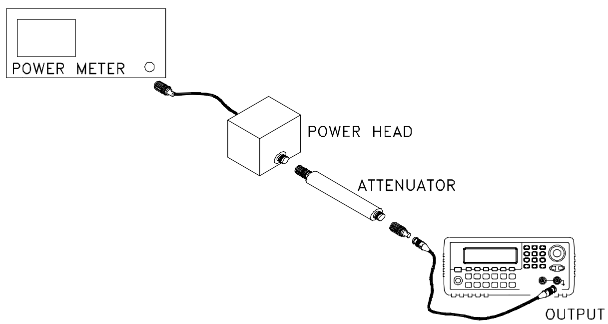
+20 dB Range Flatness Adjustment

Caution *Most power meters will require an attenuator (–20 dB) or special power head to measure the +20 dB output.*

Be sure to correct the measurements for the specifications of the attenuator you use. For example, if the nominal attenuator value is –20 dB at the specified frequency, you must add 20 dB to the power meter reading before entering the value.

4

1 Make the connections as shown below:



2 Use the power meter to measure the output amplitude for each of the setups in the table on the next page.

Note Setup 75 establishes the power meter reference for all the remaining setups in this table. You must always perform setup 75 before any of the following setups.

	Nominal Signal			
Setup	Frequency	Amplitude		
75*	100 kHz	2.8 Vrms	22 dBm	Power Meter Reference
76*	200 kHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
77*	500 kHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
78*	1.5 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
79*	3 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
80*	4 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
81*	6 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
82*	8 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
83*	10.1 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
84*	12.5 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
85*	14.1 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
86*	16.1 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
87*	17.5 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
88*	19.9 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Elliptical Filter
89*	200 kHz	2.8 Vrms	22 dBm	Flatness for +20dB, Linear Phase Filter
90*	500 kHz	2.8 Vrms	22 dBm	Flatness for +20dB, Linear Phase Filter
91*	1.5 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Linear Phase Filter
92*	3 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Linear Phase Filter
93*	4 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Linear Phase Filter
94*	6 MHz	2.8 Vrms	22 dBm	Flatness for +20dB, Linear Phase Filter

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed amplitude at each setup to match the measured amplitude (in dBm). Select **ENTER VALUE**.

4

4 After performing setup 94:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform “+20 dB Range Flatness Verification”, on page 71.

b. If you are making all the adjustments and then verifying the instrument’s performance, verify the output specifications of the instrument using the “Performance Verification Tests”, on page 60.

You have now completed the recommended adjustment procedures. Verification of the output specifications is recommended.

Calibration Errors

The following errors are failures that may occur during a calibration. System error messages are described in chapter 5 of the *Agilent 33220A User's Guide*. Self-test error messages are described beginning on page 124.

701 **Calibration error; security defeated by hardware jumper**
If you short the calibration secure jumper (CAL ENABLE) while turning ON the instrument, this error will occur indicating the security password has been overwritten. See "To Unsecure the Instrument Without the Security Code" on page 74 for details.

702 **Calibration error; calibration memory is secured**
A calibration cannot be performed when calibration memory is secured. See "To Unsecure and Secure for Calibration", on page 43 for a procedure to enter the security code from the front panel. Use the CAL:SEC:STAT ON command to enter the security code using the remote interface.

703 **Calibration error; secure code provided was invalid**
The security code specified was invalid.

706 **Calibration error; value out of range**
You have entered a value that was unexpected by the calibration firmware. For example, if a number is expected such a 50.XX ohms, and you enter 10 ohms, that number is outside the expected range of valid inputs.

707 **Calibration error; signal input is out of range**
Occurs during the ADC Adjustment, setup 6, if the 1 Volt input voltage is too high. May also occur during self-calibration (setup 7), run self-test to diagnose cause of problem.

850 **Calibration error; set up is invalid**
You have selected an invalid calibration setup number.

850 **Calibration error; set up is out of order**
Certain calibration steps require a specific beginning and ending sequence. You may not enter into the middle of a sequence of calibration steps.

4

5

Theory of Operation

Theory of Operation

This chapter provides descriptions of the circuitry shown on the schematics in chapter 9.

Block Diagram

The function generator's circuits may be divided into three main categories: power supplies, analog circuits, and digital circuits. The instrument is further divided into floating and earth referenced circuitry.

This discussion refers to the block diagram on page page 99.

The Main Processor U101 combines many instrument functions onto one custom IC. It interfaces directly with the GPIB and LAN interfaces, and through a controller chip with the USB interface. A 50 MHz crystal oscillator provides the clock signal for U101 operations. A 24 MHz clock is used for USB operations.

The Main Processor communicates with the Front Panel and performs the keyboard scanning. Serial data is used to write to the display. The cross-isolation communication with the Synthesis IC uses optically isolated serial data links.

The Synthesis IC is a gate array and performs most of instrument functions. This gate array has an on-board UART. A 50 MHz voltage-controlled-oscillator provides the main clock for the Synthesis IC and the Waveform DAC. The Synthesis IC implements clock generation, pulse generation, DDS and modulation functions, and sets the output waveform and function.

The system DAC outputs various control voltages that are multiplexed into track and hold circuits. These output voltages are used to correct the output waveform for various offsets, rise times, and calibration values. If present, the optional external timebase circuitry provides an input and output for an external time base. A Sync Out signal is available at the front panel.

Some of the output voltages are read back to the Synthesis IC via the System ADC. Here, voltages from various circuits in the instrument are multiplexed with the Modulation IN signal and measured by the Synthesis IC.

The 14–bit waveform DAC is loaded with data from the Synthesis IC. The output is then fed through one of two filters before being buffered and sent to the Main Output Circuitry.

A portion of the output sine wave is squared by a comparator and used to create a variable duty cycle signal used by the Synthesis IC to create the squarewave, pulse generator clock, and sync signals.

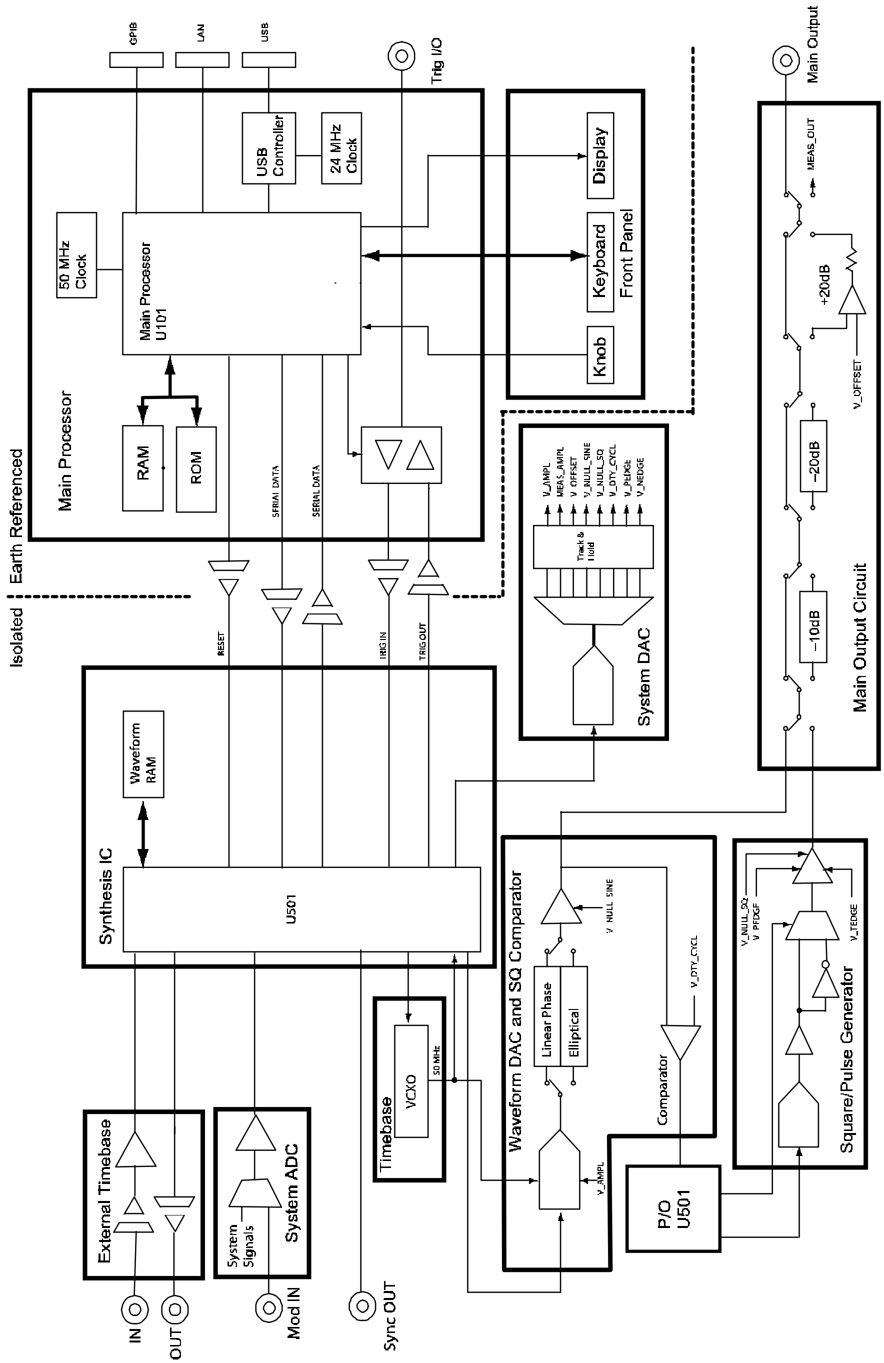
The squarewave DAC output is split into two opposite value signals and applied to a multiplexer. The output of this multiplexer is a square wave or pulse signal with the correct duty cycle. The rising edge and falling edge of the signal are adjusted and the signal is buffered and sent to the Main Output Circuit.

The Main Output circuit accepts one of two inputs; the sine/arb waveform or the squarewave/pulse waveform. Once selected, the signal can be applied to one or both attenuators and/or a +20 dB amplifier. The attenuators and amplifier are used to create the requested output signal amplitude.

The output is protected by a relay. When the relay is open, the instrument can read the value of the Main Output Circuit. The output relay is opened on user command, if a current overload is detected, or if a voltage over–range condition is found.

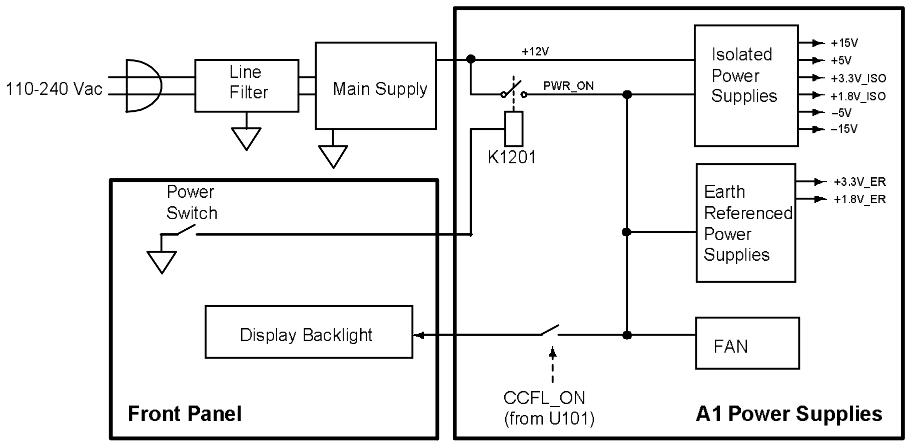
Conventions Used on Schematics and in this Discussion

Major signal and control lines are marked with a name in uppercase. If the name is followed by an ***** (for example, TRIG_SYNC*), the line is inverted logic. If the name is followed by a lowercase **e**, (for example, TRIGe), the line is the ECL-level version of a TLL or CMOS signal.


GPIB
LAN
USB
Trig I/O
Main Output
USB Controller
24 MHz Clock
50 MHz Clock
Main Processor U101
Display
Keyboard
Knob
Front Panel
RAM
ROM
Main Processor
Earth Referenced
Isolated
SERIAL DATA
SERIAL DATA
RESET
TRIG IN
TRIG OUT
V_AMPL
MEAS_AMPL
V_OFFSET
V_NULL_SINE
V_NULL_SQ
V_DTY_CYCL
V_PEDGE
V_NEDGE
Track & Hold
System DAC
MEAS_OUT
+20dB
V_OFFSET
−20dB
−10dB
Main Output Circuit
Waveform RAM
Synthesis IC
U501
V_NULL_SINE
Linear Phase
Elliptical
Waveform DAC and SQ Comparator
V_DTY_CYCL
Comparator
V_AMPL
V_NULL_SQ
V_PEDGE
V_TEDGE
Square/Pulse Generator
VCXO
50 MHz
Timebase
P/O U501
External Timebase
System Signals
System ADC
IN
OUT
Mod IN
Sync OUT

Power Supplies

The line input voltage is filtered and applied to the main power supply. The main power supply provides all power to the instrument. Secondary power supplies are contained on the main circuit board. The secondary power supplies include both isolated and earth-referenced supplies.



Main Power Supply

The main power supply is a switching supply. No schematic is given for this supply since it should be replaced as a unit. The main power supply provides an earth referenced +12 Volts to the A1 circuit board.

The +12 Volt supply is always active if line power is applied to the instrument. Switching the instrument power switch only affects the A1 secondary power supplies.

Earth Referenced Power Supplies

"A1 Earth Referenced Power Supply Schematic" on page 176

The earth referenced power supplies control the on/standby state of the instrument and provide the main power used by the communications and display. The fan is also powered by this section.

The main power supply provides the +12V power that is used by the power on/standby circuitry. The electronic power switch is controlled by the PWR_SWITCH* line. This line is grounded when the front-panel power switch is pushed and turns on Q1201 through R1205.

Pressing the power switch turns on Q1201 and C1212 and C1216 begin to charge up. Depending upon the state of relay K1201, R1204 is in parallel with either R1206 or R1207 and so one capacitor begins to charge much faster than the other. The charged capacitor turns on either Q1202 or Q1203 and energizes the relay coil of K1201, changing the relay to the opposite state. Repeatedly pushing the power switch toggles the relay from one state to another. In the ON state, PWR_ON is connected to the +12V and turns on the secondary power supplies. PWR_ON is also used to power the fan.

When K1201 is in the standby state, PWR_ON is grounded through R1201.

The earth referenced logic is powered by +3.3V_ER and +1.8V_ER. These supplies are derived from the unswitched +12V through dual switching regulator U1201. When the instrument is in standby, the SHDN_ER* line through U1202b turns off the regulated supplies. R1217, R1223 and C1214 delay shut down for a brief period to allow the earth referenced logic to complete its shutdown sequence. C1201, C1202, and C1203 provide power down storage to keep the regulators working long enough for the earth referenced logic to properly save the states and shut down if the line power is removed.

PWR_ON* is inverted by U1202a to become the PWR_FAIL* line to the earth referenced microprocessor. When K1201 is set to the standby position, this line instructs the earth referenced microprocessor to begin the shut down sequence. PWR_ON is also used to power the display backlight. This backlight is controlled by the CCFL_ON line from the earth reference microprocessor. When the line is high, Q1205 is turned on and turns on Q1204 to apply +12V_DISP to the display backlight.

The earth referenced main processor is reset to a wake-up state when the power supply is first energized by an output from the regulator U1201 through U1202c as the RESET_ER* line.

Floating Power Supplies

“A1 Isolated Power Supply Schematic” on page 177

The floating power supplies are isolated from the earth reference through transformer T1301. The unswitched +12V is applied to switching regulator U1304. The PWR_ON line enables the regulator when the power is turned ON. Feedback for the regulator comes from the opto-isolator U1301. The output of U1304 drives Q1301 and Q1302 in a push-pull manner to control the primary winding of T1301.

The secondary windings of T1301 provide all the floating voltages. Diodes CR1302 through CR1310 rectify the secondary transformer voltages.

The approximately 18 Volt winding is rectified and regulated by U1305 and U1308 into the +15V and –15V supplies, respectively.

The +5V and –5V supplies are regulated by the switching regulator U1304. A –2.5 V band gap reference is developed across U1303, buffered by U1302b, and used as the reference for the +5V supply. U1302a amplifies the error signal and drives optical isolator U1301. The output of U1301 adjusts the output duty cycle of regulator U1304.

The +5V supply is also used to derive the +3.3V_ISO and +1.8V_ISO supplies used by the floating logic through regulators U1306 and U1307.

Analog Circuitry

The analog circuitry begins at the waveform DAC and continues to the main output.

Sine, ramp, noise, and arbitrary waveforms pass directly from the waveform DAC to the main output circuitry. Squarewaves and pulses are formed in the squarewave comparator and related circuits.

Waveform DAC and Filters

“A1 Waveform DAC and Filters and Square Wave Comparator Schematic” on page 173

The 14 bit waveform DAC, U901, is loaded with data from the Synthesis IC, U501. Data is clocked using the 50 MHz WFDAC_CLK from U602. The DAC output is a differential current source at pins 21 and 22. The output amplitude is varied by changing the reference voltage to the DAC. The reference is V_AMPL from the System DAC circuit. The DAC outputs two unipolar, complementary currents. U903b uses V_ AMPL and buffer Q901 to subtract voltages from the two outputs to keep the DAC output centered around 0 Volts.

The differential output of the DAC is applied to one of two filters, as selected by K901 and K902. K901 and K902 are set and reset by SET_SIN_FLTR1, SET_ARB_FLTR1, SET_SIN_FLTR2, and SET_ARB_FLTR2 from relay driver U603.

The two filters are:

- A 9^{th} order elliptical filter with a cutoff frequency of 23.5 MHz. This filter includes sin (x)/x correction. This filter is used for continuous sine and squarewaves.
- A 7^{th} order linear phase filter with a cutoff frequency of 12.5 MHz. This filter is used for ramp, noise, and arbitrary waveforms.

The differential output of the selected filter is applied to the input of U902. The V_NULL_SINE line from the System DAC is used to remove any offset at the output of U902. The single ended output of U902, SINE_ARB, is applied to the Main Output circuitry.

5

Squarewave Comparator

"A1 Waveform DAC and Filters and Square Wave Comparator Schematic" on page 173

V_DTY_CYCL from the System DAC is applied to the positive input of U903a. The negative input is the +2.5VREF obtained from U704. By changing the voltage of V_DTY_CYCL the threshold voltage provided by U904 is varied to change the duty cycle of the output. The output of U904, SQUARE, is sent to the synthesis IC, U501, to create the squarewave output.

Square and Pulse Level Translator

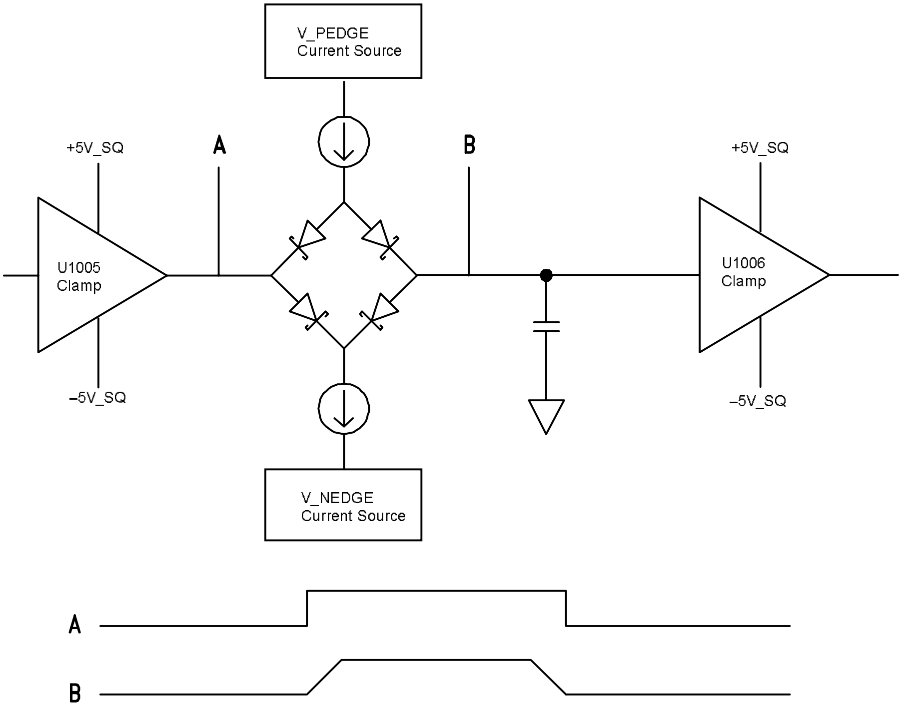
"A1 Square / Pulse Level Translation Schematic" on page 174

DAC U1002 sets the squarewave and pulse output amplitude. The amplitude information is loaded into the DAC as serial data by SQ_AMPL_DATA, clocked by SQ_AMPL_CLK and strobed by SQ_AMPL_STRB from the Synthesis IC, U501. The DAC output is filtered by a 3rd order linear filter with a cutoff frequency of 50 kHz made up of C1015, C1016 and L1001.

The output of the filter is amplified by U1003b, inverted by U1003a, and applied to the inputs of multiplexer U1004. U1004 acts as an analog switch and selects either the + or – input based upon the SQ_PLS_TTL line (from the Synthesis IC). The output of U1004 is a pulse waveform with a duty cycle controlled by SQ_PLS_TTL and amplitude set by DAC U1002. U1005 buffers the signal and applies it to the edge control circuitry.

U1005's output drives a diode switch (CR1003 and CR1004) that steers currents from Q1002 and Q1004 into integrating capacitors C1017 and C1018. The charge current is set by U1001, Q1001, and Q1002 and associated circuitry according to the value of V_PEDGE. The discharge current is set by U1007, Q1003, and Q1004 and associated circuitry according to the value of V_NEDGE.

The voltage on the integrating capacitor is amplified and buffered by U1006 and applied to the main output circuitry. V_NULL_SQ, from the System DAC removes any offset in the output signal.



Main Output Circuitry

“A1 Gain Switching and Output Amplifier Schematic” on page 175

The main output circuitry selects the desired output (squarewave/pulse or sine/arb), amplifies or attenuates the signal to its final amplitude, and adds any dc offset required. The output is also protected against harmful combinations of output current and voltages.

Relay K1101 selects either the sine/arb waveform or the square/pulse waveform. CR1101 clamps the signal to ±5 V.

R1126, R1127, R1128, R1134, R1135, and R1136 form a –10 dB attenuator that is switched by K1102. Similarly, R1129, R1130, R1131, R1137, R1138, R1139, R1141, and R1143 form a –20 dB attenuator that is switched by K1103.

K1104 switches a 20 dB amplifier made up of U1101, U1102, U1103, U1104 and associated circuitry. Attenuators and amplifiers are switched as follows ...

	Offset <2.5 V			**Offset >2.5 V**		
Amplitude Range (Vpp into 50 Ω)	**–10 dB**	**–20 dB**	**Amp**	**–10 dB**	**–20dB**	**Amp**
10 V to 3.16 V	Out	Out	In	Out	Out	In
3.16 V to 1 V	In	Out	In	In	Out	In
1 V to 0.316 V	Out	Out	Out	Out	In	In
0.316 V to 0.1 V	In	Out	Out	In	In	In
0.1 V to 0.0316 V	Out	In	Out			
0.0316 to 0.01 V	In	In	Out			

U1101, U1102, U1103, and U1104 also provide a high current amplifier used to inject a dc offset into the output path. Injecting the offset after the attenuators allows small output signals to be offset by a relatively high dc voltage. The offset is set by V_OFFSET from the System DAC. U1105 buffers V_OFFSET and translates it into a bipolar value. The resulting offset voltage is summed into the amplifier input path. When the amplifier is not used for the output signal, R1102 is switched into the input path by K1104 to provide input impedance matching for the offset voltage.

Output relay K1105 applies the amplifier/attenuator output to either the main output or to the System ADC (MEAS_OUT). This relay is opened or closed by Q1101. The output is clamped by diode CR1104. VR1101 and VR1102 provide ESD protection of the output circuitry.

There are two separate output protection circuits. U1106c and U1106d monitor the output of the attenuators. If this voltage exceeds ±6.3 V, OUTPUT_FAULT* is asserted. Similarly, U1106a and U1106b monitor the output of the +20 dB amplifier.

U1107b measures the output current of the +20 dB amplifier and modifies the thresholds of U1106a and U1106b as necessary to prevent damage. When OUTPUT_FAULT* is asserted, the U501 opens relay K1105. User intervention is required to re-enable the output.

System ADC

“A1 System ADC Schematic” on page 171

Modulation (AM, FM, PM, and PWM) by an external source is performed by digitally sampling the external input at the modulation BNC and adjusting the waveform data to match the modulation specification (deviation in FM, PM, and PWM and depth in AM).

The external modulation input is ESD protected by VR701 and VR702, and clamped to ±5 V by CR703. CR702 and CR704 provide the 5 Volt reference for the clamping action.

The modulation signal and all other analog measurement signals are applied to the inputs of multiplexer U701. U701 selects the appropriate input signal for calibration, self-test, and modulation functions based upon the U501 supplied MSEL(2:0) lines.

The multiplexer selects one of eight inputs; ground, MEAS_OUT and MEAS_BUF from the main output circuit, MEAS_MOD_DAC from the square and pulse level translator, MEAS_AMPL from the System DAC, +1.25VREF, and the modulation input (either directly or attenuated by a factor of 5).

The nominal ±1.25 V output of the multiplexer is amplified by U702 and shifted to a 0 to 5 Volt level by U702a, and then applied to a 3rd order, low-pass, anti-alias filter made up of U702 and associated circuitry. From the filter, the selected signal is applied to the system Analog-to-Digital converter, U703.

U703 is clocked by ADC_CLK from the Synthesis IC, U501. The output of the ADC is sent to the Synthesis IC as serial ADC_DATA. U703 also provides the system reference voltage. The reference voltage is +2.5 V buffered by U704a to create the +2.5VREF and inverted by U704b for the –2.5VREF system reference voltages.

System DAC

“A1 System DAC Schematic” on page 172

The system DAC provides dc voltages that control various parameters of the instrument’s operation. The system DAC, U801, is loaded with 16-bit serial data from the Synthesis IC, U501, using SYSDAC_CLK, SYSDAC_STRB, and SYSDAC_DATA. The DAC reference is the +2.5VREF from U704 and the DAC output ranges from 0 to +2.5 Volts. U802a buffers the DAC output voltage and applies it to multiplexer U803.

Each output of U803 is applied to a *hold* capacitor that is a part of a track-and-hold circuit. Each track-and-hold circuit outputs a specific instrument control voltage. In operation, SYSDAC_SEL (2:0) from U501 selects one of the track-and-hold circuits, and the DAC is loaded with a corresponding value. After allowing a brief interval for the DAC to settle, the selected channel of the multiplexer is closed by the assertion of SYS_DAC_SMPL and the appropriate holding capacitor charges to the output voltage of U803. After a delay, SYS_DAC_SMPL is negated and the process repeats for the next track-and-hold circuit. All control voltages are continuously refreshed in this manner

.

U803 Channel	U802 Output	U804 Output	Control Voltage	Function	Range
0		pin 1	V_AMPL	Sets the output amplitude	0 to +1.25 V
1			V_OFFSET	Sets the output offset	0 to +2.5 V
2		pin 7	V_NULL_SINE	Removes offsets from the waveform DAC and filters	±10 V
3			V_DTY_CYCL	Sets the squarewave duty cycle	0 to +2.5 V
4			V_PEDGE	Sets the pulse and squarewave leading edge time	0 to +2.5 V
5			V_NEDGE	Sets the pulse and squarewave trailing edge time	0 to +2.5 V
6	pin 7		V_NULL_SQ	Removes offsets from the square wave.	±10 V
7			not used		

V_NULL_SINE and V_NULL_SQ are amplified and compared to the +2.5VREF by U804b and U802. This signal removes any offsets in the output path caused by the waveform DAC and filter circuitry.

V_OFFSET settling is aided in large changes of value by Schottky diode CR802 across hold capacitor C802.

Similarly, large changes in V_AMPL are sped by Schottky diode CR801. This signal is further buffered by U804a. The MEAS_AMPL to the System ADC is also taken from here.

Digital Circuitry

The digital circuitry contains all the waveform generation circuitry and waveform memory. The main CPU and communications circuitry are also included.

Synthesis IC and Waveform Memory

"A1 Synthesis IC and Waveform RAM Schematic" on page 169

U501 is a gate array logic device that implements most of the logic for waveform generation. U501 implements clock generation, pulse generation, DDS and modulation functions, as well as triggering, waveform memory control, system DAC control and System ADC inputs. The IC has an on-board UART.

The Synthesis IC, U501, communicates with the main controller via serial read (RX_ISO) and write (TX_ISO) lines through the isolation interface.

U502 is a 64k-by-16 bit RAM used to store the waveform data. All loading, control, and reading of the memory data is controlled by the Synthesis IC.

Timebase, Sync Output, and Relay Drivers

"A1 Timebase, Sync, and Relay Drivers Schematic" on page 170

The main timebase for the instrument is created by a voltage controlled crystal oscillator, U601. This oscillator uses the +3.3V_ISO power supply derived from the +5V supply by regulator U1306.

The oscillator frequency is controlled by VCXO_CTL from the Synthesis IC, U501. VCXO_CTL is derived from one of two sources. If an external timebase reference is used (Option 001), VCXO_CTL is derived from the phase detector and operates as a phase lock loop to the external reference. If the reference is internal, VCXO_CTL is a pulse train with the correct duty cycle. The VCXO_CTL is buffered in U602 and sent through a low pass filter made up of R604, R605, C604, C605, and C606.

The buffered and filtered VCXO_CTL and +3.3V_ISO are applied to the oscillator U602. This oscillator creates a 50 MHz timebase used by all the isolated circuitry. The oscillator output is divided into two signals, DDS_CLK for input to the Synthesis IC, U501, and WFDAC_CLK used by the waveform DAC U901.

The Synthesis IC outputs the SYNC signal through transformer T601. VR601 and VR602 provide ESD protection at the Sync Output BNC connector.

U603 provides the current needed to drive the relay coils for all relays in the instrument. This buffer is controlled by RLY(15:0) from the Synthesis IC, U501. The buffer outputs set and reset the instrument's relays.

Main Processor

"A1 Clocks, IRQ, RAM, ROM, and USB Schematic" on page 165
"A1 Front Panel Interface, LAN, GPIB, and Beeper Schematic" on page 166
"A1 Cross Guard, Serial Communications, Non-Volatile Memory, and Trigger Schematic" on page 167
"A1 Power Distribution Schematic" on page 168

U101 is the main processor for the instrument. This CPU combines many instrument functions into a single chip and portions of it are shown on multiple schematics. Included in U101 are memory control, a bus interface, and several peripherals used to provide front panel control, beeper control, and external interfaces (GPIB, USB and LAN). U10111 has an internal 200 MHz cache.

The main CPU portion of U101 connects to system ROM U103 using the BIU_DATA(31:16) and BIU_ADDR(0:15) lines. The address and data bus operate at 50 MHz. U103 is an 8 MB flash ROM.

System RAM, U102, is an 8 MB synchronous dynamic DRAM. The HSMC_DATA(31:0) and HSMC_ADDR(11:0) are a 100 MHz bus.

U104 is a 50 MHz oscillator that provides the timebase for U101.

Main interrupts to the microprocessor are PWR_FAIL* from the power supplies, USB_IRQ* from the USB interface, and RESET_ER* from the earth referenced power supply.

U105 provides a 24 MHz clock for the USB (Universal Serial Bus) interface, U106. The BIU_DATA(31:16) and BIU_ADDR(0:2) lines are used to move the data to and from the interface (the bus operates at 50 MHz rate). U106 can assert USB_IRQ* when data is available. The incoming data is sent to System RAM, U102, using direct memory access (DMA). The DMA is controlled by DREQ* and DACK* from U106.

U101 also provides the GPIB interface functions. It is connected directly to the GPIB connector J202.

The LAN connector is a standard RJ45 connector. J203 includes built-in LEDs to indicate network activity and link status. The 50 MHz clock, LAN_CLK, from U104 clocks the LAN operations.

U101 provides the main interface to the front panel through connector J201. Serial data (SCP_DATA) to and from the front panel is clocked by SCP_CLK. These lines are buffered by U201. The input from the rotary encoder ENCODER_A and ENCODER_B is debounced by R204, C202, R206, and C203. U201a and U201f are schmidt triggers. DISP_MCS* and DISP_SCS* are chip select lines to the LCD display. KBD_DRIVE*(4:0) and KBD_SENSE*(7:0) scan the keyboard for key presses. These lines are held high by RP206, RP208, RP209, and RP210. During operation, KBD_DRIVE*(4:0) lines are driven low. Any key press then drives one of the KBD_SENSE(7:0) lines low. The keyboard is then scanned using the KBD_DRIVE*(4:0) to determine which key is pressed.

The cross isolation interface is also managed by U101 using a series of opto-isolators. The main serial data interface to the Synthesis IC is TX_ISO and RX_ISO. These asynchronous data lines send a 39 bit data frame consisting of a start bit, 32 data bits, 4 error bits, a channel bit, and a stop bit. Opto-isolators U304a and U305a provide this serial isolation.

U308 isolates the RESET_ISO line from the main controller to reset the floating circuitry.

The Trigger I/O BNC can accept an input trigger or output a trigger signal. VR301 provides ESD protection. When the trigger is output, U307c and U307d are enabled by TRIG_OUT_EN* from the main processor. The actual trigger comes from the Synthesis IC as TRIG_OUT_ISO, is optically isolated by U304b, and named TRIG_OUT_ER. U307b and U307c are used in parallel to provide the required drive current.

When an external trigger source is selected, the signal is applied to multiplexer U303. U303 selects either the U501 configuration control signals from U101, or the external trigger and XG_TXD signals. These signals are isolated by U305 to become the RX_ISO and TRIG_IN_ISO lines.

5

Front Panel

"A2 Keyboard Scanner and Display Connector Schematic" on page 178
"A2 Key Control Schematic" on page 179

The front panel contains a keyboard, a liquid crystal display, and a rotary encoder.

The keyboard is arranged in five columns and eight rows. The drive and sense lines are pulled up on the main circuit board. During operation, all the KBD_DRIVE(4:0) lies are low one at a time. If a key is pressed in the column being driven, the corresponding KBD_SENSE*(7:0) line will go low.

Some keys have an LED incorporated into the key to indicate the instrument's operating state. U201 and U202 are shift registers that convert the serial data on FP_SDATA into the parallel data to light the appropriate LED. U203 buffers the LED drive lines. The serial data is loaded into the shift registers by FP_SCLK and strobed to the outputs of U201 and U202 by LED_STRB.

The display is a 256 X 64 liquid crystal display. This display assembly includes the backlight lamp and LCD driver circuitry. The FP_SDATA, FP_SCLK provide the serial data to the display. DISP_A0, DISP_MCS*, and DISP_SCS* control how the serial data is used. +12_DISP turns on or off the backlight. DISP_RESET* resets the display.

The rotary encoder uses a quadrature coding techniques to allow motion, speed, and direction to be detected. Two sense lines from the encoder, ENCODER_A and ENCODER_B, are debounced and buffered on the main board and applied to the main processor. The main processor tracks and accumulates knob motion information.

External Timebase (Option 001)

"A3 External Timebase Schematic" on page 180

The external timebase circuitry is contained on a separate PC board, installed as Option 001 to the instrument.

The external timebase has three parts: a reference clock output, a reference input, and a reference input detection circuit. The reference frequency out and reference frequency input are through BNC connectors on the rear panel. All connections to the main PC board are made through connector P1 and A1J601.

The reference clock is provided by A1U501 through resistor A1R502 and a low pass filter (A1C508, A1L501, A1R502, A1R503, and A1C509) to pin 8 of P1. The signal is isolated by transformer T2. VR4 provides overvoltage protection at the rear panel BNC connector.

The external signal input is protected from ESD by VR1 and VR2. External signals down to 100 mV may be used. The signal is applied to isolation transformer T1. CR2 clamps the input signal to acceptable levels. U1 is a two channel comparator. The logic level output of U1 on pin 11 is at the applied frequency (nominally 10 mhZ) and at pin 3 of P1 becomes the EXT_TB_IN signal applied to A1U501.

Connecting a valid signal to the reference frequency input at the rear panel automatically sets the instrument to use the external timebase. No user intervention is required. The logic level output of comparator U1 at pin9 activates a charge pump consisting of C7, CR3, C8, R9, and U2. U2e's output becomes the EXT_TB_DET signal applied to A1U501. This signal informs A1U501 that an external timebase is applied.

5

5

Service

Service

This chapter discusses the procedures involved for returning a failed instrument to Agilent Technologies for service or repair. Subjects covered include the following:

Operating Checklist

Before returning your instrument to Agilent Technologies for service or repair, check the following items:

Is the instrument inoperative?

- Verify that the ac power cord is connected to the instrument.
- Verify that the front-panel On/Standby switch has been pushed.

Is the display working?

- If the display appears blank, but front-panel keys are lit (and the fan is working), the display screen saver may be enabled. Press any key to restore the display.
- If the display appears blank, but front-panel keys are lit (and the fan is working), the display contrast setting may be too low. Use the Utility menu to set the display contrast.

Does the instrument fail self-test?

Remove all external connections to the instrument. Errors may be induced by signals present on the external wiring during a self-test. Long test leads, even leads that are otherwise unconnected, can act as an antenna causing pick-up of ac signals.

Types of Service Available

If your instrument fails during the warranty period (within three years of original purchase), Agilent Technologies will replace or repair it free of charge. After your warranty expires, Agilent will replace or repair it at a competitive price. The standard repair process is “whole unit exchange”. The replacement units are fully refurbished and are shipped with new calibration certificates.

Standard Repair Service (worldwide)

Contact your nearest Agilent Technologies Service Center. They will arrange to have your instrument repaired or replaced.

Agilent Express Unit Exchange (U.S.A. Only)

You will receive a refurbished, calibrated replacement Agilent 33220A in 1 to 4 days.

1 Call **1-877-447-7278** (toll free) to place your Agilent Express order.

   a You will be asked for your serial number, shipping address, and a credit card number to guarantee the return of your failed unit.

   b If you do not return your failed unit within 15 business days, your credit card will be billed for the cost of a new Agilent 33220A.

2 Agilent will immediately send a replacement 33220A directly to you.

   a The replacement unit will come with instructions for returning your failed unit. Please retain the shipping carton and packing materials to return the failed unit to Agilent. If you have any questions regarding these instructions, please call 1-877-447-7278.

   b The replacement unit will have a different serial number than your failed unit. If you need to track your original serial number, a blank label will be shipped with the replacement unit to record your original serial number.

Note Your replacement unit will not include accessories, bumpers, or the handle. Remove any accessories and transfer them to the replacement unit before returning the failed unit.

Repackaging for Shipment

If the unit is to be shipped to Agilent for service or repair, be sure to:

- Attach a tag to the unit identifying the owner and indicating the required service or repair. Include the model number and full serial number.
- Place the unit in its original container with appropriate packaging material for shipping.
- Secure the container with strong tape or metal bands.

If the original shipping container is not available, place your unit in a container which will ensure at least 4 inches of compressible packaging material around all sides for the instrument. Use static-free packaging materials to avoid additional damage to your unit.

Agilent suggests that you always insure shipments.

Cleaning

Clean the outside of the instrument with a soft, lint-free, slightly dampened cloth. Do not use detergent. Disassembly is not required or recommended for cleaning.

Electrostatic Discharge (ESD) Precautions

Almost all electrical components can be damaged by electrostatic discharge (ESD) during handling. Component damage can occur at electrostatic discharge voltages as low as 50 volts.

The following guidelines will help prevent ESD damage when servicing the instrument or any electronic device.

- Disassemble instruments *only* in a static-free work area.
- Use a conductive work area to reduce static charges.
- Use a conductive wrist strap to reduce static charge accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, foam, vinyl, paper, and other static-generating materials from the immediate work area.
- Use *only* anti-static solder suckers.

Surface Mount Repair

Surface mount components should only be removed using soldering irons or desoldering stations expressly designed for surface mount components. Use of conventional solder removal equipment will almost always result in permanent damage to the printed circuit board and will void your Agilent Technologies factory warranty.

Troubleshooting Hints

This section provides a brief check list of common failures. Before troubleshooting or repairing the instrument, make sure the failure is in the instrument rather than any external connections. Also make sure that the instrument is accurately calibrated within the last year (*see "Calibration Interval", on page 55*). The instrument's circuits allow troubleshooting and repair with basic equipment such as a 6½ digit multimeter.

Unit is Inoperative

- Verify that the ac power cord is connected to the instrument.
- Verify that the front-panel On/Standby switch has been pushed.

Is the display working?

- If the display appears blank, but front-panel keys are lit (and the fan is working), the display screen saver may be enabled. Press any key to restore the display.
- If the display appears blank, but front-panel keys are lit (and the fan is working), the display contrast setting may be too low. Use the [Utility] menu to set the display contrast.

Unit Fails Self-Test

Ensure that all terminal connections (both front panel and rear terminals) are removed while the self-test is performed.

6

Power Supply

Verify the main power supply.

WARNING *Shock Hazard. To check the power supplies, remove the instrument cover as described in “Disassembly”, on page 127.*

The main power supply provides a +12 Vdc supply to the main circuit board. All other supplies are derived from this supply. This supply is energized at all times while the line power cord is connected.

Power Supply	Minimum	Maximum
+12 V	11.4 V	12.6 V

- Circuit failure can cause heavy supply loads which may pull down the supply output voltage. Disconnect the main supply from the A1 circuit board to test.
- Always check the supply is free of oscillations using an oscilloscope.
- The main power supply contains a fuse rated T2AL250V. Replacing this fuse is not recommended. Replace the entire main power supply assembly. Note that power supply failures are often caused by other instrument failures.

Self-Test Procedures

Power-On Self-Test

Each time the instrument is powered on, a small set of self-tests are performed. These tests check that the minimum set of logic and output hardware are functioning properly. In addition to some basic checks, the power-on self test consists of tests 601 through 632.

Complete Self-Test

To perform a complete self-test:

1 Press [Utility] on the front panel.

2 Select the **Self Test** softkey from the “Test / Cal” menu.

A complete description of the self-tests is given in the next section. The instrument will automatically perform the complete self-test procedure when you release the key. The self-test will complete in approximately 30 seconds.

- If the self-test is successful, “Self Test Pass” is displayed on the front panel.
- If the self-test fails, “Self Test Fail” and an error number are displayed.

Self-Tests

A complete self-test performs the following tests. A failing test is indicated by the test number and description in the display.

601 **Self-test failed; system logic**
This error indicates a failure of the main processor (U101), system RAM (U102), or system ROM (U103).

603 **Self-test failed; waveform logic**
This error indicates that the waveform logic in the synthesis IC (U501) has failed.

604 **Self-test failed; waveform memory bank**
This error indicates either the waveform RAM (U502) or the synthesis IC (U501) has failed.

605 **Self-test failed; modulation memory bank**
This error indicates the modulation memory bank in the synthesis IC (U501) has failed.

606 **Self-test failed; cross-isolation interface**
This error indicates that the cross-isolation interface between the main processor (U101) and Synthesis IC (U501) has failed, or that the synthesis IC itself has failed.

619 to 621
623 to 625

619: Self-test failed; leading edge DAC
620: Self-test failed; trailing edge DAC
621: Self-test failed; square-wave threshold DAC
623: Self-test failed; dc offset DAC
624: Self-test failed; null DAC
625: Self-test failed; amplitude DAC
These errors indicate a malfunctioning system DAC(U801), or failed DAC multiplexer (U803) channels.

622 **Self-test failed; time base calibration DAC**
This error indicates that the time base calibration DAC in the synthesis IC (U501), or voltage controlled oscillator (U602) has failed.

626 - 629

626: Self-test failed; waveform filter path select relay
627: Self-test failed; -10 dB attenuator path
628: Self-test failed; -20 dB attenuator path
629: Self-test failed; +20 dB amplifier path

These errors indicate that the specified relay is not being properly switched or the attenuator/amplifier is not providing the expected amplification or gain. These self-tests use the internal ADC to verify that attenuators are operating properly.

630

Self-test failed; internal ADC over-range condition

This error indicates a probable ADC failure. The failure could be of the system ADC (U703)), the ADC input multiplexer (U701), or the ADC input buffer amplifier (U702).

631

Self-test failed; internal ADC measurement error

This error indicates a probable ADC failure. The failure could be of the system ADC (U703)), the ADC input multiplexer (U701), or the ADC input buffer amplifier (U702).

632

Self-test failed; square/pulse DAC test failure

This error indicates a probable failure of the square/pulse DAC (U1002).

Disassembly

For procedures in this manual, the following tools are required for disassembly:

- T20 Torx driver (most disassembly)
- T15 Torx driver (support plate and fan removal)
- 14 mm nut driver, hollow shaft (rear-panel BNC connectors)

The following tools may also be needed if further disassembly is required.

- 7 mm nut driver (rear-panel GPIB connector)

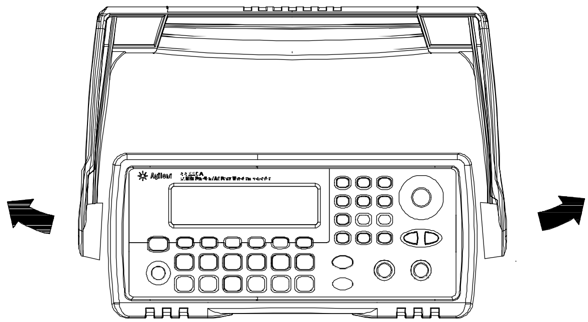
WARNING *SHOCK HAZARD. Only service-trained personnel who are aware of the hazards involved should remove the instrument covers. To avoid electrical shock and personal injury, make sure to disconnect the power cord from the instrument before removing the covers. Some circuits are active and have power applied even when the power switch is turned off.*

6

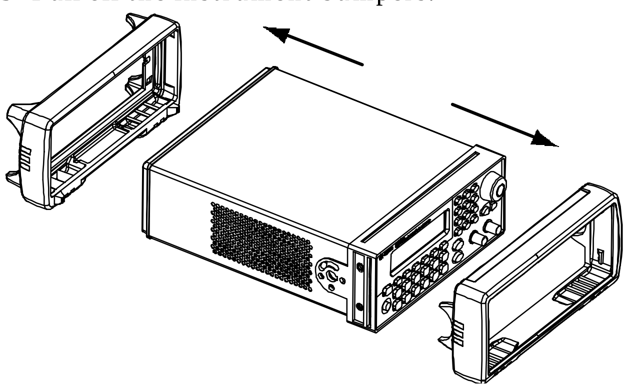
General Disassembly Procedure

1 Turn off the power. Remove all cables from the instrument.

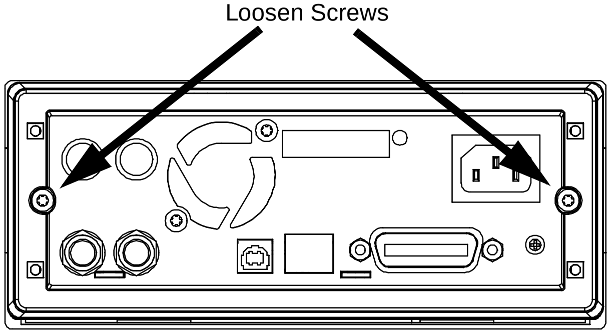
2 Rotate the handle upright and pull off.



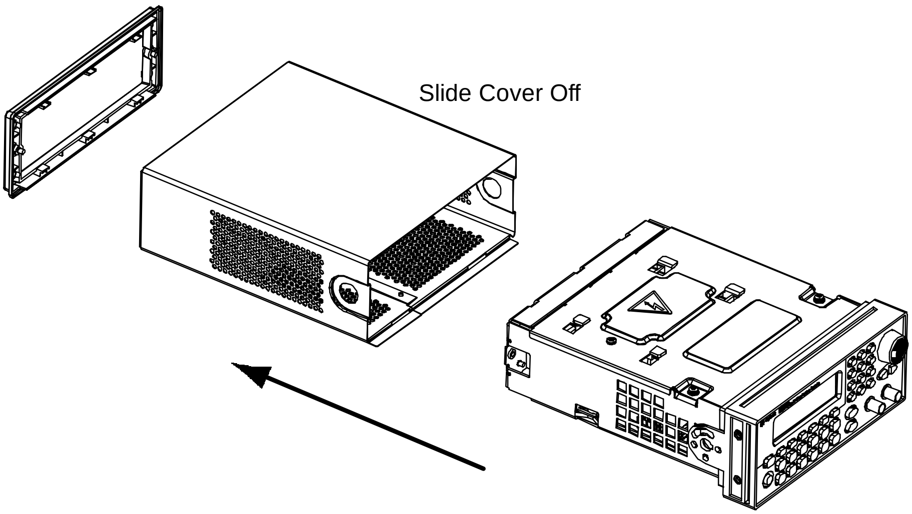
3 Pull off the instrument bumpers.



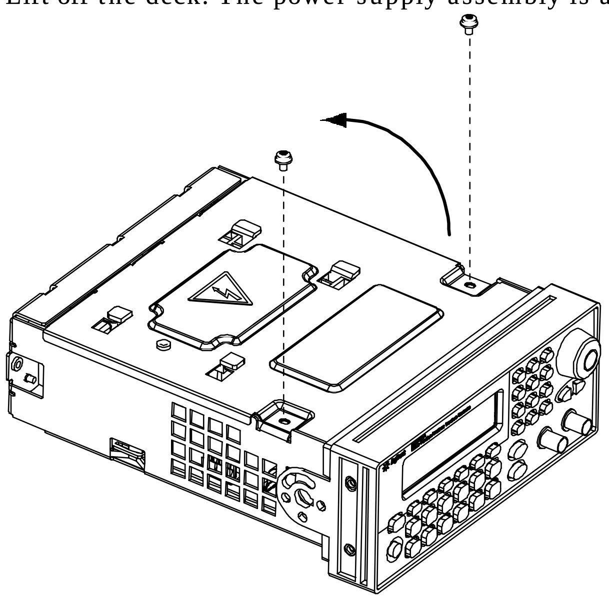
4 Loosen the two captive screws in the rear bezel and remove the rear bezel.



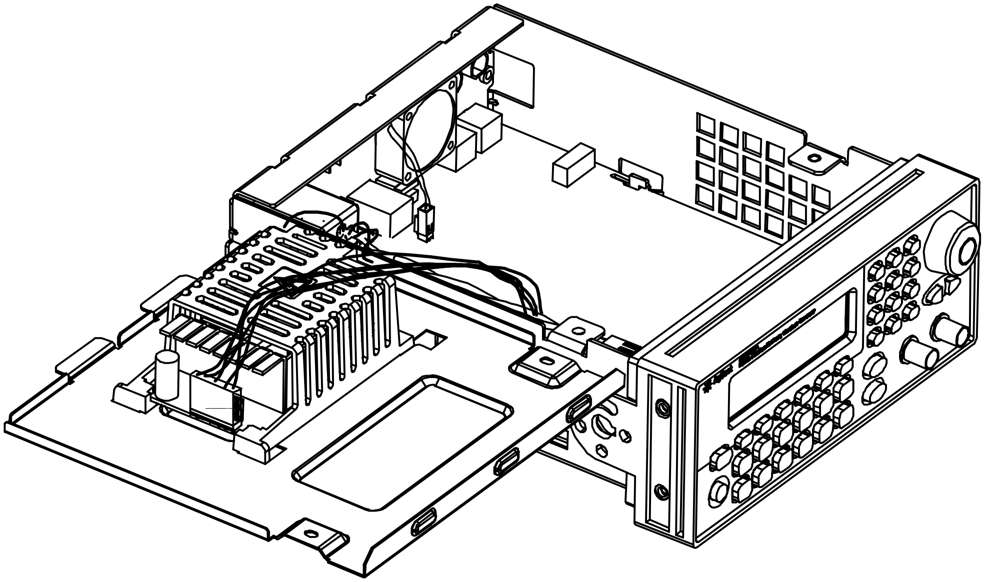
5 Slide off the instrument cover.



6 Remove the two screws securing the power supply deck to the chassis. Lift off the deck. The power supply assembly is attached to the deck.



7 Lay the deck and power supply assembly to the side.



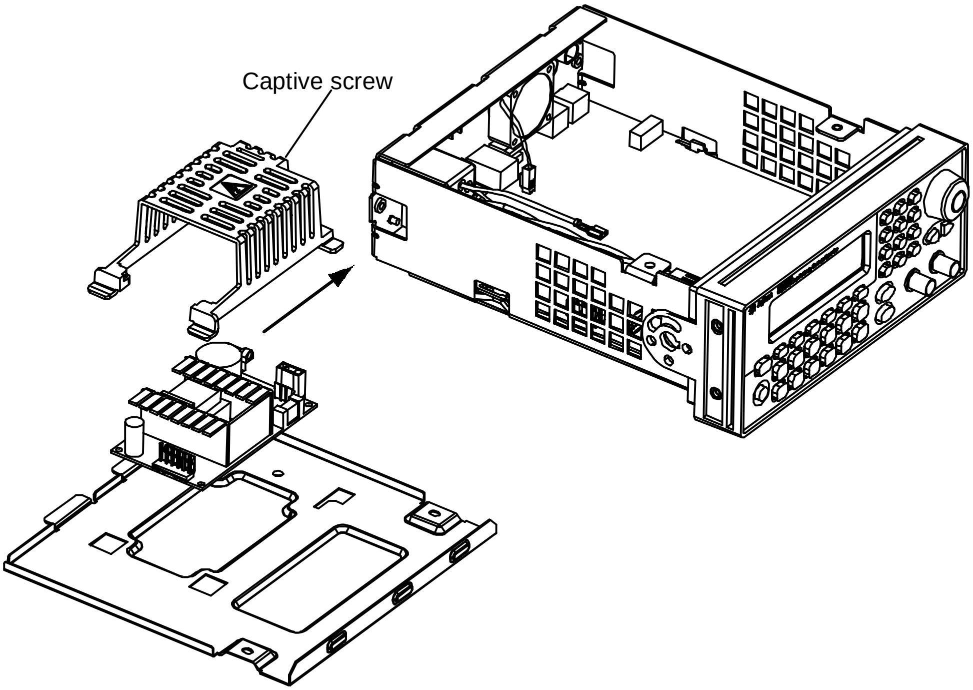
Many of the service procedures can now be performed without further disassembly. Troubleshooting and service procedures that require power be applied can be performed with the instrument in this state of disassembly.

WARNING *SHOCK HAZARD. Only service-trained personnel who are aware of the hazards involved should remove the instrument covers. Dangerous voltages may be encountered with the instrument covers removed.*

Removing the Main Power Supply Assembly

Loosen the captive screw securing the power supply cover to the deck. Slide the power supply cover and power supply and lift from the deck. Slightly spread the ends of the power supply cover and slide the power supply out of the cover. Disconnect the line input, ground, and output cables from the power supply. The main power supply should be replaced as an assembly.

WARNING *Always be sure to re-attach the green ground wire to the power supply before operating the instrument.*

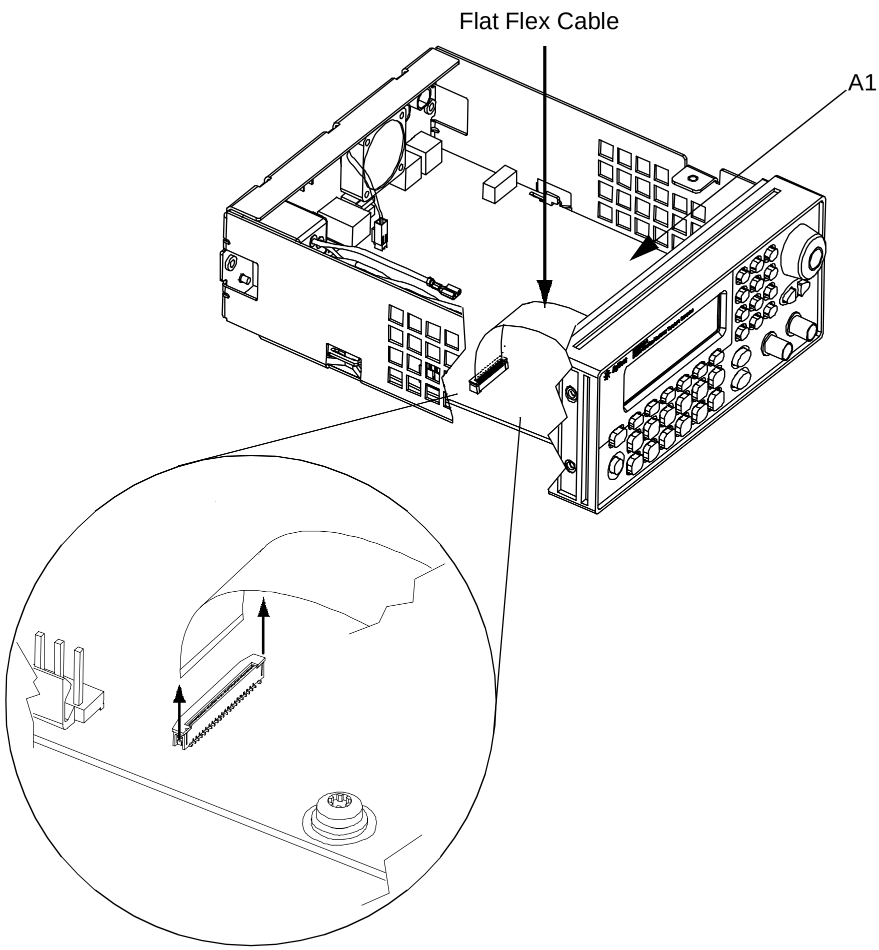


6

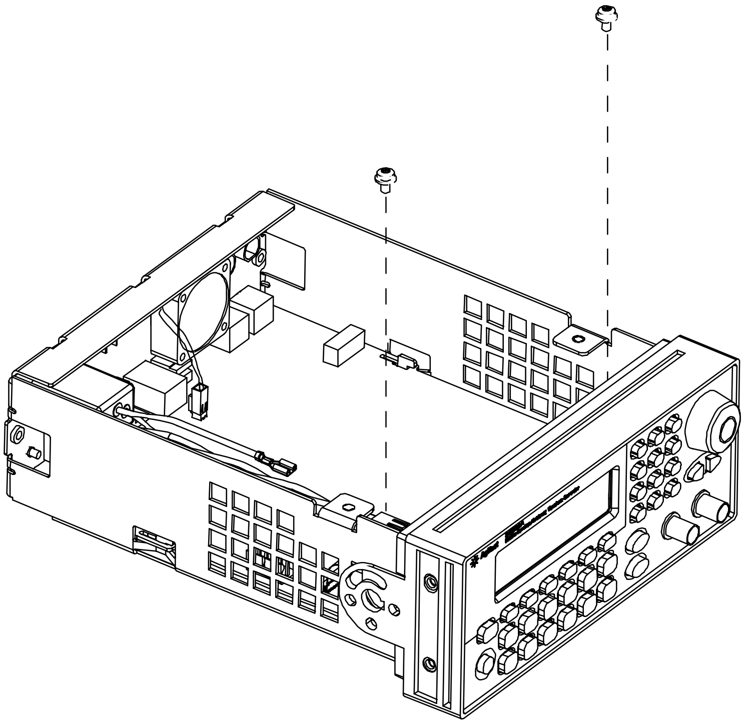
Front-Panel Removal Procedure

1 Gently lift both ends of the flat flex cable connector actuator and disconnect the cable from the main PC board (A1 assembly).

Caution To prevent damage to the cable and connector, use care when lifting the actuator. Excessive or uneven force may damage the actuator or connector.



2 Remove the two screws from the front edge of the main PC board (A1 assembly).



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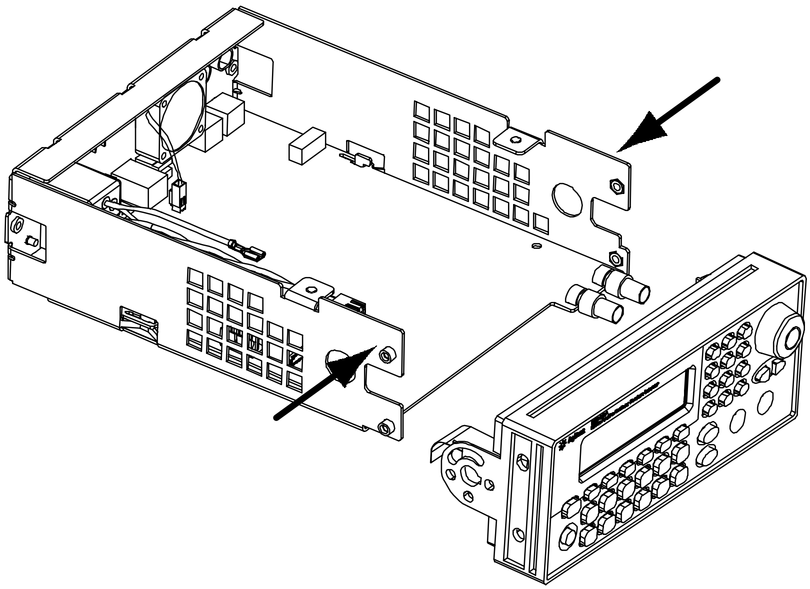
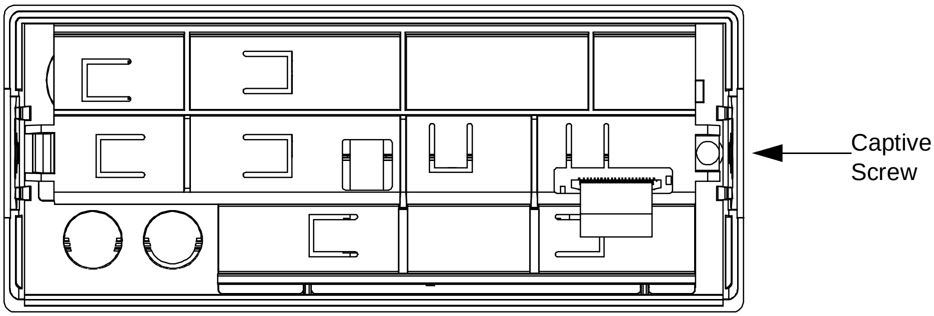
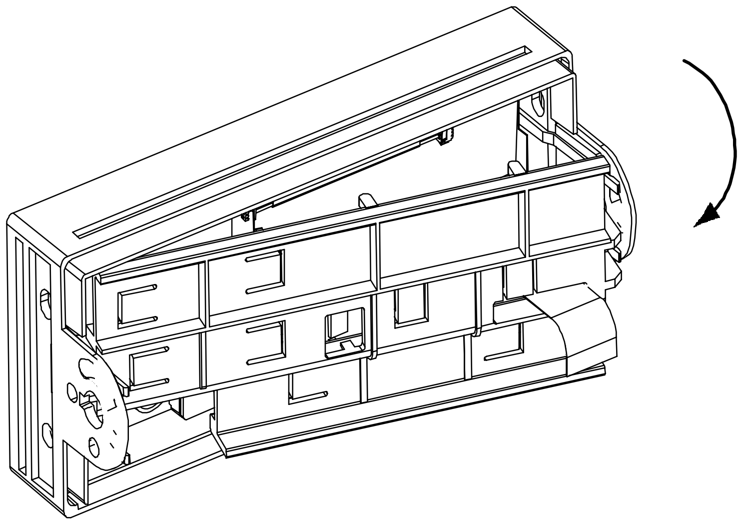
3 Push the side flanges of the chassis inward while lifting off the front panel. There should now be enough play in the chassis sides and front panel assembly to allow the side of the front panel to be disconnected from the chassis.



Front-Panel Disassembly

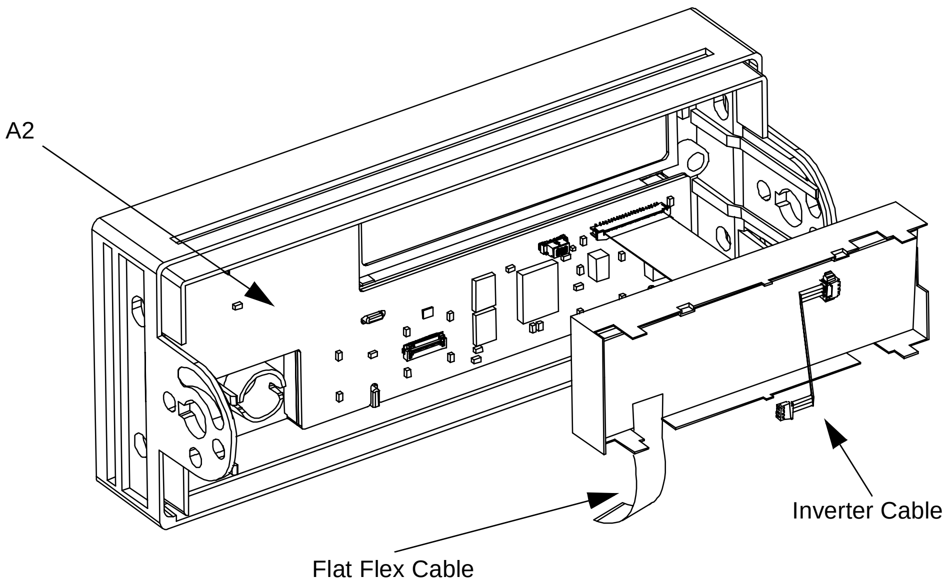
1 Loosen the captive screw holding the support plate. Lift the end of the support plate and rotate out of the front panel assembly.





2 Unplug the inverter cable from the keyboard PC board (A2 assembly). Gently lift both ends of the flat flex cable connector actuator and disconnect the cable from the PC board. Lift out the display assembly

Caution To prevent damage to the cable and connector, use care when lifting the actuator. Excessive or uneven force may damage the actuator or connector.



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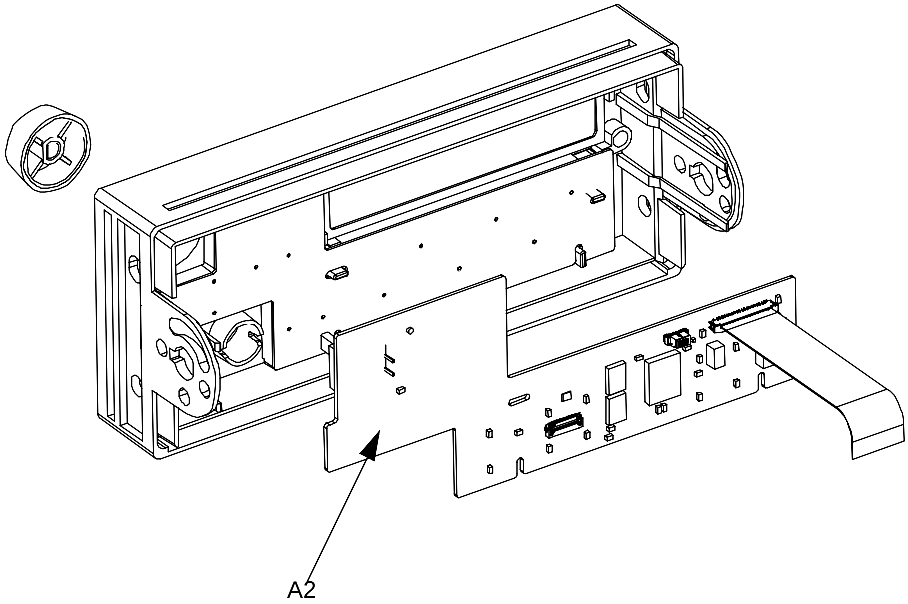
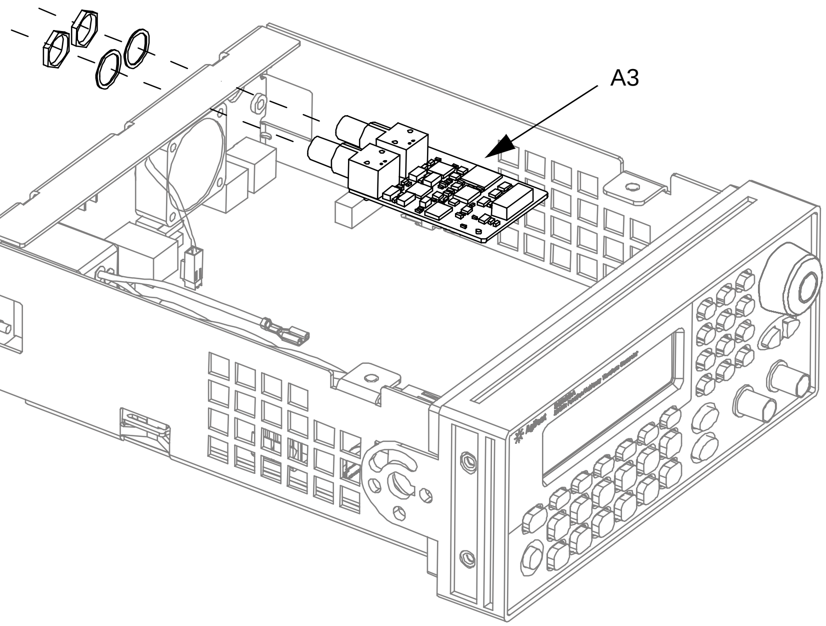
3 Pull to remove the knob. Lift out the keyboard PC board (A2 assembly).



External Timebase Circuit Board Disassembly

The External Timebase is an option to the basic instrument.

Remove the nuts and washers holding the rear panel BNC connectors. Remove the ribbon cable between the External Timebase PC board (A3 assembly) and main PC board (A1 assembly). Lift out the circuit board.



Replaceable Parts

Replaceable Parts

This chapter contains information for ordering replacement parts for your instrument. The parts lists are divided into the following sections.

Parts are listed in alphanumeric order according to their schematic reference designators. The parts lists include a brief description of each part with applicable Agilent part number and manufacturer part number.

To Order Replaceable Parts

You can order replaceable parts from Agilent using the Agilent part number or directly from the manufacturer using specified manufacturer's part number shown. Note that not all parts listed in this chapter are available as field-replaceable parts. To order replaceable parts from Agilent, do the following:

1 Contact your nearest Agilent Sales Office or Service Center.

2 Identify the parts by the Agilent part number shown in the replaceable parts list.

3 Provide the instrument model number and serial number.

33220-66501 – Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
C201	0160-7798	69	CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C202 - C203	0160-7748	10	CAP-FXD 1000PF +-10PCT 50 V CER X7R	09939	GRM188R71H102KA01D
C204 - C206	0160-7751	7	CAP-FXD 0.01UF +-10PCT 50 V CER X7R	12340	C0603C103K5RAC
C311	0160-7737	2	CAP-FXD 130PF +-1PCT 50 V CER C0G	02010	08055A131FAT_A
C312	0160-7748		CAP-FXD 1000PF +-10PCT 50 V CER X7R	09939	GRM188R71H102KA01D
C403	0160-8961	23	CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C420	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C501	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C502	0160-7736	8	CAP-FXD 1UF +-10PCT 16 V CER X7R	12340	C1206C105K4RAC
C503	0160-7751		CAP-FXD 0.01UF +-10PCT 50 V CER X7R	12340	C0603C103K5RAC
C504	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C505	0160-7736		CAP-FXD 1UF +-10PCT 16 V CER X7R	12340	C1206C105K4RAC
C506	0160-7751		CAP-FXD 0.01UF +-10PCT 50 V CER X7R	09939	GRM188R71H103KA01D
C507	0160-7736		CAP-FXD 1UF +-10PCT 16 V CER X7R	09939	GRM31MR71C105KA01L
C508	0160-7792	6	CAP-FXD 18PF +-5PCT 50 V CER C0G	12340	C0603C180J5GAC
C511	0160-7792		CAP-FXD 18PF +-5PCT 50 V CER C0G	02010	06035A180JAT
C523 - C524	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C541	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C601 - C602	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C603	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C605 - C606	0160-8361	13	CAP-FXD 0.22UF +-10PCT 25 V CER X7R	06352	C2012X7R1E224K
C607	0180-4918	4	CAP-FXD 100UF +-20PCT 10 V TA	12340	T491D107M010AS
C608 - C611	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C612	0160-7792		CAP-FXD 18PF +-5PCT 50 V CER C0G	02010	06035A180JAT
C701 - C702	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C703	0160-7849	3	CAP-FXD 220PF +-5PCT 50 V CER C0G	12340	C0603C221J5GAC
C704	0160-7708		CAP-FXD 1000PF +-5PCT 50 V CER C0G	12340	C0805C102J5GAC
C706	0160-7715	2	CAP-FXD 470pF +-1pct 50 V CER C0G	12340	C0805C471F5GAC
C707	0160-8157	2	CAP-FXD 330pF +-1pct 50 V CER C0G	02010	08055A331FATA
C708	0160-7714	5	CAP-FXD 150pF +-1pct 50 V CER C0G	12340	C0805C151F5GAC
C709 - C711	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C713	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C714	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C716 - C717	0161-1024	14	CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C804	0160-7751		CAP-FXD 0.01UF +-10PCT 50 V CER X7R	12340	C0603C103K5RAC
C805	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C806	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C807	0160-8361		CAP-FXD 0.22UF +-10PCT 25 V CER X7R	06352	C2012X7R1E224K
C808	0160-7748		CAP-FXD 1000PF +-10PCT 50 V CER X7R	12340	C0603C102K5RAC
C809	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C810	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C811	0160-8361		CAP-FXD 0.22UF +-10PCT 25 V CER X7R	06352	C2012X7R1E224K

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C812	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C813	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C814 - C815	0160-8361		CAP-FXD 0.22UF +-10PCT 25 V CER X7R	06352	C2012X7R1E224K
C816	0160-7748		CAP-FXD 1000PF +-10PCT 50 V CER X7R	12340	C0603C102K5RAC
C901	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C902	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C903	0160-8239	5	CAP-FXD 33PF +-1PCT 50 V CER C0G	12340	C0805C330F5GAC
C904	0160-8475	6	CAP-FXD 56PF +-1PCT 50 V CER C0G	12340	C0805C560F5GAC
C905	0160-7722	2	CAP-FXD 39PF +-1PCT 50 V CER C0G	12340	C0805C390F5GAC
C906	0160-7775	3	CAP-FXD 5.6PF +-4.5PCT 50 V CER C0G	13853	0603G5R6C500ST
C907	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C908	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C911 - C913	0160-8475		CAP-FXD 56PF +-1PCT 50 V CER C0G	12340	C0805C560F5GAC
C914	0160-7728	1	CAP-FXD 62PF +-1PCT 50 V CER C0G	02010	08055A620FAT_A
C915	0160-7737		CAP-FXD 130PF +-1PCT 50 V CER C0G	02010	08055A131FAT_A
C916	0160-7841	4	CAP-FXD 15PF +-5PCT 50 V CER C0G	06352	C1608C0G1H150J
C917	0160-7733	1	CAP-FXD 100PF +-1PCT 50 V CER C0G	12340	C0805C101F5GAC
C918	0160-7775		CAP-FXD 5.6PF +-4.5PCT 50 V CER C0G	13853	0603G5R6C500ST
C919	0160-7757	5	CAP-FXD 47PF +-1PCT 50 V CER C0G	12340	C0805C470F5GAC
C921	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C922	0160-7324	3	CAP-FXD 120PF +-1PCT 50 V CER C0G	12340	C0805C121F5GAC
C923	0160-7867	1	CAP-FXD 6.8PF +-3.68PCT 50 V CER C0G	13853	0603G6R8C500ST
C924	0160-7307	1	CAP-FXD 180PF +-1PCT 50 V CER C0G	12340	C0805C181F5GAC
C925	0160-7850	3	CAP-FXD 27PF +-5PCT 50 V CER C0G	45178	223886715279
C926	0160-7714		CAP-FXD 150pF +-1pct 50 V CER C0G	12340	C0805C151F5GAC
C927	0160-7834	6	CAP-FXD 10PF +-5PCT 50 V CER C0G	12340	C0603C100J5GAC
C928	0160-7324		CAP-FXD 120PF +-1PCT 50 V CER C0G	12340	C0805C121F5GAC
C929	0160-8239		CAP-FXD 33PF +-1PCT 50 V CER C0G	12340	C0805C330F5GAC
C930	0160-7722		CAP-FXD 39PF +-1PCT 50 V CER C0G	12340	C0805C390F5GAC
C932	0160-7757		CAP-FXD 47PF +-1PCT 50 V CER C0G	12340	C0805C470F5GAC
C934	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C936	0180-4758	11	CAP-FXD 47UF +-20PCT 20 V TA	12340	T491D476M020AS
C937	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C938	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C939	0160-7771	2	CAP-FXD 8.2PF +-3PCT 50 V CER C0G	02010	06035A8R2CAT
C940	0160-8475		CAP-FXD 56PF +-1PCT 50 V CER C0G	12340	C0805C560F5GAC
C941	0160-7721	1	CAP-FXD 82PF +-1PCT 50 V CER C0G	12340	C0805C820F5GAC
C942	0160-7757		CAP-FXD 47PF +-1PCT 50 V CER C0G	12340	C0805C470F5GAC
C943 - C945	0160-8239		CAP-FXD 33PF +-1PCT 50 V CER C0G	12340	C0805C330F5GAC
C946	0160-7714		CAP-FXD 150pF +-1pct 50 V CER C0G	12340	C0805C151F5GAC
C947	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C948 - C949	0160-7835		CAP-FXD 100PF +-5PCT 50 V CER C0G	12340	C0603C101J5GAC
C951	0160-7853	2	CAP-FXD 3.3PF +-7.6PCT 50 V CER C0G	02010	06035A3R3CAT
C952	0160-7324		CAP-FXD 120PF +-1PCT 50 V CER C0G	12340	C0805C121F5GAC
C953	0160-7714		CAP-FXD 150pF +-1pct 50 V CER C0G	12340	C0805C151F5GAC

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C954	0160-7771		CAP-FXD 8.2PF +-3PCT 50 V CER C0G	02010	06035A8R2CAT
C955	0160-8157		CAP-FXD 330pF +-1pct 50 V CER C0G	02010	08055A331FATA
C956	0160-8475		CAP-FXD 56PF +-1PCT 50 V CER C0G	12340	C0805C560F5GAC
C958 - C959	0160-7835		CAP-FXD 100PF +-5PCT 50 V CER C0G	09939	GRM1885C1H101JD51D
C960	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C961	0180-4758		CAP-FXD 47UF +-20PCT 20 V TA	12340	T491D476M020AS
C962	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C963	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C964	0160-7715		CAP-FXD 470pF +-1pct 50 V CER C0G	12340	C0805C471F5GAC
C965	0160-7850		CAP-FXD 27PF +-5PCT 50 V CER C0G	45178	223886715279
C966	0160-7305	1	CAP-FXD 220PF +-1PCT 50 V CER C0G	12340	C0805C221F5GAC
C967	0160-7714		CAP-FXD 150pF +-1pct 50 V CER C0G	12340	C0805C151F5GAC
C968	0160-7792		CAP-FXD 18PF +-5PCT 50 V CER C0G	02010	06035A180JAT
C969 - C970	0160-7757		CAP-FXD 47PF +-1PCT 50 V CER C0G	12340	C0805C470F5GAC
C971	0160-7841		CAP-FXD 15PF +-5PCT 50 V CER C0G	06352	C1608C0G1H150J
C972	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C973 - C974	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C975	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C979 - C980	0160-8361		CAP-FXD 0.22UF +-10PCT 25 V CER X7R	06352	C2012X7R1E224K
C981	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C982	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C983	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C984	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C985	0160-7830	1	CAP-FXD 1PF +-25PCT 50 V CER C0G	12340	C0603C109C5GAC
C1001	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1002	0160-8361		CAP-FXD 0.22UF +-10PCT 25 V CER X7R	06352	C2012X7R1E224K
C1003 - C1005	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1006	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C1007 - C1008	0160-8961		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1009	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C1010 - C1012	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1013	0160-6108	3	CAP-FXD 4700pF +-5pct 50 V CER C0G	12340	C1206C472J5GAC
C1014	0160-7834		CAP-FXD 10PF +-5PCT 50 V CER C0G	12340	C0603C100J5GAC
C1015	0160-6108		CAP-FXD 4700pF +-5pct 50 V CER C0G	12340	C1206C472J5GAC
C1016	0160-8625	1	CAP-FXD 3300PF +-5PCT 50 V CER C0G	12340	C1206C332J5GAC
C1017	0160-7749	1	CAP-FXD 22PF +-5PCT 50 V CER C0G	12340	C0603C220J5GAC
C1018	0160-7775		CAP-FXD 5.6PF +-4.5PCT 50 V CER C0G	13853	0603G5R6C500ST
C1019	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1021 - C1024	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1025	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C1026	0160-6108		CAP-FXD 4700pF +-5pct 50 V CER C0G	12340	C1206C472J5GAC
C1027	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C1028 - C1029	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1030	0160-8361		CAP-FXD 0.22UF +-10PCT 25 V CER X7R	06352	C2012X7R1E224K
C1031	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC

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C1101	0160-7708	6	CAP-FXD 1000PF +-5PCT 50 V CER C0G	12340	C0805C102J5GAC
C1102 - C1103	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1104	0160-7708		CAP-FXD 1000PF +-5PCT 50 V CER C0G	12340	C0805C102J5GAC
C1105	0160-7850		CAP-FXD 27PF +-5PCT 50 V CER C0G	45178	223886715279
C1106	0160-7853		CAP-FXD 3.3PF +-7.6PCT 50 V CER C0G	02010	06035A3R3CAT
C1107	0160-7835	12	CAP-FXD 100PF +-5PCT 50 V CER C0G	12340	C0603C101J5GAC
C1108	0160-7835		CAP-FXD 100PF +-5PCT 50 V CER C0G	12340	C0603C101J5GAC
C1109 - C1110	0160-7792		CAP-FXD 18PF +-5PCT 50 V CER C0G	12340	C0603C180J5GAC
C1111 - C1112	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1115	0160-7708		CAP-FXD 1000PF +-5PCT 50 V CER C0G	12340	C0805C102J5GAC
C1117 - C1122	0160-7835		CAP-FXD 100PF +-5PCT 50 V CER C0G	12340	C0603C101J5GAC
C1123	0160-7748		CAP-FXD 1000PF +-10PCT 50 V CER X7R	09939	GRM188R71H102KA01D
C1124	0160-7736		CAP-FXD 1UF +-10PCT 16 V CER X7R	12340	C1206C105K4RAC
C1125 - C1126	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1127	0160-7736		CAP-FXD 1UF +-10PCT 16 V CER X7R	12340	C1206C105K4RAC
C1128	0160-7751		CAP-FXD 0.01UF +-10PCT 50 V CER X7R	09939	GRM188R71H103KA01D
C1129	0160-7748		CAP-FXD 1000PF +-10PCT 50 V CER X7R	09939	GRM188R71H102KA01D
C1130	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1131	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C1132	0160-7736		CAP-FXD 1UF +-10PCT 16 V CER X7R	09939	GRM31MR71C105KA01L
C1133	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C1134	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1135 - C1142	0180-4758		CAP-FXD 47UF +-20PCT 20 V TA	12340	T491D476M020AS
C1143 - C1150	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1201	0180-3809	3	CAP-FXD 470UF +-20PCT 25 V AL-ELCTLT	00779	UPW1E471MPH10X16
C1203	0180-3809		CAP-FXD 470UF +-20PCT 25 V AL-ELCTLT	00779	UPW1E471MPH10X16
C1204	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1205	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C1206	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1208 - C1209	0160-7849		CAP-FXD 220PF +-5PCT 50 V CER C0G	12340	C0603C221J5GAC
C1210	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C1212	0160-5944	2	CAP-FXD 0.047uF +-10pct 50 V CER X7R	12340	C0805C473K5RAC
C1213	0160-7708		CAP-FXD 1000PF +-5PCT 50 V CER C0G	12340	C0805C102J5GAC
C1214	0160-8361		CAP-FXD 0.22UF +-10PCT 25 V CER X7R	06352	C2012X7R1E224K
C1215	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C1216	0160-5944		CAP-FXD 0.047uF +-10pct 50 V CER X7R	12340	C0805C473K5RAC
C1217	0160-8361		CAP-FXD 0.22UF +-10PCT 25 V CER X7R	06352	C2012X7R1E224K
C1218	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1219	0180-4758		CAP-FXD 47UF +-20PCT 20 V TA	12340	T491D476M020AS
C1301 - C1302	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1303	0160-7988	1	CAP-FXD 470PF +-5PCT 50 V CER C0G	09939	GRM1885C1H471HA01D
C1304	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1305	0160-7736		CAP-FXD 1UF +-10PCT 16 V CER X7R	09939	GRM31MR71C105KA01L
C1306	0180-4480	2	CAP-FXD 220uF +-20pct 50 V AL-ELCTLT	06360	LXV50VB221M10X25LL
C1307	0160-7575	1	CAP-FXD 0.22UF +-10PCT 50 V CER X7R	12340	C1210C224K5RAC

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
C1308	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1310	0180-3809		CAP-FXD 470UF +-20PCT 25 V AL-ELCTLT	00779	UPW1E471MPH10X16
C1311	0180-4918		CAP-FXD 100UF +-20PCT 10 V TA	12340	T491D107M010AS
C1312	0180-4535	1	CAP-FXD 47UF +-20PCT 20 V TA	12340	T495X476M020AS
C1313	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1314 - C1315	0160-7834		CAP-FXD 10PF +-5PCT 50 V CER C0G	12340	C0603C100J5GAC
C1316	0160-7841		CAP-FXD 15PF +-5PCT 50 V CER C0G	06352	C1608C0G1H150J
C1317 - C1318	0160-7834		CAP-FXD 10PF +-5PCT 50 V CER C0G	12340	C0603C100J5GAC
C1319	0180-4918		CAP-FXD 100UF +-20PCT 10 V TA	12340	T491D107M010AS
C1320	0160-7748		CAP-FXD 1000PF +-10PCT 50 V CER X7R	12340	C0603C102K5RAC
C1321	0160-7841		CAP-FXD 15PF +-5PCT 50 V CER C0G	02010	06035A150JAT
C1322 - C1323	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C1325	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C1327	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1328	0160-8006	1	CAP-FXD 1200PF +-5PCT 50 V CER C0G	12340	C0805C122J5GAC
C1329	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C1331	0160-8152	2	CAP-FXD 0.022UF +-10PCT 500 V CER X7R	03521	500S41W223KV6
C1332	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	12340	C0805C104K5RAC
C1333	0160-8152		CAP-FXD 0.022UF +-10PCT 500 V CER X7R	03521	500S41W223KV6
C1334	0180-4918		CAP-FXD 100UF +-20PCT 10 V TA	12340	T491D107M010AS
C1335	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C1336	0160-7748		CAP-FXD 1000PF +-10PCT 50 V CER X7R	12340	C0603C102K5RAC
C1337	0160-8361		CAP-FXD 0.22UF +-10PCT 25 V CER X7R	06352	C2012X7R1E224K
C1338	0180-4480		CAP-FXD 220uF +-20pct 50 V AL-ELCTLT	06360	LXV50VB221M10X25LL
CR206	1906-0291	8	DIODE-DUAL 70V 100MA T0-236AA	02910	BAV99
CR301 - CR302	1906-0395	9	DIODE-DUAL 75V TO-253	36393	BAS28
CR501	1906-0291		DIODE-DUAL 70V 100MA T0-236AA	02910	BAV99
CR502	1902-1563	1	DIODE-ZNR 2.7V 2PCT TO-236 (SOT-23)	02910	BZX84-B2V7
CR701	1906-0291		DIODE-DUAL 70V 100MA T0-236AA	02910	BAV99
CR702	1901-1276	2	DIODE-V-SUPPR D0-214AA	05524	SMBJ5.0A
CR703	1906-0334	1	DIODE-DUAL 200V 200MA T0-236AA	02237	MMBD1503
CR704	1901-1276		DIODE-V-SUPPR D0-214AA	05524	SMBJ5.0A
CR705	1906-0291		DIODE-DUAL 70V 100MA T0-236AA	02910	BAV99
CR801 - CR802	1900-0202	2	DIODE-SCHOTTKY SM SIG	02364	HSMS-2825-TR1
CR901	1906-0320	1	DIODE-DUAL 40V 40MA T0-236AA	36393	BAS 40-04
CR1001	1902-1804	2	DIODE-ZNR 3V PD=.3W IR=10UA	02910	BZX84-C3V0
CR1002	1906-0291		DIODE-DUAL 70V 100MA T0-236AA	02910	BAV99
CR1003-CR1004	1900-0321	2	DIODE-PAIR MATCHED	02364	HSMS-2865-TR2
CR1005	1902-1804		DIODE-ZNR 3V PD=.3W IR=10UA	02910	BZX84-C3V0
CR1006	1906-0291		DIODE-DUAL 70V 100MA T0-236AA	02910	BAV99
CR1101	1902-1583	2	DIODE-ZNR 5.1V 5PCT PD=1.5W IR=5UA	36633	1SMB5918BT3
CR1102	1906-0291		DIODE-DUAL 70V 100MA T0-236AA	02910	BAV99
CR1103	1902-1583		DIODE-ZNR 5.1V 5PCT PD=1.5W IR=5UA	36633	1SMB5918BT3
CR1104	1906-0291		DIODE-DUAL 70V 100MA T0-236AA	02910	BAV99
CR1105	1906-0395		DIODE-DUAL 75V TO-253	36393	BAS28

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
CR1201-CR1203	1906-0395		DIODE-DUAL 75V TO-253	36393	BAS28
CR1204	1901-1366	1	DIODE-PWR-S 40V 4A	05524	SS34
CR1205	1906-0395		DIODE-DUAL 75V TO-253	36393	BAS28
CR1206-CR1207	1901-1352	4	DIODE-PWR-S 30V 1A	36633	MBRS130LT3
CR1208	1906-0395		DIODE-DUAL 75V TO-253	36393	BAS28
CR1301	1906-0395		DIODE-DUAL 75V TO-253	36393	BAS28
CR1302-CR1303	1901-1544	6	DIODE-PWR RECT 60V 1A	36633	MBRS1100T3
CR1304-CR1305	1901-1352		DIODE-PWR-S 30V 1A	36633	MBRS130LT3
CR1306	1902-1574	1	DIODE-ZNR 6.8V 5PCT TO-236 (SOT-23)	02910	BZX84C6V8
CR1307-CR1310	1901-1544		DIODE-PWR RECT 60V 1A	36633	MBRS1100T3
CR1311	1901-1335	1	DIODE-PWR RECT 400V 1A 50NS	36633	MURS140T3
DP201	9164-0173	1	ALARM-AUDIBLE PIEZO ALARM PIN TYPE; 25V	09939	PKM22EPP-40S2-B0
HS1305	1205-0686	2	HEAT SINK SGL TO-220-CS	07179	576802B04000
HS1308	1205-0686		HEAT SINK SGL TO-220-CS	07179	576802B04000
J101	1252-8483	1	CONN-RECT USB 4-CKT 4-CONT	03418	67488-0001
J201	1252-8157	1	CONN-POST TYPE .5MM-PIN-SPCG-MTG-END	03418	52559-4092
J202	1252-2161	1	CONN-RECT MICRORBN 24-CKT 24-CONT	01380	554923-2
J203	1253-5030	1	MODULAR-JACK 8-PIN RJ-45	07398	0810-1X1T-03
J301	1252-1325	3	CONN-POST TYPE .100-PIN-SPCG-MTG-END	04726	N2510-6002UB
J302	1250-2913	1	CONNECTOR-RF BNC FEMALE PC-W-STDFS	01380	413879-2
J401	1252-7431	1	CONN-SKT VERT SMT 38-POS 0.64MM 2-ROWS	01380	2-767004-2
J501	1252-1325		CONN-POST TYPE .100-PIN-SPCG-MTG-END	04726	N2510-6002UB
J601	1252-1325		CONN-POST TYPE .100-PIN-SPCG-MTG-END	04726	N2510-6002UB
J602	1250-3241	2	CONN-BNC FEMALE THD-JACK PC-EDGE MOUNT	12355	361V504ET
J701	1250-2110	1	CONNECTOR-RF BNC FEMALE PC-W-STDFS	01380	227161-7
J1101	1250-3241		CONN-BNC FEMALE THD-JACK PC-EDGE MOUNT	12355	361V504ET
J1201	1251-8031		CONN-POST TYPE .156-PIN-SPCG-MTG-END	03418	26-60-4060
J1202	1251-5066	1	CONN-POST TYPE 2.5-PIN-SPCG-MTG-END	03418	22-04-1021
K901 - K902	0490-2665	6	RELAY 2C 3VDC-COIL 2A 30VDC	00467	G6SU-2F-DC3
K1101 - K1104	0490-2665		RELAY 2C 3VDC-COIL 2A 30VDC	00467	G6SU-2F-DC3
K1105	0490-2666	1	RELAY 2C 4.5VDC-COIL 2A 30VDC	01850	TX2SA-4.5
K1201	0490-2653	1	RELAY 2C 12VDC-COIL 2A LOW-SIGNAL	00467	G6SK-2F-DC12
L301	9140-2193	4	INDUCTOR 330NH +2PCT -2PCT	01886	1008CS-331XGB
L501	9140-2045	3	INDUCTOR 680NH +2PCT -2PCT	01886	1008CS-681XGBC
L601	9140-1508	2	INDUCTOR 100UH +-5PCT 2.8W-MMX3.4LG-MM	09891	KL32TE101J
L901	9140-1508		INDUCTOR 100UH +-5PCT 2.8W-MMX3.4LG-MM	09891	KL32TE101J
L902 - L903	9140-2044	4	INDUCTOR 470NH +2PCT -2PCT	01886	1008CS-471XGBC
L905	9140-2046	1	INDUCTOR 750NH +2PCT -2PCT	01886	1008CS-751XGBC
L909	9140-2194	1	INDUCTOR 390NH +2PCT -2PCT	01886	1008CS-391XGB
L910	9140-2193		INDUCTOR 330NH +2PCT -2PCT	01886	1008CS-331XGB
L911	9140-2193		INDUCTOR 330NH +2PCT -2PCT	01886	1008CS-331XGB
L912	9140-1206	1	INDUCTOR 100nH +-5pct 2.8W-mmX3.4LG-mm	09891	KL32TER10J
L913	9140-2044		INDUCTOR 470NH +2PCT -2PCT	01886	1008CS-471XGBC
L914	9140-2045		INDUCTOR 680NH +2PCT -2PCT	01886	1008CS-681XGBC

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
L915	9140-1716	1	INDUCTOR-FIXED	01886	1008HS-911TGBC
L916	9140-2045		INDUCTOR 680NH +2PCT -2PCT	01886	1008CS-681XGBC
L917	9140-2044		INDUCTOR 470NH +2PCT -2PCT	01886	1008CS-471XGBC
L918	9140-2193		INDUCTOR 330NH +2PCT -2PCT	01886	1008CS-331XGB
L919	9140-1600	1	INDUCTOR 1.2uH +-5pct 2.8W-mmX3.4LG-mm	06352	NL322522T-1R2J
L1001	9140-1244	2	INDUCTOR 1MH +-5PCT 3.4W-MMX4.8LG-MM Q=30	06352	NL453232T-102J
L1003	9140-1205	1	INDUCTOR 82NH +-5PCT 2.8W-MMX3.4LG-MM Q=27	06352	NL322522T-082J
L1101	9140-1424	1	INDUCTOR 180NH +-5PCT 2.8W-MMX3.4LG-MM	09891	KL32TER18J
L1104	9140-1244		INDUCTOR 1MH +-5PCT 3.4W-MMX4.8LG-MM Q=30	06352	NL453232T-102J
L1201	9140-2329	1	INDUCTOR 68uH +20pct -20pct SHIELDED	01886	DS5022P-683
L1202 - L1203	9140-5144	2	INDUCTOR-FXD 3.9uH +-20PCT SMT	01886	1812PS-392M
L1301	9140-1950	1	INDUCTOR 10UH +20PCT -20PCT	01886	DT3316P-103
L1302	9140-2477	2	SURFACE MOUNT FXD IDCTR 220uH +-20.0 pct	01886	DT3316P-224
L1303	9140-1999	1	INDUCTOR 33uH +20pct -20pct .37W-INX.51LG-IN	01886	DT3316P-333
L1304 - L1306	9140-2512	3	INDUCTOR 150UH +20PCT -20PCT SHIELDED	01886	DT3316P-154
L1307	9140-2477		SURFACE MOUNT FXD IDCTR 220uH +-20.0 pct	01886	DT3316P-224
Q901	1853-0568	2	TRANSISTOR PNP SI TO-236AA PD=350MW	36633	MMBT5087LT1
Q1001	1855-0480	1	TRANSISTOR J-FET N-CHAN D-MODE SOT-23	05524	SST4416
Q1002	1853-0568		TRANSISTOR PNP SI TO-236AA PD=350MW	36633	MMBT5087LT1
Q1003	1855-0731	1	TRANSISTOR J-FET P-CHAN D-MODE TO-236AA	02910	PMBFJ175
Q1004	1854-1014	1	TRANSISTOR NPN SI TO-236AA PD=350MW	36633	MMBT6429LT1
Q1101	1855-0734	3	TRANSISTOR MOSFET 2N7002 N-CHAN E-MODE	36393	SN7002
Q1201	1853-0567	1	TRANSISTOR PNP SI SOT-23 (TO-236AB)	00746	SST3906T116
Q1202	1855-0734		TRANSISTOR MOSFET 2N7002 N-CHAN E-MODE	36393	SN7002
Q1203	1855-0734		TRANSISTOR MOSFET 2N7002 N-CHAN E-MODE	36393	SN7002
Q1204	1855-1101	1	TRANSISTOR-MOSFET DUAL P-CHAN E-MODE SI	05524	SI9953DY
Q1205	1854-1037	1	TRANSISTOR NPN SI TO-236AA PD=350MW	00746	SST3904T116
Q1301 - Q1302	1855-0800	2	TRANSISTOR MOSFET N-CHAN E-MODE TO-252AA	36633	MTD3055VL
R101	0699-3970	36	RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R104	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R201 - R202	0699-3918	15	RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R204	0699-3993	15	RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R206	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R210 - R213	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R215	0699-3972	1	RESISTOR 12.1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1212F
R216 - R217	0699-3918		RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R218	0699-3901	8	RESISTOR 10 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J10R0F
R223 - R224	0699-3911	3	RESISTOR 26.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J26R1F
R225 - R226	0699-3918		RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R227	0699-3911		RESISTOR 26.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J26R1F
R228	0699-3574	4	RESISTOR 0 .0625W TKF	05524	CRCW0603000
R301	0699-3918		RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R303	0699-3974	4	RESISTOR 14.7K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1472F
R304 - R306	0699-1419	3	RESISTOR 147 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT1470F
R307	0699-3937	7	RESISTOR 348 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J3480F

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
R308 - R309	0699-3931	5	RESISTOR 196 +-1PCT .063W TKF TC=0+-200	00746	MCR03-F-1960
R310	0699-3937		RESISTOR 348 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J3480F
R311	0699-3931		RESISTOR 196 +-1PCT .063W TKF TC=0+-200	00746	MCR03-F-1960
R312 - R313	0699-3937		RESISTOR 348 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J3480F
R314	0699-3931		RESISTOR 196 +-1PCT .063W TKF TC=0+-200	00746	MCR03-F-1960
R315	0699-3937		RESISTOR 348 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J3480F
R316	0699-3954	5	RESISTOR 1.96K +-1pct .063W TKF TC=0+-200	09891	RK73H1J1961F
R401	0699-3574		RESISTOR 0 .0625W TKF	05524	CRCW0603000
R505	0699-1357	5	RESISTOR 34.8 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT34R8F
R506	0699-3918		RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R601 - R603	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R604	0699-3954		RESISTOR 1.96K +-1pct .063W TKF TC=0+-200	09891	RK73H1J1961F
R606	0699-3954		RESISTOR 1.96K +-1pct .063W TKF TC=0+-200	09891	RK73H1J1961F
R607 - R608	0699-3918		RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R609	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R610	0699-3918		RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R701	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R702	0699-2489	10	RESISTOR 10K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1002B
R703	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R704	0699-3947	8	RESISTOR 1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1001F
R705	0699-3942	3	RESISTOR 619 +-1PCT .063W TKF TC=0+-200	05524	CRCW06036190F
R706 - R708	0699-3966	4	RESISTOR 6.81K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J6811F
R709	0699-2530	1	RESISTOR 100 +-1PCT .25W TKF TC=0+-100	09891	RK73H2ETE1000F
R710	0699-2483	1	RESISTOR 4K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE4001B
R712	0699-4002	1	RESISTOR 237K +-1pct .063W TKF TC=0+-200	09891	RK73H1J2373F
R713	0699-2489		RESISTOR 10K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1002B
R714	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R715	0699-2490	1	RESISTOR 1K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1001B
R716 - R720	0699-2489		RESISTOR 10K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1002B
R801 - R802	0699-3954		RESISTOR 1.96K +-1pct .063W TKF TC=0+-200	09891	RK73H1J1961F
R803 - R804	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R805	0699-4503	2	RESISTOR 24.9K +-1PCT .063W TKF TC=0+-200	45178	232270462493
R806	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R807	0699-4830	3	RESISTOR 33.2K +-1pct .063W TKF TC=0+-200	09891	RK73H1J3322F
R808	0699-4503		RESISTOR 24.9K +-1PCT .063W TKF TC=0+-200	45178	232270462493
R809	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R810	0699-4830		RESISTOR 33.2K +-1pct .063W TKF TC=0+-200	09891	RK73H1J3322F
R901	0699-3947		RESISTOR 1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1001F
R902	0699-2488	4	RESISTOR 100 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1000B
R906	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R907	0699-2832	2	RESISTOR 200 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE2000B
R908	0699-3604	2	RESISTOR 909 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE9090B
R909	0699-2488		RESISTOR 100 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1000B
R910	0699-1357		RESISTOR 34.8 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT34R8F
R911 - R912	0699-3763	2	RESISTOR 69 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE69R0B

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
R913	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R914	0699-2832		RESISTOR 200 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE2000B
R915	0699-3604		RESISTOR 909 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE9090B
R916	0699-1425	2	RESISTOR 261 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT2610F
R917	0699-2847	1	RESISTOR 2K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE2001B
R918	0699-2488		RESISTOR 100 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1000B
R919	0699-3931		RESISTOR 196 +-1PCT .063W TKF TC=0+-200	00746	MCR03-F-1960
R921	0699-1425		RESISTOR 261 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT2610F
R923	0699-2488		RESISTOR 100 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1000B
R924	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R925	0699-3991	1	RESISTOR 82.5K +-1PCT .063W TKF TC=0+-200	00746	MCR03-F-8252
R926	0699-3947		RESISTOR 1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1001F
R927	0699-3828	5	RESISTOR 21.5 +-1PCT .1W TKF TC=0+-100	45178	232273462159
R929	0699-3918		RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R931 - R933	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R934	0699-3918		RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R1001	0699-2720	2	RESISTOR 5.11K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE5111B
R1002	0699-2835	2	RESISTOR 500 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE5000B
R1003	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1006	0699-3909	3	RESISTOR 21.5 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J21R5F
R1007	0699-3848	2	RESISTOR 2.05K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2B2051B
R1008	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1009	0699-3951	1	RESISTOR 1.47K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1471F
R1010 - R1011	0699-2489		RESISTOR 10K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1002B
R1012	0699-3574		RESISTOR 0 .0625W TKF	05524	CRCW0603000
R1013	0699-3942		RESISTOR 619 +-1PCT .063W TKF TC=0+-200	05524	CRCW06036190F
R1014	0699-3937		RESISTOR 348 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J3480F
R1015	0699-3909		RESISTOR 21.5 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J21R5F
R1016	0699-3947		RESISTOR 1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1001F
R1017	0699-3828		RESISTOR 21.5 +-1PCT .1W TKF TC=0+-100	45178	232273462159
R1018	0699-1357		RESISTOR 34.8 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT34R8F
R1019	0699-3930	1	RESISTOR 178 +-1PCT .063W TKF TC=0+-200	45178	232270461781
R1020 - R1021	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R1022	0699-3942		RESISTOR 619 +-1PCT .063W TKF TC=0+-200	05524	CRCW06036190F
R1023	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R1025	0699-3936	5	RESISTOR 316 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J3160F
R1026	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1027	0699-3936		RESISTOR 316 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J3160F
R1028	0699-3848		RESISTOR 2.05K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2B2051B
R1029	0699-3936		RESISTOR 316 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J3160F
R1032	0699-3909		RESISTOR 21.5 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J21R5F
R1033	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1034	0699-2720		RESISTOR 5.11K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE5111B
R1035	0699-2835		RESISTOR 500 +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE5000B
R1101	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
R1103	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R1104	0699-3978	5	RESISTOR 21.5K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J2152F
R1105	0699-3918		RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R1106	0699-3918		RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
R1107	0699-1357		RESISTOR 34.8 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT34R8F
R1108	0699-1357		RESISTOR 34.8 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT34R8F
R1109	0699-3828		RESISTOR 21.5 +-1PCT .1W TKF TC=0+-100	45178	232273462159
R1110	0699-1362	9	RESISTOR 56.2 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT56R2F
R1111 - R1114	0699-4332	6	RESISTOR 21.5 +-1pct .5W TKF TC=0+-100	09891	RK73H2HTE21R5F
R1115	0699-3947		RESISTOR 1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1001F
R1116	0699-1362		RESISTOR 56.2 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT56R2F
R1117 - R1120	0699-4332		RESISTOR 21.5 +-1pct .5W TKF TC=0+-100	09891	RK73H2HTE21R5F
R1121	0699-4751	1	RESISTOR 30.1K +-1PCT .063W TKF TC=0+-200	01172	MC06033012-FT
R1122	0699-3960	1	RESISTOR 3.48K +-1PCT .063W TKF TC=0+-200	45178	232270463482
R1123	0699-2972	4	RESISTOR 178 +-1PCT .1W TKF TC=0+-100	09891	RK73H2A1780F
R1124	0699-1438	5	RESISTOR 909 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT9090F
R1125	0699-3978		RESISTOR 21.5K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J2152F
R1126	0699-1429	8	RESISTOR 383 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT3830F
R1127	0699-3028	2	RESISTOR 287 +-1pct .1W TKF TC=0+-100	09891	RK73H2A2870F
R1128	0699-1429		RESISTOR 383 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT3830F
R1129	0699-3060	1	RESISTOR 237 +-1PCT .1W TKF TC=0+-100	09891	RK73H2A2370F
R1130	0699-3975	1	RESISTOR 16.2K +-1PCT .063W TKF TC=0+-200	45178	232270461623
R1131	0699-1429		RESISTOR 383 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT3830F
R1132	0699-3828		RESISTOR 21.5 +-1PCT .1W TKF TC=0+-100	45178	232273462159
R1133	0699-1362		RESISTOR 56.2 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT56R2F
R1134	0699-1429		RESISTOR 383 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT3830F
R1135	0699-3028		RESISTOR 287 +-1pct .1W TKF TC=0+-100	09891	RK73H2A2870F
R1136	0699-1429		RESISTOR 383 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT3830F
R1137	0699-3630	1	RESISTOR 249 +-1PCT .1W TKF TC=0+-100	09891	RK73H2A2490F
R1138	0699-3032	1	RESISTOR 511 +-1PCT .1W TKF TC=0+-100	09891	RK73H2A5110F
R1139	0699-1429		RESISTOR 383 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT3830F
R1140	0699-1362		RESISTOR 56.2 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT56R2F
R1141	0699-1429		RESISTOR 383 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT3830F
R1142	0699-3977	7	RESISTOR 19.6K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1962F
R1143	0699-2932	1	RESISTOR 3.6K +-0.1pct TF TC=0+-25	09891	RN73E2BTE3601B
R1144	0699-2972		RESISTOR 178 +-1PCT .1W TKF TC=0+-100	09891	RK73H2A1780F
R1145	0699-1438		RESISTOR 909 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT9090F
R1146	0699-4001	3	RESISTOR 215K +-1PCT .063W TKF TC=0+-200	45178	232270462154
R1147	0699-2489		RESISTOR 10K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1002B
R1148	0699-3223	1	RESISTOR 45.3K +-0.1PCT .125W TF TC=0+-25	05524	PTN1206E4532BB
R1149	0699-3901		RESISTOR 10 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J10R0F
R1150 - R1152	0699-3059	3	RESISTOR 162 +-1PCT .1W TKF TC=0+-100	09891	RK73H2A1620F
R1153	0699-3828		RESISTOR 21.5 +-1PCT .1W TKF TC=0+-100	45178	232273462159
R1154	0699-1362		RESISTOR 56.2 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT56R2F
R1155	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
R1156	0699-2887	1	RESISTOR 31.6 +-1PCT .1W TKF TC=0+-100	09891	RK73H2A31R6F
R1157	0699-1362		RESISTOR 56.2 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT56R2F
R1158	0699-3367	4	RESISTOR 5.62K +-1pct .0625W TKF TC=0+-200	00746	MCR03-F-5621
R1159	0699-3901		RESISTOR 10 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J10R0F
R1160	0699-2972		RESISTOR 178 +-1PCT .1W TKF TC=0+-100	09891	RK73H2A1780F
R1161	0699-1438		RESISTOR 909 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT9090F
R1163	0699-3602	1	RESISTOR 12.4K +-0.1PCT .125W TF TC=0+-25	09891	RN73E2BTE1242B
R1164	0699-3670	2	RESISTOR 59K +-1PCT .1W TKF TC=0+-100	09891	RK73H2A5902F
R1165	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R1166	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1167	0699-3828		RESISTOR 21.5 +-1PCT .1W TKF TC=0+-100	45178	232273462159
R1168	0699-1362		RESISTOR 56.2 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT56R2F
R1169	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R1170	0699-1362		RESISTOR 56.2 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT56R2F
R1171 - R1172	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1173 - R1174	0699-3901		RESISTOR 10 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J10R0F
R1175	0699-2972		RESISTOR 178 +-1PCT .1W TKF TC=0+-100	09891	RK73H2A1780F
R1176	0699-1438		RESISTOR 909 +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT9090F
R1177	0699-4001		RESISTOR 215K +-1PCT .063W TKF TC=0+-200	45178	232270462154
R1178	0699-3986	3	RESISTOR 46.4K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J4642F
R1179	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R1180 - R1181	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1182	0699-3367		RESISTOR 5.62K +-1pct .0625W TKF TC=0+-200	00746	MCR03-F-5621
R1183	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1201	0699-3901		RESISTOR 10 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J10R0F
R1202	0699-1503	9	RESISTOR 0 CWM	09891	RM73Z2BT
R1203 - R1204	0699-3974		RESISTOR 14.7K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1472F
R1205	0699-3986		RESISTOR 46.4K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J4642F
R1206 - R1207	0699-4009	6	RESISTOR 464K +-1PCT .063W TKF TC=0+-200	05524	CRCW06034643F
R1208	0699-1503		RESISTOR 0 CWM	09891	RM73Z2BT
R1209	0699-3974		RESISTOR 14.7K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1472F
R1210	0699-3986		RESISTOR 46.4K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J4642F
R1211 - R1212	0699-3977		RESISTOR 19.6K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1962F
R1213	0699-3966		RESISTOR 6.81K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J6811F
R1214	0699-1503		RESISTOR 0 CWM	09891	RM73Z2BT
R1215	0699-3367		RESISTOR 5.62K +-1pct .0625W TKF TC=0+-200	00746	MCR03-F-5621
R1216	0699-4016	5	RESISTOR 1M +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1004F
R1217 - R1218	0699-4009		RESISTOR 464K +-1PCT .063W TKF TC=0+-200	05524	CRCW06034643F
R1219	0699-4016		RESISTOR 1M +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1004F
R1220	0699-3947		RESISTOR 1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1001F
R1221	0699-4016		RESISTOR 1M +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1004F
R1222	0699-3978		RESISTOR 21.5K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J2152F
R1223	0699-4001		RESISTOR 215K +-1PCT .063W TKF TC=0+-200	45178	232270462154
R1224	0699-1362		RESISTOR 56.2 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT56R2F
R1225	0699-4009		RESISTOR 464K +-1PCT .063W TKF TC=0+-200	05524	CRCW06034643F

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
R1226	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1227	0699-4016		RESISTOR 1M +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1004F
R1228	0699-3976	1	RESISTOR 17.8K +-1pct .063W TKF TC=0+-200	09891	RK73H1J1782F
R1229	0699-4016		RESISTOR 1M +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1004F
R1230	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1231	0699-4830		RESISTOR 33.2K +-1pct .063W TKF TC=0+-200	09891	RK73H1J3322F
R1232	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1233	0699-4009		RESISTOR 464K +-1PCT .063W TKF TC=0+-200	05524	CRCW06034643F
R1234	0699-3901		RESISTOR 10 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J10R0F
R1301	0699-3947		RESISTOR 1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1001F
R1302	0699-3367		RESISTOR 5.62K +-1pct .0625W TKF TC=0+-200	00746	MCR03-F-5621
R1303	0699-3993		RESISTOR 100K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1003F
R1304	0699-3977		RESISTOR 19.6K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1962F
R1306	0699-3977		RESISTOR 19.6K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1962F
R1308	0699-3574		RESISTOR 0 .0625W TKF	05524	CRCW0603000
R1309	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1311	0699-3977		RESISTOR 19.6K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1962F
R1312 - R1314	0699-1503		RESISTOR 0 CWM	09891	RM73Z2BT
R1315	0699-3947		RESISTOR 1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1001F
R1317	0699-3932	1	RESISTOR 215 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J2150F
R1318	0699-3937		RESISTOR 348 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J3480F
R1319	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1320	0699-1503		RESISTOR 0 CWM	09891	RM73Z2BT
R1321	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1322	0699-3977		RESISTOR 19.6K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1962F
R1323 - R1324	0699-3936		RESISTOR 316 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J3160F
R1325 - R1326	0699-3978		RESISTOR 21.5K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J2152F
R1327	0699-3901		RESISTOR 10 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J10R0F
R1328	0699-1364	1	RESISTOR 68.1 +-1pct .125W TKF TC=0+-100	09891	RK73H2BT68R1F
R1329	0699-1327	1	RESISTOR 1M +-1PCT .125W TKF TC=0+-100	09891	RK73H2BT1004F
R1330	0699-1503		RESISTOR 0 CWM	09891	RM73Z2BT
R1331	0699-4995	1	RESISTOR .03 +-1PCT 1W MFS TC=0+-75	05524	WSL2512.031%
R1334	0699-3970		RESISTOR 10K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1002F
R1336	0699-1503		RESISTOR 0 CWM	09891	RM73Z2BT
RP101 - RP103	1810-1645	26	NET-RES 4 10.0K OHM 8-PIN	09891	CN1J4103J
RP104 - RP114	1810-1785	48	NET-RES 4 27.0 OHM 8-PIN	00746	MNR14FOABJ270
RP115 - RP119	1810-1645		NET-RES 4 10.0K OHM 8-PIN	09891	CN1J4103J
RP120	1810-1785		NET-RES 4 27.0 OHM 8-PIN	00746	MNR14FOABJ270
RP1201	1810-1645		NET-RES 4 10.0K OHM 8-PIN	09891	CN1J4103J
RP122	1810-1645		NET-RES 4 10.0K OHM 8-PIN	09891	CN1J4103J
RP123	1810-1785		NET-RES 4 27.0 OHM 8-PIN	00746	MNR14FOABJ270
RP124	1810-1645		NET-RES 4 10.0K OHM 8-PIN	09891	CN1J4103J
RP125 - RP138	1810-1785		NET-RES 4 27.0 OHM 8-PIN	00746	MNR14FOABJ270
RP201 - RP202	1810-1785		NET-RES 4 27.0 OHM 8-PIN	00746	MNR14FOABJ270
RP204 - RP205	1810-1785		NET-RES 4 27.0 OHM 8-PIN	00746	MNR14FOABJ270
RP206 - RP210	1810-1645		NET-RES 4 10.0K OHM 8-PIN	09891	CN1J4103J

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
RP212 - RP213	1810-1649	11	NET-RES 4 1.0K OHM 8-PIN	09891	CN1J4TD102J
RP214	1810-1785		NET-RES 4 27.0 OHM 8-PIN	00746	MNR14FOABJ270
RP301	1810-1645		NET-RES 4 10.0K OHM 8-PIN	09891	CN1J4103J
RP303	1810-1649		NET-RES 4 1.0K OHM 8-PIN	09891	CN1J4TD102J
RP401 - RP405	1810-1649		NET-RES 4 1.0K OHM 8-PIN	09891	CN1J4TD102J
RP501	1810-1649		NET-RES 4 1.0K OHM 8-PIN	09891	CN1J4TD102J
RP502 - RP509	1810-1645		NET-RES 4 10.0K OHM 8-PIN	09891	CN1J4103J
RP510 - RP518	1810-1785		NET-RES 4 27.0 OHM 8-PIN	00746	MNR14FOABJ270
RP520 - RP524	1810-1785		NET-RES 4 27.0 OHM 8-PIN	00746	MNR14FOABJ270
RP525 - RP526	1810-1720	2	NET-RES 4 220.0 OHM 8-PIN	05524	CRA06S0803221J
RP527 - RP528	1810-1785		NET-RES 4 27.0 OHM 8-PIN	00746	MNR14FOABJ270
RP601	1810-1645		NET-RES 4 10.0K OHM 8-PIN	09891	CN1J4103J
RP801 - RP802	1810-1649		NET-RES 4 1.0K OHM 8-PIN	09891	CN1J4TD102J
T101	9140-5010	1	INDUCTOR COMMON-MODE CHOKE COIL	06352	ACM2012-900-2P-T
T601	9170-1629	3	INDUCTOR 3.2W-MMX4.5LG-MM	06352	ACM4532-801-2P
T701	9170-1629		INDUCTOR 3.2W-MMX4.5LG-MM	06352	ACM4532-801-2P
T1101	9170-1629		INDUCTOR 3.2W-MMX4.5LG-MM	06352	ACM4532-801-2P
T1301	9100-6089	1	XFMR-PWR 11.88-12.12V/18V	53471	31482R
TP1301-TP1310	1460-2594	11	CONNECTOR-SGL CONT SPR .01-IN-BSC-SZ REC	12965	TP-108
TP701	1460-2594		CONNECTOR-SGL CONT SPR .01-IN-BSC-SZ REC	12965	TP-108
U101	1822-0615	1	IC KOM EMBEDDED PROCESSOR	09905	SA27-E
U102	1818-8191	1	SYNC-DRAM 512KX32X4 BANKS 86-TSOPII 3.3V	12125	K4S643232E-TC70
U104	1813-1104	1	CRYSTAL OSC 50.000MHZ 0.01pct	13545	DSO751SM-50.000MHZ
U105	1813-1914	1	CRYSTAL OSC 24.000-MHZ 0.01PCT	11686	MIN30A-T-24.000MHZ
U106	1822-0376	1	IC INTERFACE MISC USB CONTROLLER CMOS	11345	CY7C68001-56PVC
U107	1822-0210	1	IC INV CMOS SINGLE	02910	74LVC1G04GW
U108 - U109	1822-1096	2	IC GATE CMOS-LVC POS-OR SGL 2-INP 5-SOP (SC-70)	01698	SN74LVC1G32DCKR
U201	1821-2691	2	IC INV CMOS/LVC HEX	02910	74LVC14AD
U301	1821-4806	1	IC INTERFACE DRVR/RCVR EIA RS-232	01698	SN75LV4737ADBR
U302	1818-8814	1	64K BIT FRAM CMOS 8-SOP	14543	FM25CL64-S
U303	1821-5349	1	IC MULTIPLEXER/DATA SELECT CMOS/LVC QD	01698	SN74LVC257AD
U304	HCPL-063L	2	Optocoupler(15MBd,3.3V)	02364	HCPL-063L
U305	HCPL-063L		Optocoupler(15MBd,3.3V)	02364	HCPL-063L
U306	1821-2691		IC INV CMOS/LVC HEX	02910	74LVC14AD
U307	1821-3993	1	IC GATE CMOS/LVC BUS BFR QUAD 4-INP	01698	SN74LVC125AD
U308	1990-1481	2	OPTO-ISOLATOR LED-PXSTR IF=60MA-MAX	02237	MOC207
U501	1822-0862	1	IC PLD CPLD UNPRGMD CMOS 20K200C 240-QFP	12880	EP20K200CQ240C7
U502	1818-7887	1	IC 1M-BIT SRAM 12-NS CMOS	12125	K6R1016V1D-TC10
U601	1821-5969	1	IC GATE BUS BFR CMOS/LVC 5-SOP (SC-70)	10253	IDT74LVC1G125ADY
U602	1813-2043	1	CRYSTAL OSCILLATOR VCXO 50.000MHZ	03170	VF294L-50.000MHZ
U603	1820-7733	1	IC DRVR CMOS/ACT LINE 16-BIT	01698	74ACT16244DL
U701	1826-2147	2	ANALOG MULTIPLEXER 8 CHNL 16 -P-SOIC	05524	DG408DY
U702	1826-1862		IC OP AMP LOW-BIAS-H-IMPD DUAL 8 PIN	04078	TL072CD
U703	1827-0159	1	A/D 12-BIT SAMPLING CMOS 8-MSOP	01698	ADS7818EB

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
U704	1826-1862		IC OP AMP LOW-BIAS-H-IMPD DUAL 8 PIN	04078	TL072CD
U801	1826-8828	1	D/A 16-BIT 8-P-SOIC	11302	MAX5541CSA
U802	1826-1862		IC OP AMP LOW-BIAS-H-IMPD DUAL 8 PIN	04078	TL072CD
U803	1826-2147		ANALOG MULTIPLEXER 8 CHNL 16 -P-SOIC	05524	DG408DY
U804	1826-1862		IC OP AMP LOW-BIAS-H-IMPD DUAL 8 PIN	04078	TL072CD
U901	1827-0170	1	D/A 14-BIT 28-SOIC PRECISION CMOS	03285	AD9744AR
U902	1827-0124		IC OP AMP HS CURR-FDBK SGL 8-MSOP	01698	THS3001CDGN
U903	1826-1862		IC OP AMP LOW-BIAS-H-IMPD DUAL 8 PIN	04078	TL072CD
U904	1826-1950	1	IC COMPARATOR HS SINGLE 8 PIN PLSTC-SOIC	11302	MXL1016CS8
U1001	1826-2420	3	IC OP AMP LP DUAL 8 PIN PLSTC-SOIC	03285	AD706JR
U1002	1826-2793	1	D/A 16-BIT 16-P-SOIC BICMOS	03285	AD1851R
U1003	1826-2420		IC OP AMP LP DUAL 8 PIN PLSTC-SOIC	03285	AD706JR
U1004	1826-4193	1	ANALOG MULTIPLEXER 8 -P-SOIC	03285	AD8180AR
U1005 - U1006	1826-3564	2	IC RF/IF AMPL HS 8 PIN PLSTC-SOIC	03285	AD8009AR
U1007	1826-2420		IC OP AMP LP DUAL 8 PIN PLSTC-SOIC	03285	AD706JR
U1101 - U1104	1827-0124	4	IC OP AMP HS CURR-FDBK SGL 8-MSOP	01698	THS3001CDGN
U1105	1826-1862	8	IC OP AMP LOW-BIAS-H-IMPD DUAL 8 PIN	04078	TL072CD
U1106	1826-1528	2	IC COMPARATOR LP QUAD 14 PIN PLSTC-SOIC	03406	LM339M
U1107	1826-1862		IC OP AMP LOW-BIAS-H-IMPD DUAL 8 PIN	04078	TL072CD
U1201	1827-0393	1	IC PWR MGT V-REG STEP DOWN DUAL 16-TSSOP	10858	LT1940EFE
U1202	1826-1528		IC COMPARATOR LP QUAD 14 PIN PLSTC-SOIC	03406	LM339M
U1203	1826-1784	2	IC PWR MGT-V-REF-FXD 2.425/2.575V 8 PINS	03406	LM385M-2.5
U1301	1990-1481		OPTO-ISOLATOR LED-PXSTR IF=60MA-MAX	02237	MOC207
U1303	1826-1784		IC PWR MGT-V-REF-FXD 2.425/2.575V 8 PINS	03406	LM385M-2.5
U1303	1826-1862		IC OP AMP LOW-BIAS-H-IMPD DUAL 8 PIN	04078	TL072CD
U1304	1826-8903	1	IC V-REG SMT PUSH-PULL DC/DC CONTROLLER	10858	LT1683EG
U1305	1826-0106	1	IC PWR MGT-V-REG-FXD-POS 14.4/15.6V	03406	LM340T-15
U1306	1826-6676	1	IC PWR MGT-V-REG-ADJ-POS 3-SOT-223	04078	LD1117S
U1307	1826-2771	1	IC PWR MGT-V-REG-ADJ-POS 3 PINS	04078	LM317D2T
U1308	1826-0214	1	IC PWR MGT-V-REG-FXD-NEG -14.4/-15.6V	36633	MC7915CT
VR301	0960-1073	4	ESD SUPPRESSOR SMT TRNST VOLT SUPPR; ESD	13851	0805ESDA
VR601	0960-1073		ESD SUPPRESSOR SMT TRNST VOLT SUPPR; ESD	13851	0805ESDA
VR602	1901-1346	3	DIODE-V-SUPPR DO-214AB	05524	SMCJ43CA
VR701	0960-1073		ESD SUPPRESSOR SMT TRNST VOLT SUPPR; ESD	13851	0805ESDA
VR702	1901-1346		DIODE-V-SUPPR DO-214AB	05524	SMCJ43CA
VR1101	0960-1073		ESD SUPPRESSOR SMT TRNST VOLT SUPPR; ESD	13851	0805ESDA
VR1102	1901-1346		DIODE-V-SUPPR DO-214AB	05524	SMCJ43CA

33220-66502 – Front-Panel PC Assembly

Reference Designator	Part Number	Qty	Description	Mfr Code	Mrf. Part Number
C101	0180-4758	2	CAP-FXD 47UF +-20PCT 20 V TA	12340	T491D476M020AS
C102	0160-7798	6	CAP-FXD 0.1UF +-10PCT 50 V CER X7R	06352	C2012X7R1H104K
C201 - C205	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	06352	C2012X7R1H104K
C206	0180-4758	2	CAP-FXD 47UF +-20PCT 20 V TA	12340	T491D476M020AS
DS201- DS215	1990-2411	15	LED-LAMP	12416	CMD67-21VGC
J101	1252-8157	1	CONN-POST TYPE .5MM-PIN-SPCG-MTG-END	03418	52559-4092
J102	1253-0381	1	CONN-POST TYPE N/S-PIN-SPCG-MTG-END	03418	52559-1890
J103	1253-3345	1	CONN-POST TYPE 1.25-PIN-SPCG-MTG-END	03418	53398-0390
R201- R215	0699-3918	15	RESISTOR 51.1 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J51R1F
RP101 - RP201	1810-1645	2	NET-RES 4 10.0K OHM 8-PIN	09891	CN1J4103J
S1	0960-0892	1	ROTARY ENCODER	11318	EC16B2410402
U201 -U202	1822-0834	2	IC SHIFT REGISTER 8-BIT 16-SOIC	01698	SN74LV594AD
U203	1821-1217	1	IC BFR BICMOS/LVT LINE DRVR 16-BIT	02910	74LVT16244BDL

33220-66503 – External Timebase PC Assembly

Reference Designator	Part Number	Qty	Part Description	Mfr Code	Mfr. Part Number
C1	0160-8961	2	CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C2 - C3	0160-7798	9	CAP-FXD 0.1UF +-10PCT 50 V CER X7R	06352	C2012X7R1H104K
C4	0161-1024	2	CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C5 - C6	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	06352	C2012X7R1H104K
C7	0160-7861	2	CAP-FXD 47PF +-5PCT 50 V CER C0G	02010	06035A470JAT
C8 - C9	0160-7988		CAP-FXD 470PF +-5PCT 50 V CER C0G	06352	C1608COG1H471J
C10	0161-1024		CAPACITOR-FXD 10uF +-20PCT 25V CER X5R	11702	CE TMK325BJ106MM
C11	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	06352	C2012X7R1H104K
C12	0160-8961		CAP-FXD 22UF +-20PCT 6.3V CER X5R	11702	CE JMK325BJ226MM
C13 - C14	0160-7798		CAP-FXD 0.1UF +-10PCT 50 V CER X7R	06352	C2012X7R1H104K
C15	0160-7861		CAP-FXD 47PF +-5PCT 50 V CER C0G	02010	06035A470JAT
CR1	1902-1592	3	DIODE-ZNR 5.1V 5pct TO-236 (SOT-23)	02910	BZX84C5V1
CR2	1906-0291	2	DIODE-DUAL 70V 100MA T0-236AA	02910	BAV99
CR3	1900-0202	1	DIODE-SCHOTTKY SM SIG	02364	HSMS-2825-TR1
CR4 - CR5	1902-1592		DIODE-ZNR 5.1V 5pct TO-236 (SOT-23)	02910	BZX84C5V1
CR6	1906-0291	1	DIODE-DUAL 70V 100MA T0-236AA	02910	BAV99
J1	1250-2110	1	CONNECTOR-RF BNC FEMALE PC-W-STDFS	01380	227161-7
J2	1250-2913	1	CONNECTOR-RF BNC FEMALE PC-W-STDFS	01380	413879-2
L1	9140-1101	1	INDUCTOR 470NH +-5PCT 2.8W-MMX3.4LG-MM	06352	NL322522T-R47J
P1	33250-61616		CABLE,10 POS. PASSTHRU	04726	
R1 - R2	0699-3947	3	RESISTOR 1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1001F
R3	0699-3053	4	RESISTOR 100K +-1PCT .1W TKF TC=0+-100	00746	MCR10-F-1003
R4 - R5	0699-3924	5	RESISTOR 100 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1000F
R6 - R7	0699-3955	3	RESISTOR 2.15K +-1pct .063W TKF TC=0+-200	09891	RK73H1J2151F
R8	0699-3924		RESISTOR 100 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1000F
R9 - R11	0699-3053		RESISTOR 100K +-1PCT .1W TKF TC=0+-100	00746	MCR10-F-1003
R12	0699-3032	1	RESISTOR 511 +-1PCT .1W TKF TC=0+-100	00746	MCR10-F-5110
R14	0699-3947		RESISTOR 1K +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1001F
R15	0699-3955	1	RESISTOR 2.15K +-1pct .063W TKF TC=0+-200	09891	RK73H1J2151F
R18 - R19	0699-3924		RESISTOR 100 +-1PCT .063W TKF TC=0+-200	09891	RK73H1J1000F
R20	0699-1503	1	RESISTOR 0 CWM	00746	MCR18-J-00
T1 - T2	9100-5703	2	TRANSFORMER-RF F= 0.15-400 MHZ	02739	ADT1-1
U1	1826-2387	1	IC COMPARATOR HS 14 PIN PLSTC-SOIC	02910	NE529D
U2	1820-7312	1	IC SCHMITT-TRIG CMOS/ACT INV HEX	01698	SN74ACT14D
VR1	0960-1073	2	ESD SUPPRESSOR SMT TRNST VOLT SUPPR; ESD	13851	0805ESDA
VR2	1901-1346	1	DIODE-V-SUPPR DO-214AB	05524	SMCJ43CA
VR4	0960-1073		ESD SUPPRESSOR SMT TRNST VOLT SUPPR; ESD	13851	0805ESDA
NUT1 - NUT2	2940-0256	2	NUT-HEX-DBL-CHAM 1/2-28-THD .095-IN-THK	01380	1-329631-2
HDW1 -HDW2	2190-0699	2	WASHER-LK INTL T 1/2 IN .5-IN-ID	01380	1-329632-2

33220A Chassis Assembly

Reference Designator	Agilent Part Number	Quantity	Part Description	Mfr. Code	Mfr. Part Number
CBL1	33220-61613	1	CABLE ASSEMBLY FRONT PANEL	02364	33220-61613
CBL2	33220-61617	1	CABLE ASSEMBLY POWER SUPPLY	02364	33220-61617
CBL3	33220-61618	1	GROUND WIRE-GREEN W/YELLO STRIP	02364	33220-61618
FIL1	33220-67601	1	ASSEMBLY LINE FILTER	02364	33220-67601
FRM1	2090-0886	1	LIQUID CRYSTAL DISPLAY MODULE	02364	2090-0886
HDW1 - HDW6	2190-0577	6	WASHER-LK HLCL NO. 10 .194-IN-ID	02364	2190-0577
HDW7 - HDW8	2190-0699	2	WASHER-LK INTL T 1/2 IN .5-IN-ID	01380	1-329632-2
HDW9	6960-0167	2	PLUG-HOLE TR-HD FOR .5-D-HOLE NYL	03480	2493
MP1	33220-00611	1	FRAME POWER SUPPLY	02364	33220-00611
MP2	33220-04102	1	PLATE BACKER	02364	33220-04102
MP3	33220-40603	1	SHIELD POWER SUPPLY	02364	33220-40603
MP4	33220-60201	1	ASSEMBLY FRONT PANEL	02364	33220-60201
MP5	33220-68501	1	ASSEMBLY FAN	02364	33220-68501
MP6	33220-80101	1	ASSEMBLY CHASIS	02364	33220-80101
MP7	33220-84101	1	COVER	02364	33220-84101
MP8	33220-88304	1	BEZEL REAR	02364	33220-88304
MP9	33250-44104	1	SUPPORT PLATE-FR.PANEL	22090	33250-44104
MP10	33250-49301	1	"WINDOW,FRONT"	35854	33250-49301
MP11	33250-87401	1	KNOB	06793	33250-87401
MP12	33250-88001	1	33250 KEYPAD	03418	33250-88001
MP13	34401-45021	1	HANDLE	02364	34401-45021
MP14	34401-86020	1	KIT BUMPER	02364	34401-86020
NUT1 - NUT2	2940-0256	2	NUT-HEX-DBL-CHAM 1/2-28-THD .095-IN-THK	01380	1-329631-2
POW1	33220-87910	1	POWER SUPPLY ASSEMBLY	27419	NLP40-7612
SCR1 - SCR8	0515-0433	8	SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG	07606	
SCR9	0624-0520	1	SCREW-TPG 6-19 .5-IN-LG PAN-HD-TORX T15	05610	0624-0520
STD1 - STD 10	0380-0644	10	STANDOFF-HEX .327-IN-LG 6-32-THD	02121	0380-0644

Manufacturer's List

MFR Code	Manufacturer's Name	Manufacturer's Address			ZIP
00467	OMRON ELECTRONICS INC (DEL)	CHICAGO	IL	US	60673-7285
00746	ROHM ELECTRONICS USA LLC	NASHVILLE	TN	US	37230-7062
00779	CALTRON COMPONENTS CORPORATION	SANTA CLARA	CA	US	95054-2927
01172	R C D COMPONENTS INC	MANCHESTER	NH	US	03109-5310
01380	TYCO ELECTRONICS CORPORATION	HARRISBURG	PA	US	17111
01698	TEXAS INSTRUMENTS INCORPORATED	DALLAS	TX	US	75320-0666
01850	AROMAT CORPORATION	SAN JOSE	CA	US	95110-1018
01886	COILCRAFT INC	CARY	IL	US	60013-1697
02010	AVX CORPORATION	DALLAS	TX	US	75395-1370
02121	LYN-TRON INC	SPOKANE	WA	US	99224-9406
02237	FAIRCHILD SEMICONDUCTOR CORP	IRVING	TX	US	75063-7528
02364	AGILENT TECHNOLOGIES, INC	LOVELAND	CO	US	80537
02739	DISMAN-BAKNER INC	MOUNTAIN VIEW	CA	US	94043-1942
02910	PHILIPS SEMICONDUCTORS INC	ENGLEWOOD	CO	US	80112-3530
03170	VALPEY- FISHER CORP	HOPINKTON	MA	US	01748
03285	ANALOG DEVICES INC	NORWOOD	MA	US	02062-2666
03406	NATIONAL SEMICONDUCTOR CORP	SAN FRANCISCO	CA	US	94160
03418	MOLEX CONNECTOR CORPORATION	LISLE	IL	US	60532-1682
03480	HEYCO PRODUCTS INC	TOMS RIVER	NJ	US	08755-4809
03521	JOHANSON TECHNOLOGY	LOS ANGELES	CA	US	90084-7325
04078	SGS-THMSON MCROELECTRONICS INC	DALLAS	TX	US	75320-0017
04726	MINNESOTA MINING & MFG CO	SAINT PAUL	MN	US	55144-0001
05524	VISHAY INTERTECHNOLOGY INC	KIRKLAND	WA	US	98034-4341
05610	TEXTRON INC	CHICAGO	IL	US	60694-4839
06352	TDK CORPORATION OF AMERICA	MOUNT PROSPECT	IL	US	60056-6014
06360	UNITED CHEMI-CON INC (NY)	DES PLAINES	IL	US	60018-4725
06793	MOUNTAIN MOLDING LTD	LONGMONT	CO	US	80504-9626
07179	AAVID ENGINEERING INC	DALLAS	TX	US	75381-0839
07398	BEL FUSE INC	JERSEY CITY	NJ	US	07302-4421
07606	SIMCO ELECTRONICS	CHICAGO	IL	US	60674-1299
09891	KOA DENKO (S) PTE LTD	SINGAPORE		SG	339941
09905	INTERNATIONAL BUSINESS MACHINES CORP	SAN JOSE	CA	US	95123-3696
09939	MURATA ELECTRONICS NORTH AMER	SMYRNA	GA	US	30080-7604
10253	INTEGRATED DEVICE TECHNOLOGY	SAN JOSE	CA	US	95131-1021
10858	LINEAR TECHNOLOGY CORPORATION	MILPITAS	CA	US	95035-7406
11302	MAXIM INTEGRATED PRODUCTS INC	SUNNYVALE	CA	US	94086
11318	ALPS ELECTRIC USA INC	SAN FRANCISCO	CA	US	94120-7225
11345	CYPRESS SEMICONDUCTOR CORP	SAN FRANCISCO	CA	US	94160-1688
11686	KYUSHU DENTSU K.K.	OMURA NAGASAKI		JP	856-0006
11702	TAIYO YUDEN (USA) INC	SAN MARCOS	CA	US	92069-5106
12125	SAMSUNG SEMICONDUCTOR INC	CHICAGO	IL	US	60693-6161
12340	KEMET ELECTRONICS CORPORATION	SIMPSONVILLE	SC	US	
12355	INTERCONNECTION PRODUCTS INC	LAKE WORTH	FL	US	33462
12416	SLI INC		NJ	US	07601-3426

MFR Code	Manufacturer's Name	Manufacturer's Address			ZIP
12880	ALTERA CORPORATION	SAN JOSE	CA	US	95134-1941
12965	COMPONENTS CORP	DENVILLE	NJ	US	07834
13545	DAISHINKU (AMERICA) CORP	IRVINE	CA	US	92612-1523
13851	COOPER ELECTRONIC TECHNOLOGIES	BOYNTON BEACH	FL	US	33426-8638
13853	CAPAX TECHNOLOGIES INC	VALENCIA	CA	US	91355
14543	RAMTRON CORP	COLORADO SPRINGS	CO	US	80921-3620
22090	TENERE INC	MINNEAPOLIS	MN	US	55485-1450
27419	ARTESYN TECHNOLOGIES INC	REDWOOD FALLS	MN	US	56283-1905
35854	T S POLYMERS INC	BATAVIA	OH	US	45103-1676
36393	INFINEON TECHNOLOGIES AG	LAATZEN NIEDERSACHSEN		DE	30880
36633	SEMICNDCTOR CMPONENTS INDS LLC	PHOENIX	AZ	US	85008-4229
45178	THOM LUKE SALES INC	EL PASO	TX	US	79928-5204
53471	MIDCOM INC	WATERTOWN	SD	US	57201-5602

7

Backdating

Backdating

This chapter normally contains information necessary to adapt this manual to instruments not directly covered by the current content.

At this printing, the manual applies to all instruments.

9

Schematics

Schematics

Conventions Used on Schematics

Major signal and control lines are marked with a name in uppercase. If the name is followed by an ***** (for example, TRIG_SYNC*), the line is inverted logic. If the name is followed by a lowercase **e**, (for example, TRIGe), the line is the ECL-level version of a TLL or CMOS signal.

You may notice parts labeled as “No Load” on several of the schematics. These are parts that were included for design and development but were later removed to enhance performance or reduce cost.

⇦ Binder Edge (RH Page)
Foldout Cut Size = 9 x 19 inches

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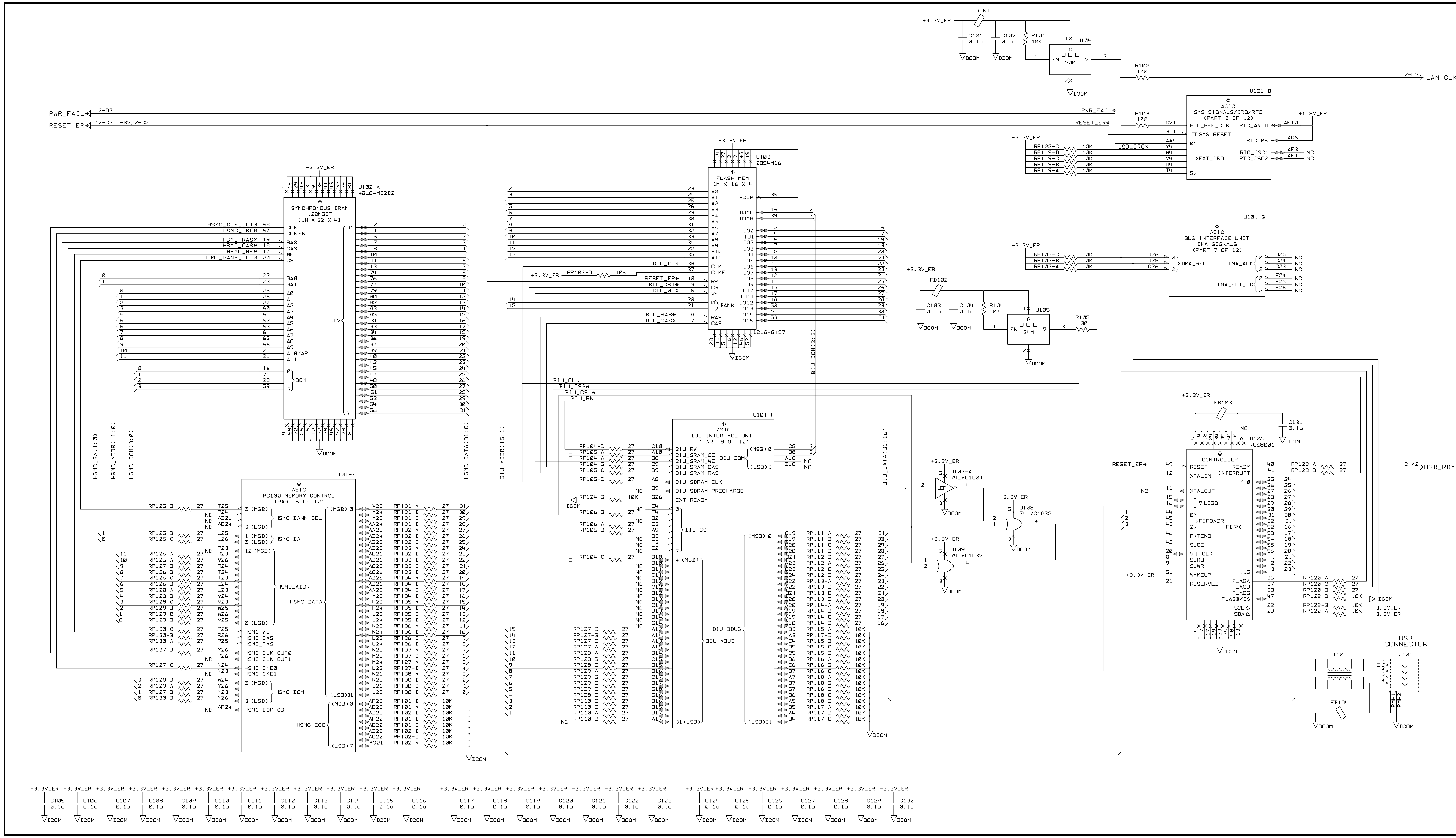

33220-66501 (sheet 1 of 20)
A1 Clocks, IRQs, RAM, ROM, USB Schematic

⇦ Binder Edge (RH Page)
Foldout Cut Size = 9 x 19 inches

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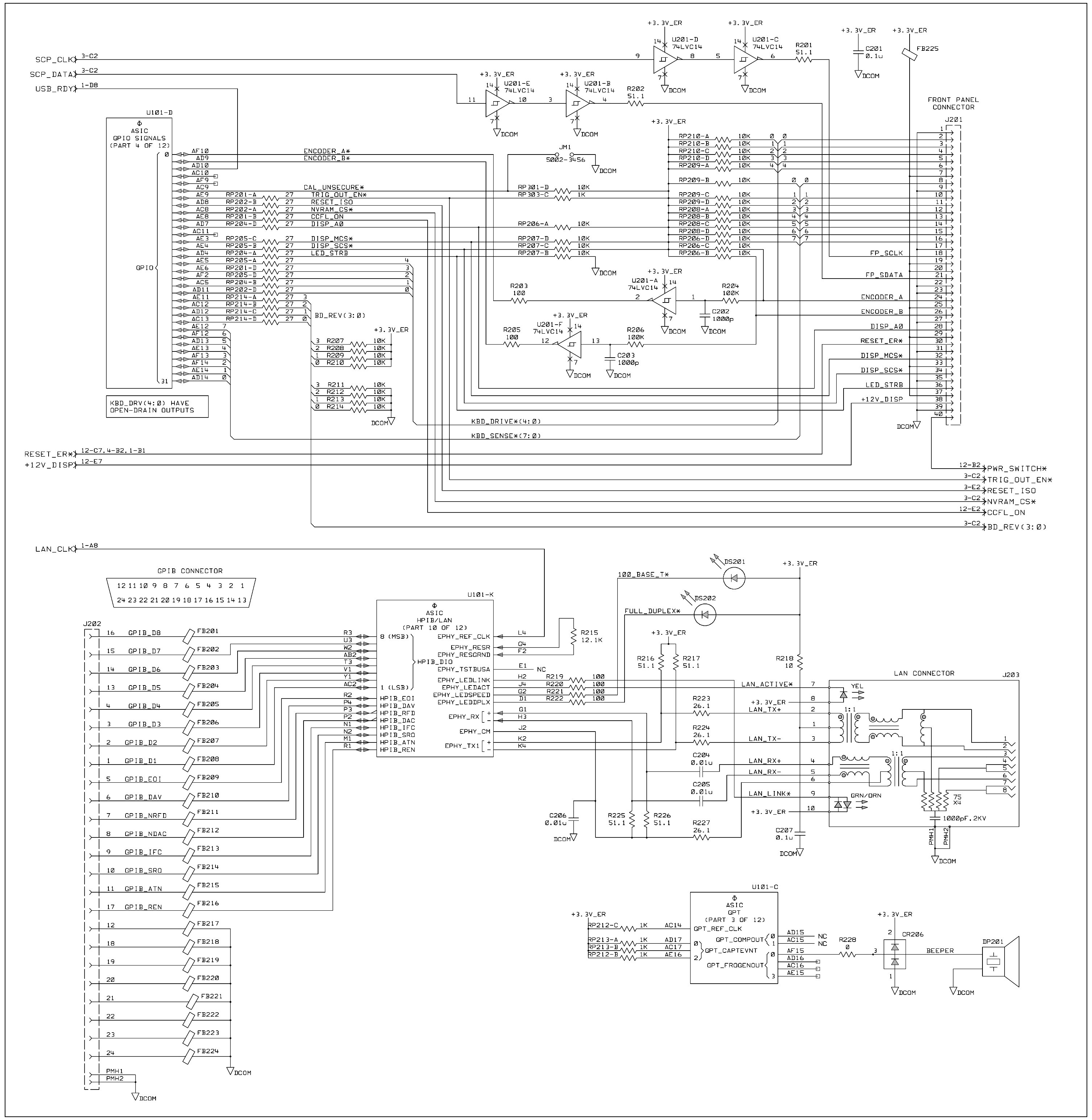
Binder Edge (LH Page) ⇨
Foldout Cut Size = 9 x 19 inches



33220-66501 (sheet 2 of 20)
A1 Front Panel Interface, LAN, GPIB, and Beeper Schematic

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Binder Edge (LH Page) ⇨
Foldout Cut Size = 9 x 19 inches

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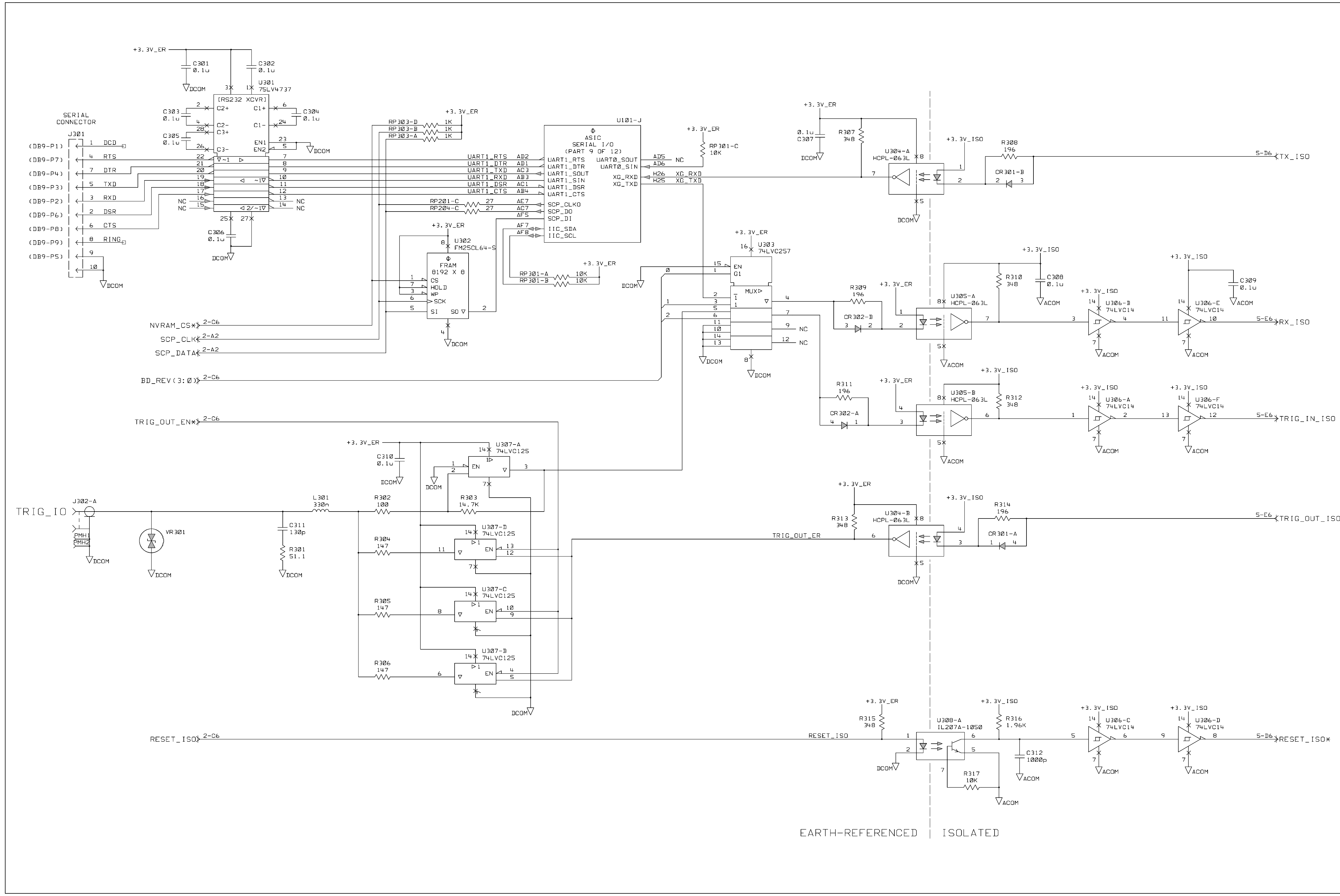

33220-66501 (sheet 3 of 20)
A1 Cross Guard, Serial Communications, Non-Volatile Memory, and Trigger Schematic

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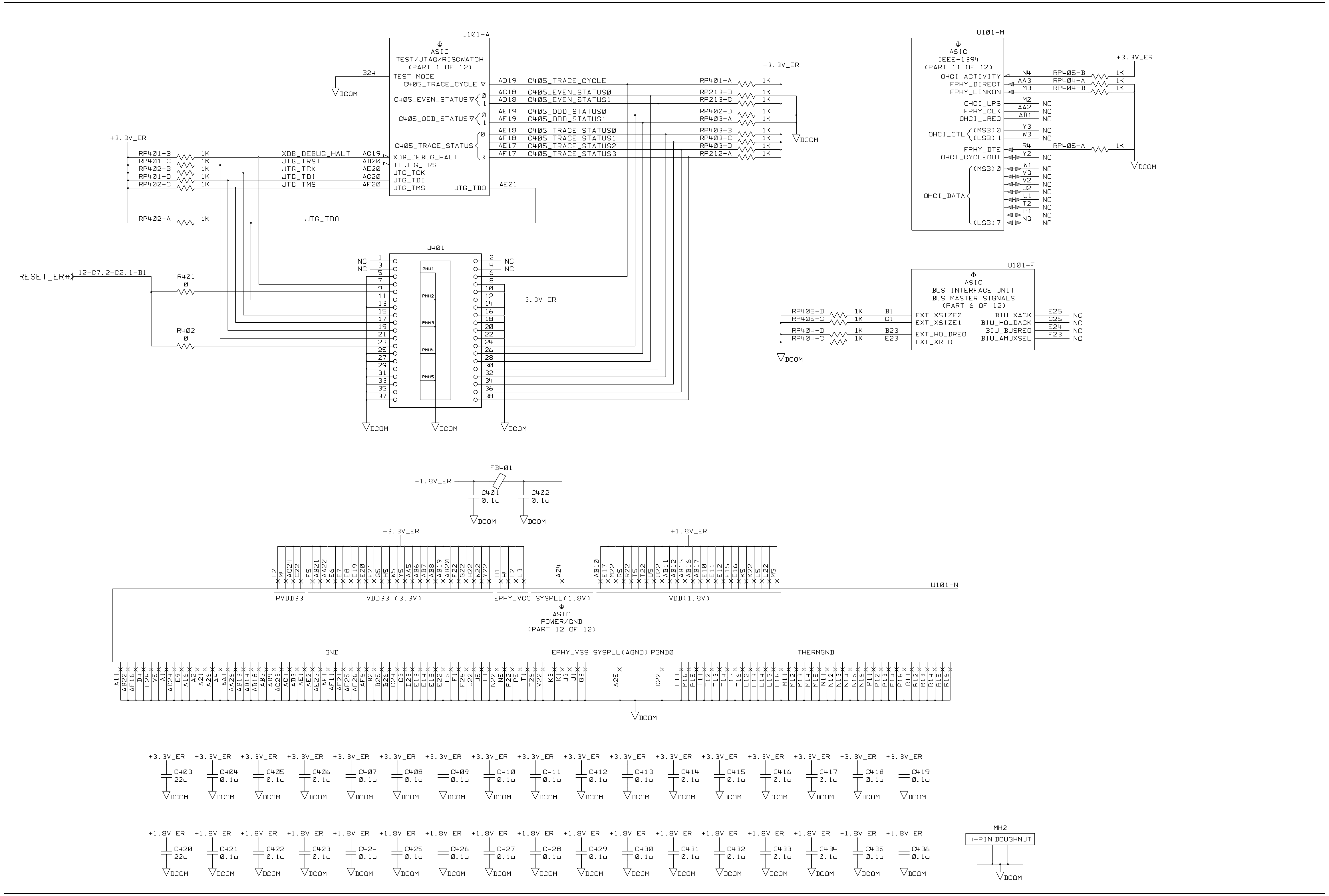

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Binder Edge (LH Page) ⇨
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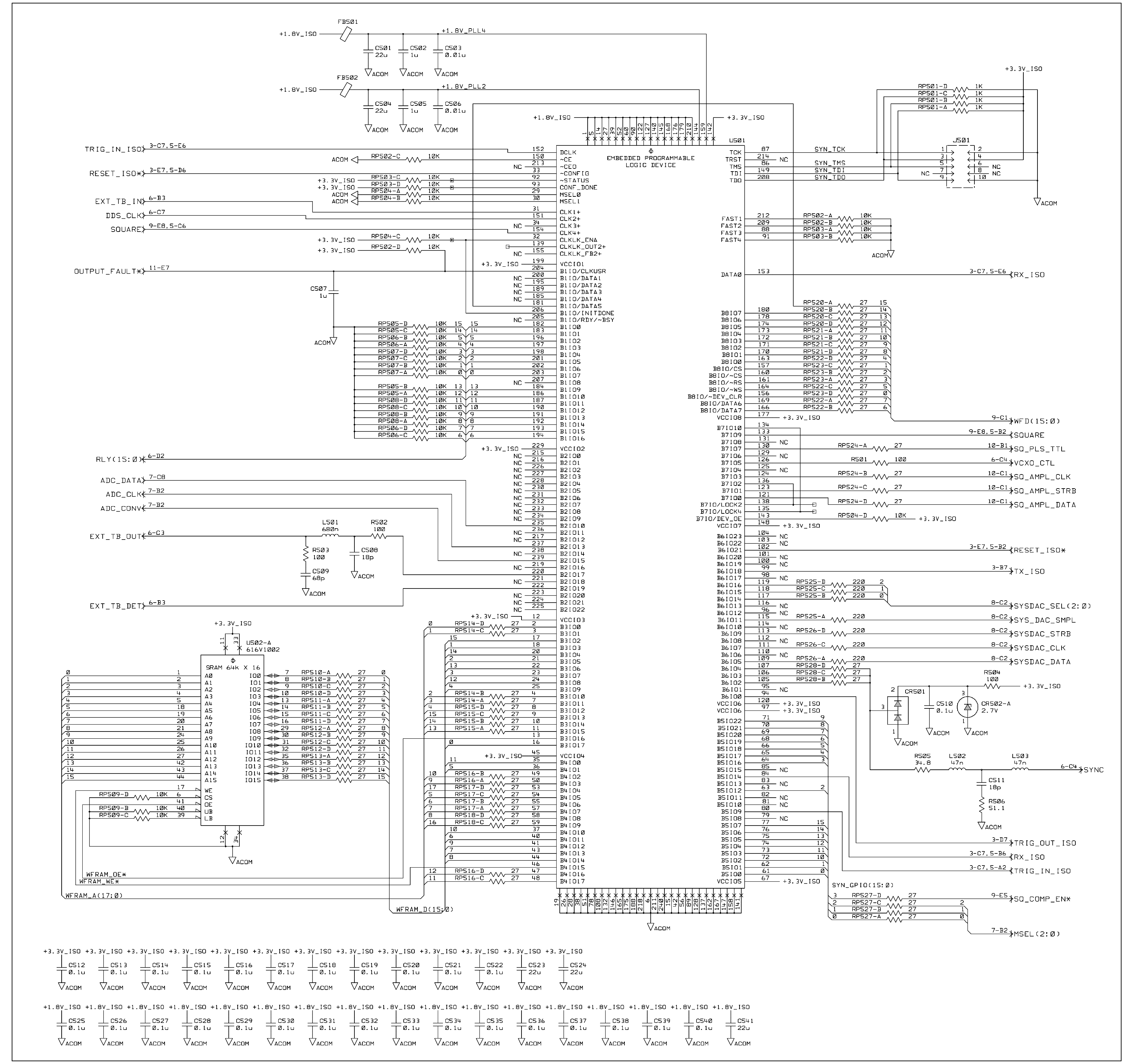
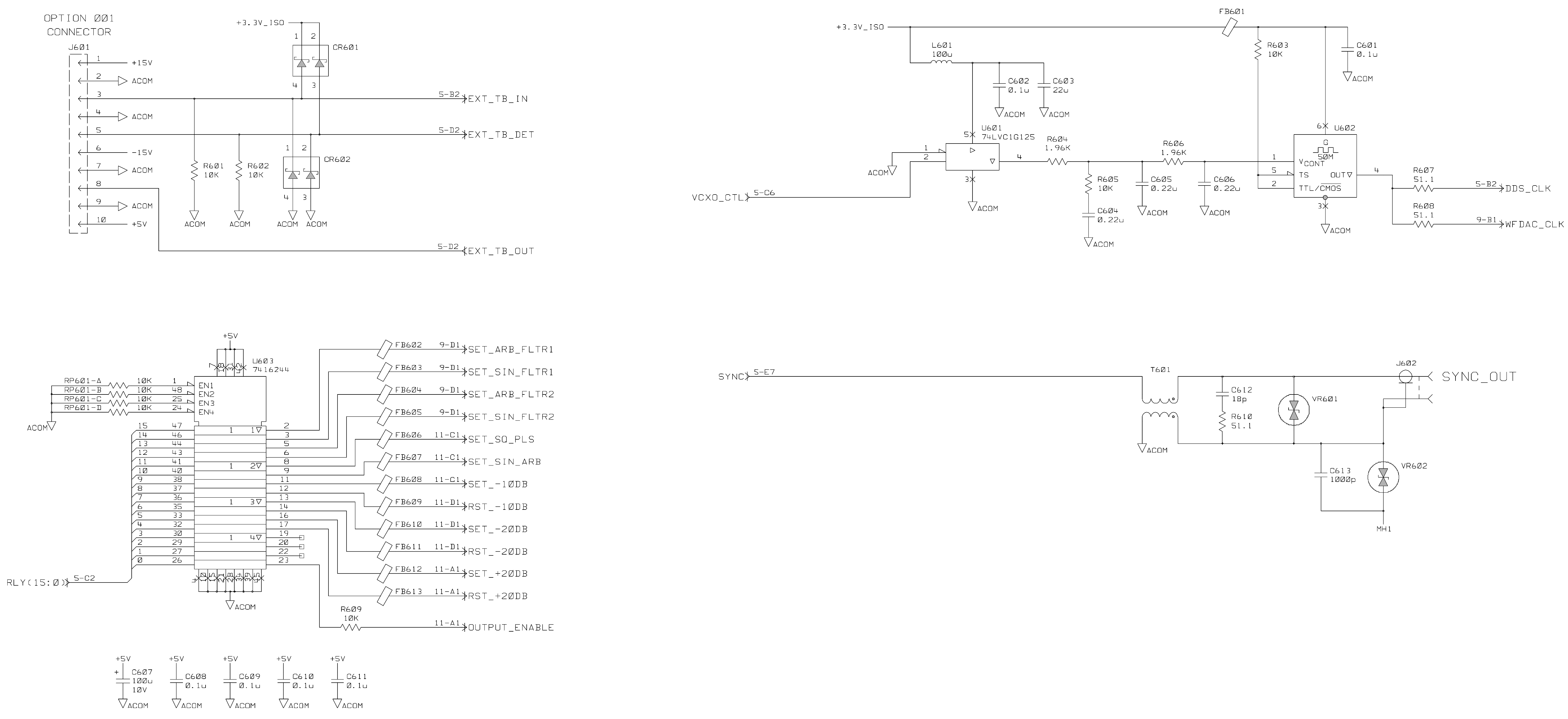
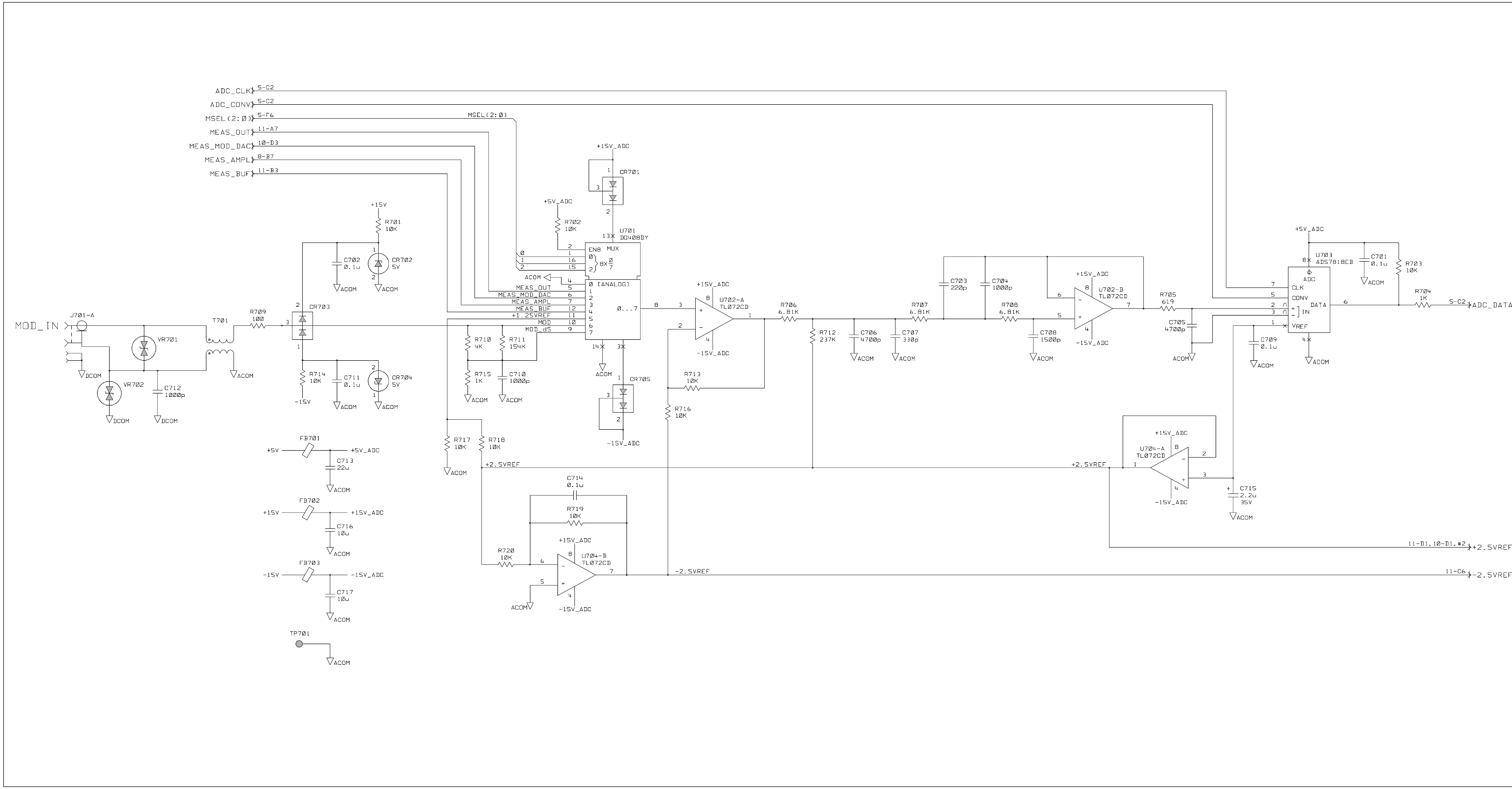


33220-66501 (sheet 5 of 20)
A1 Synthesis IC and Waveform RAM Schematic



33220-66501 (sheet 6 of 20)
A1 Timebase, Sync, and Relay
Drivers Schematic



33220-66501 (sheet 7 of 20)
A1 System ADC Schematic

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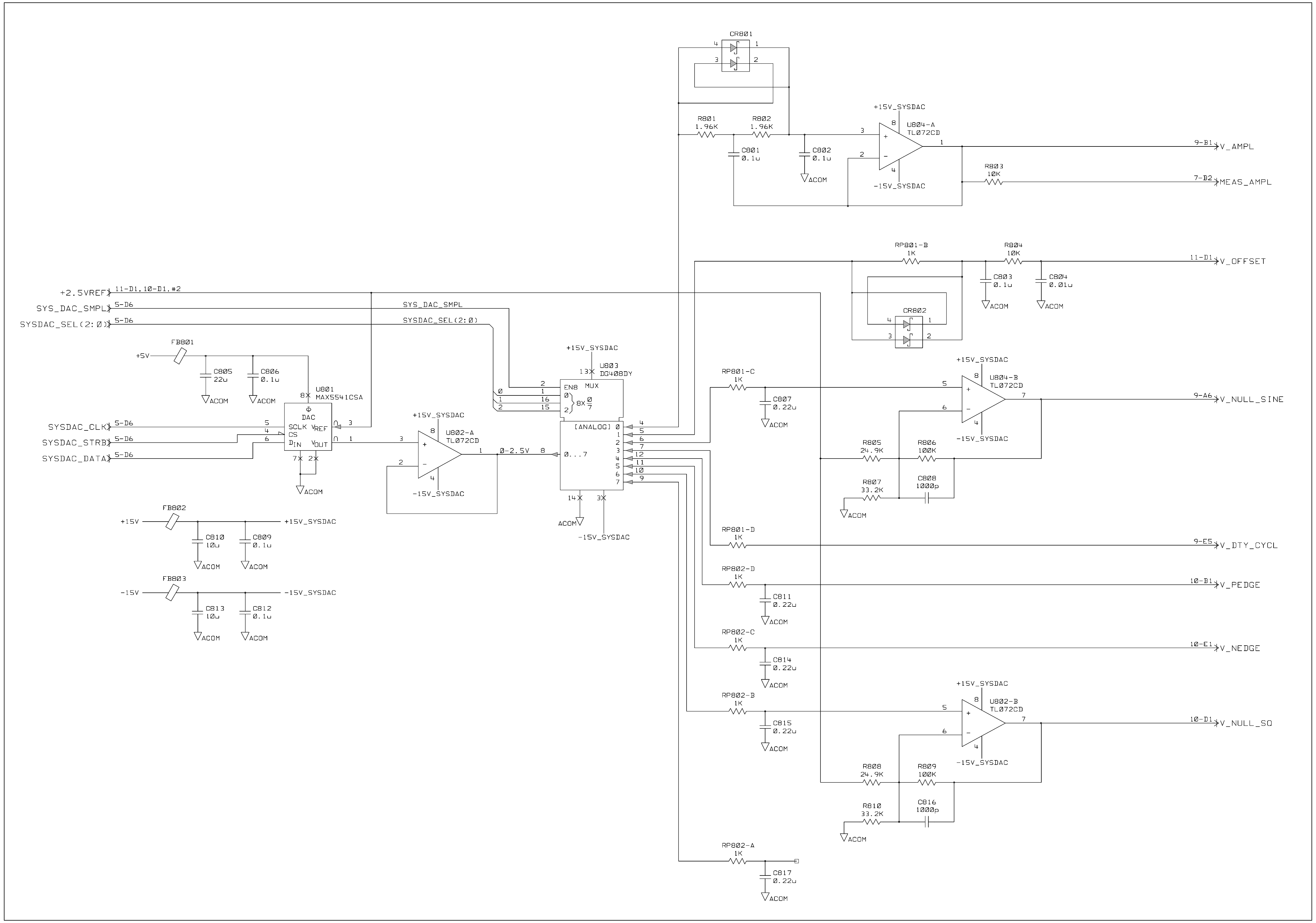

33220-66501 (sheet 8 of 20)
A1 System DAC Schematic

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⇦ Binder Edge (RH Page)
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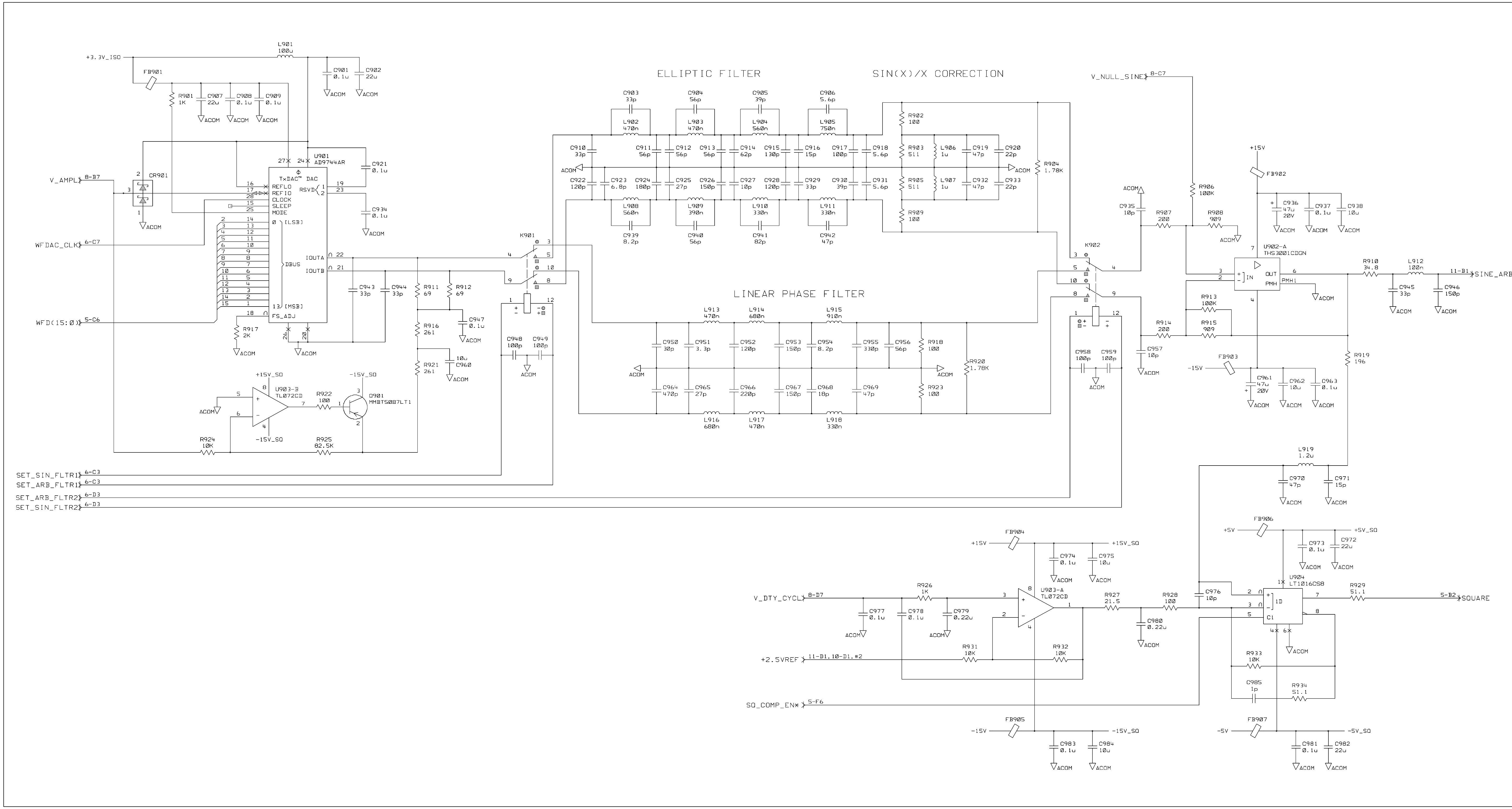

33220-66501 (sheet 9 of 20)
A1 Waveform DAC and Filters and Square Wave Comparator Schematic

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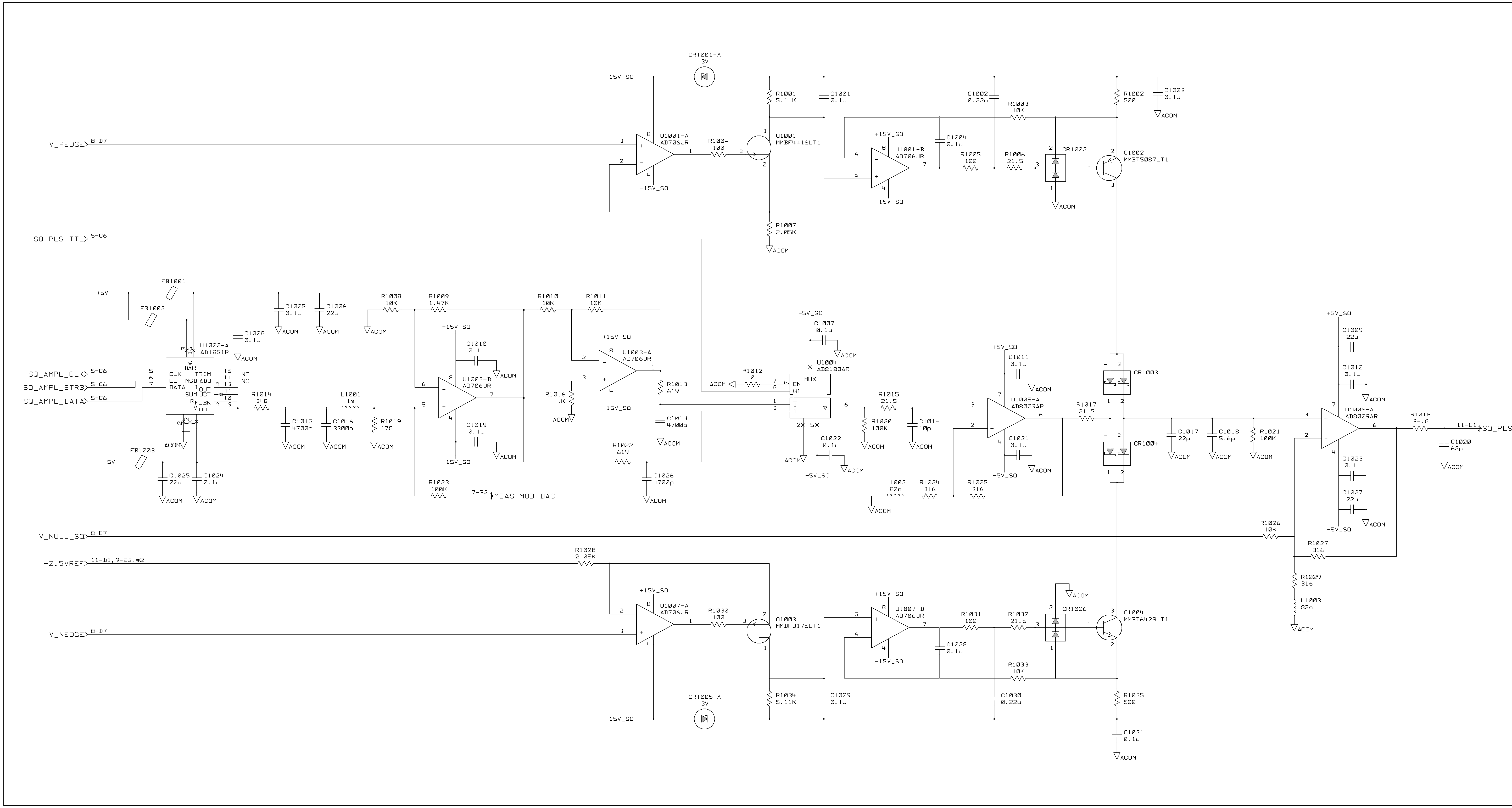

33220-66501 (sheet 10 of 20)
A1 Square / Pulse Level Translation
Schematic

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⇦ Binder Edge (RH Page)
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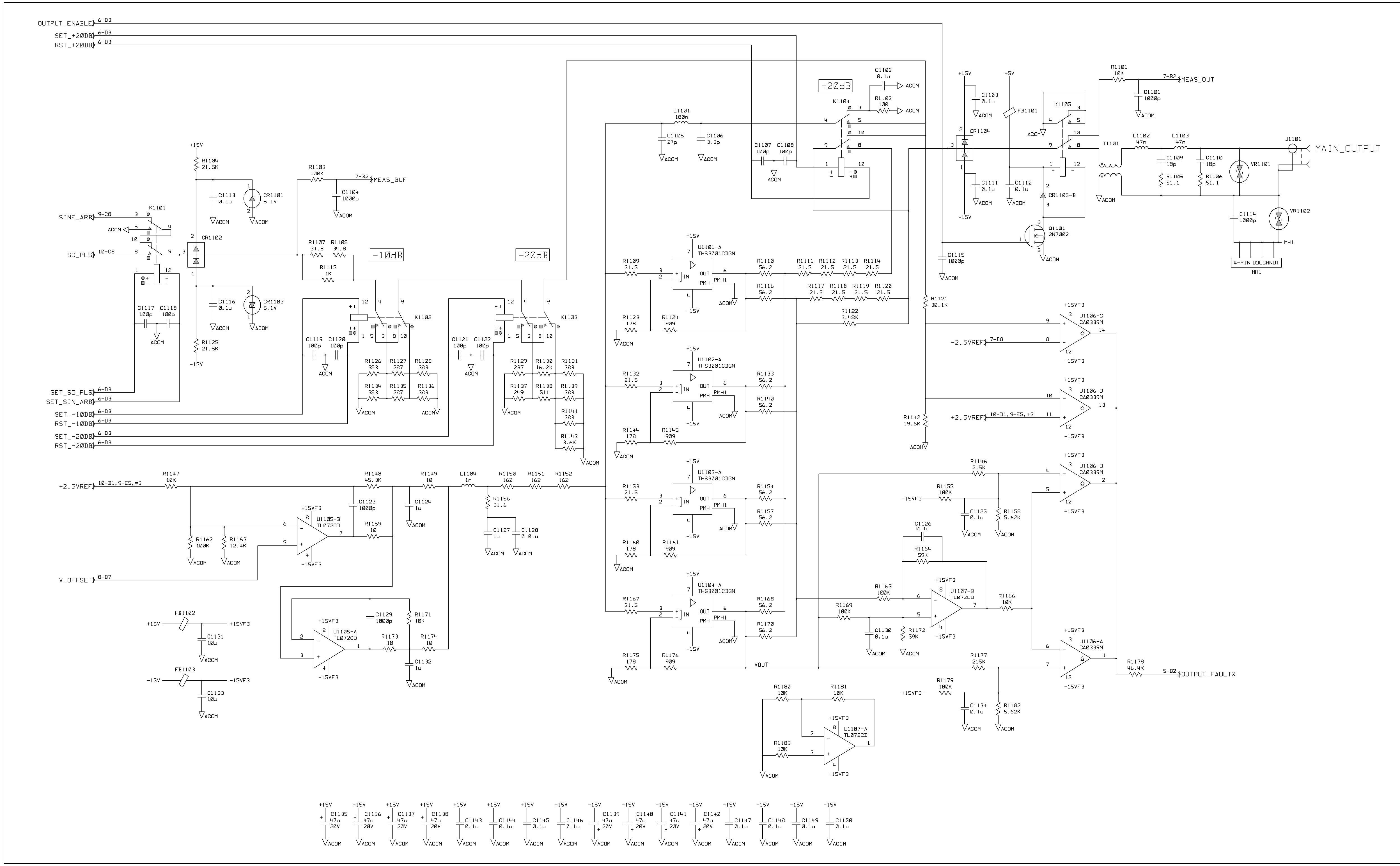

33220-66501 (sheet 11 of 20)
A1 Gain Switching and Output Amplifier Schematic

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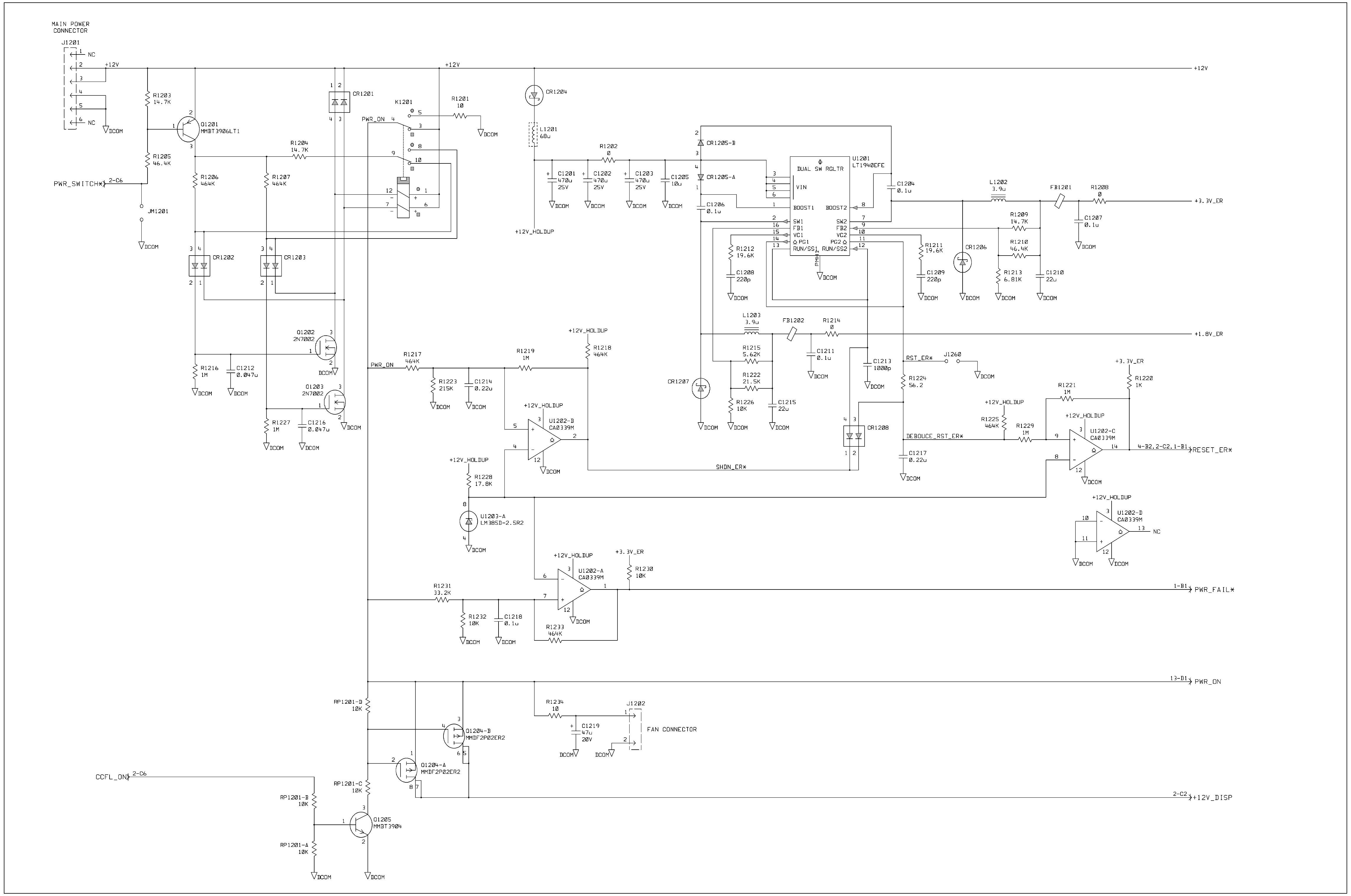

33220-66501 (sheet 12 of 20)
A1 Earth Referenced Power Supply
Schematic

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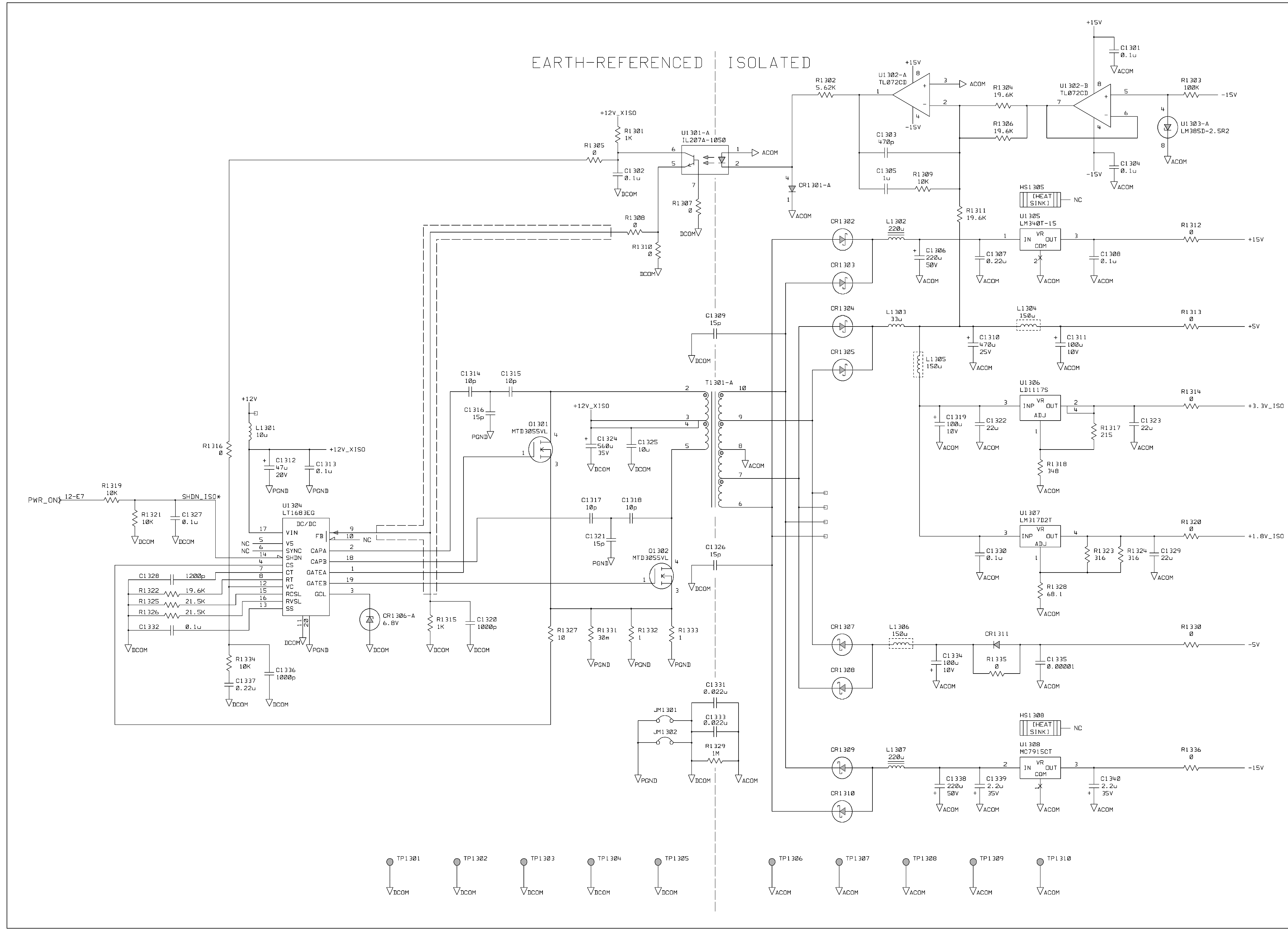

33220-66501 (sheet 13 of 20)
A1 Isolated Power Supply Schematic

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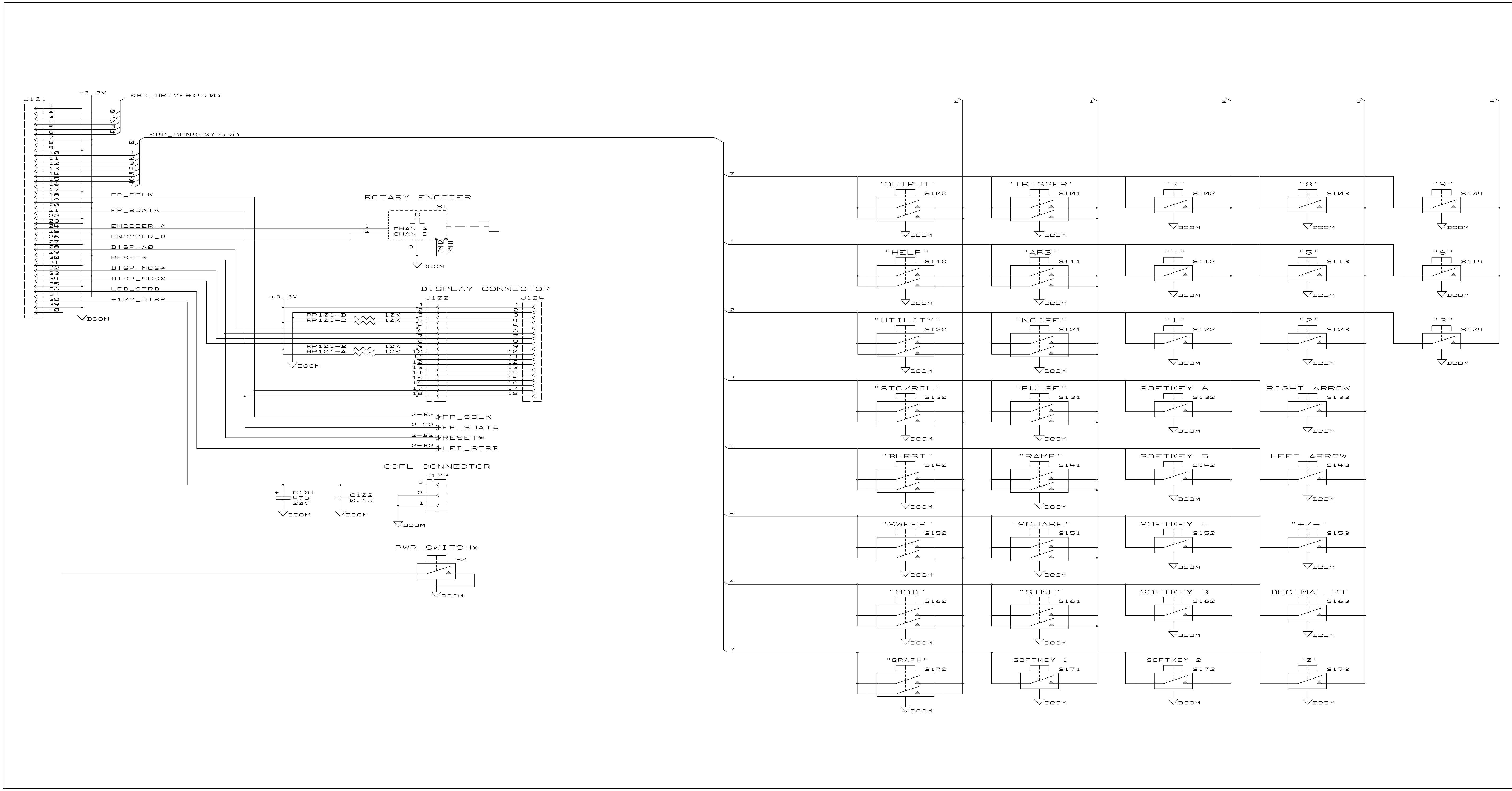

33220-66502 (sheet 1 of 2)
A2 Keyboard Scanner and Display Connector Schematic

⇦ Binder Edge (RH Page)
Foldout Cut Size = 9 x 19 inches

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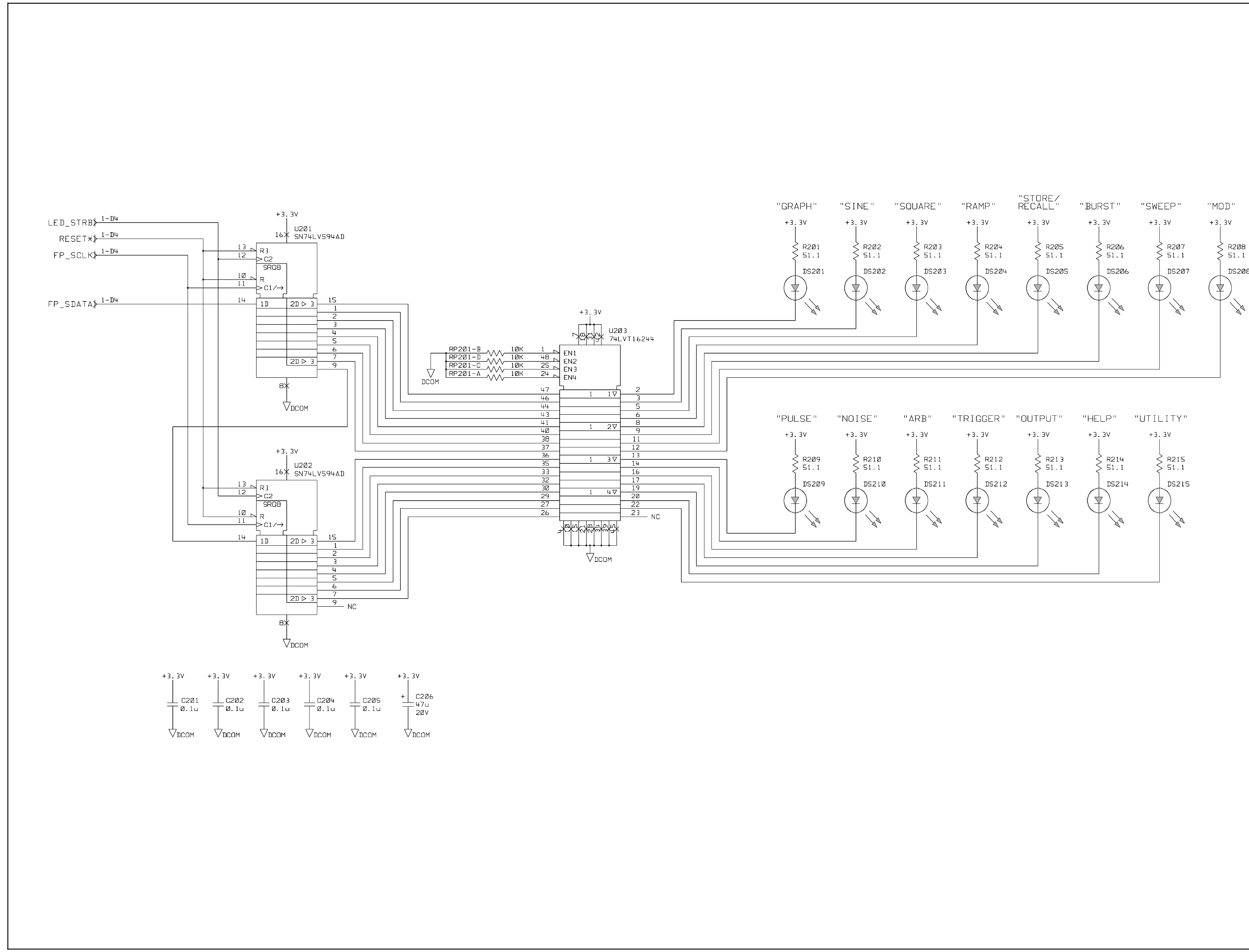

33220-66502 (sheet 2 of 2)
A2 Key Control Schematic

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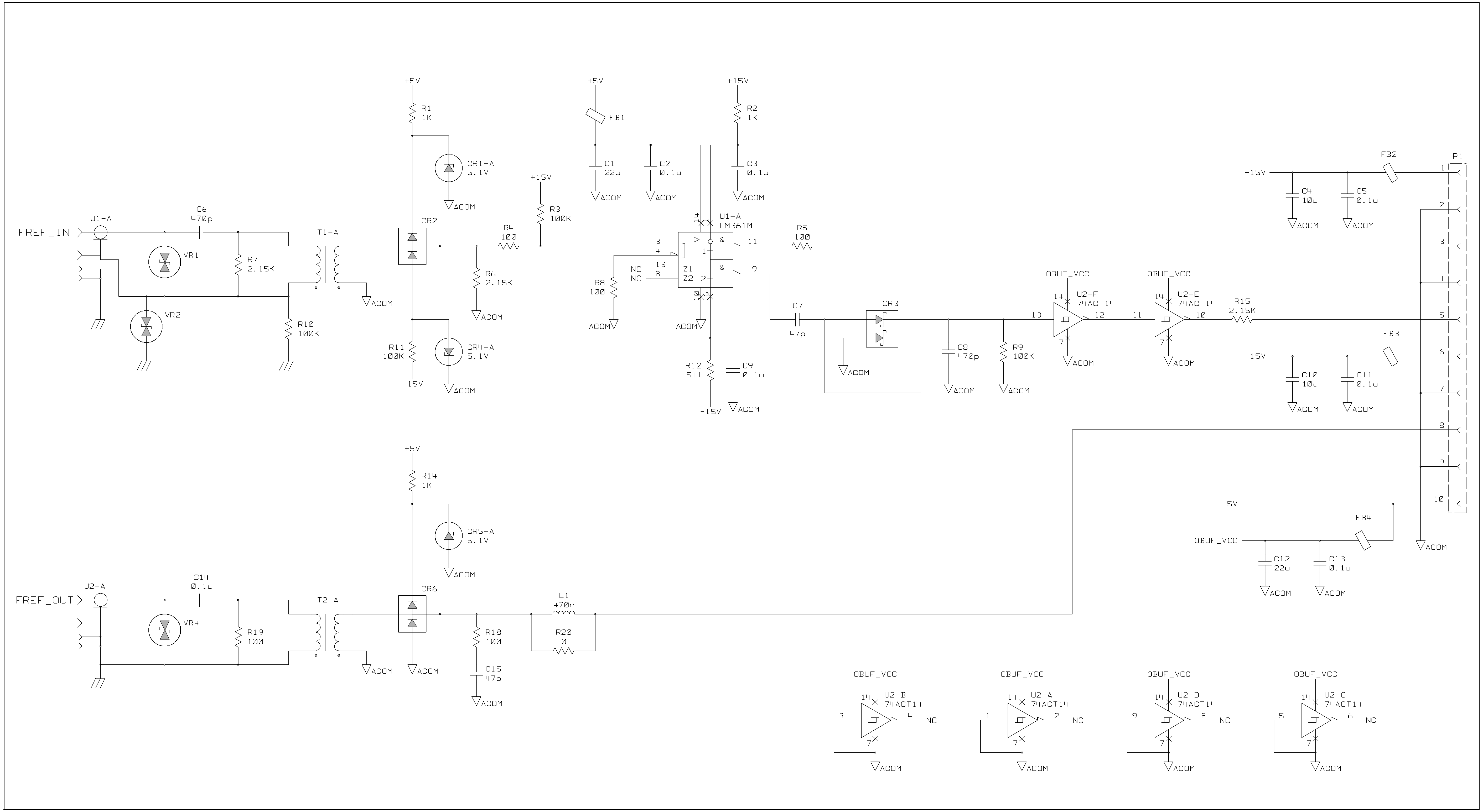

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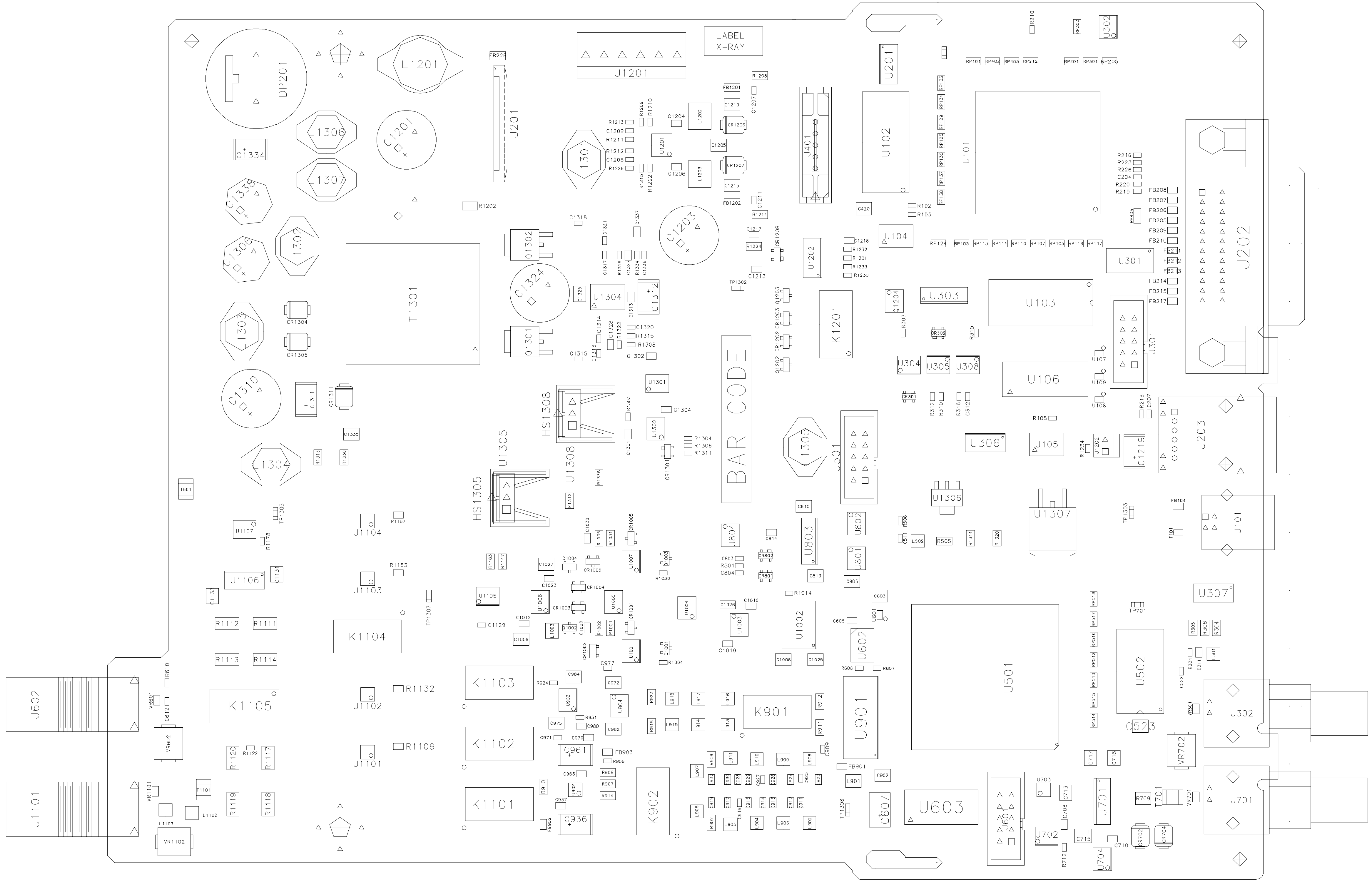

⇦ Binder Edge (RH Page)
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33220-66501 (sheet 2 of 2)
A1 Component Locator (bottom)

⇦ Binder Edge (RH Page)
Foldout Cut Size = 9 x 19 inches

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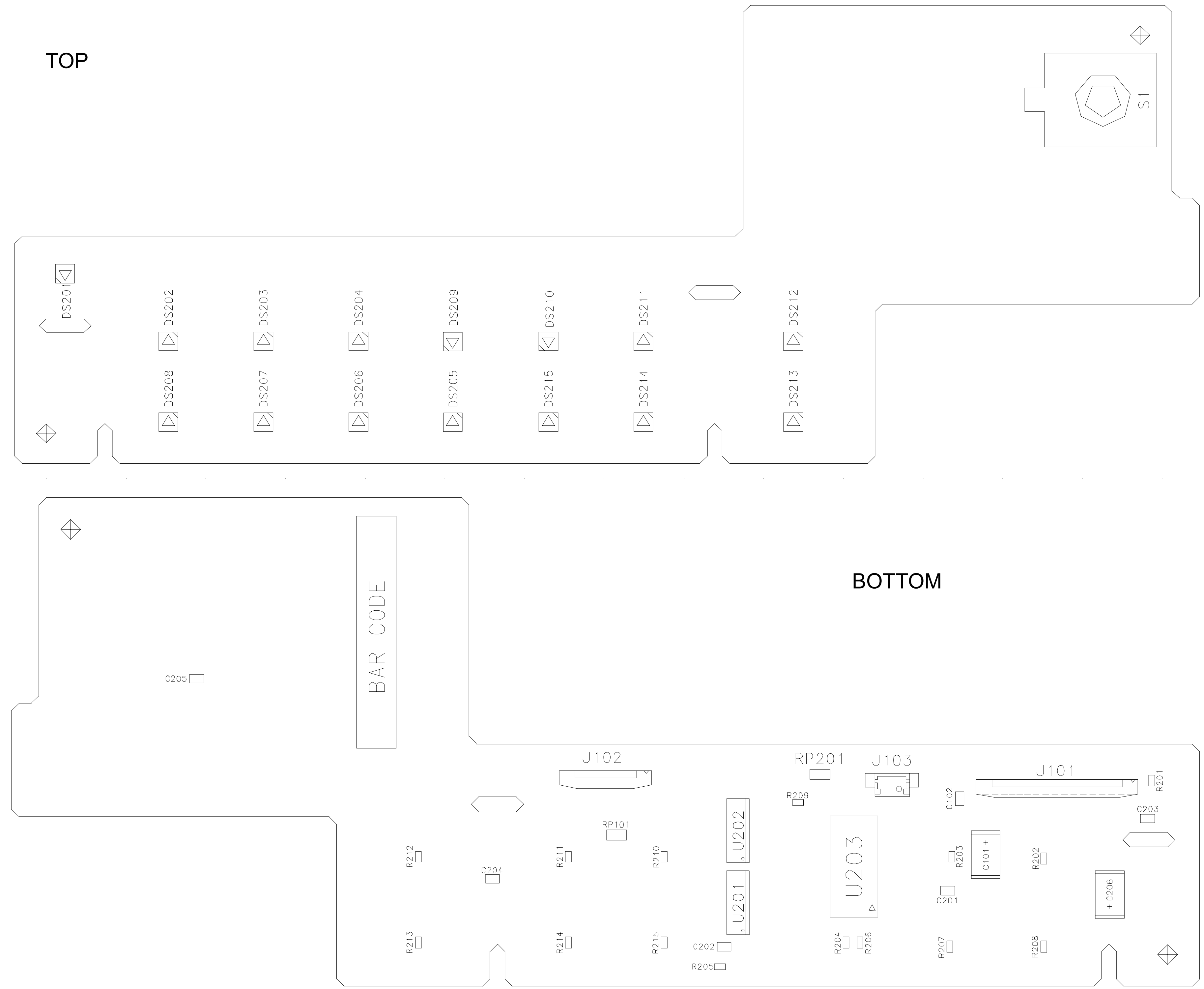

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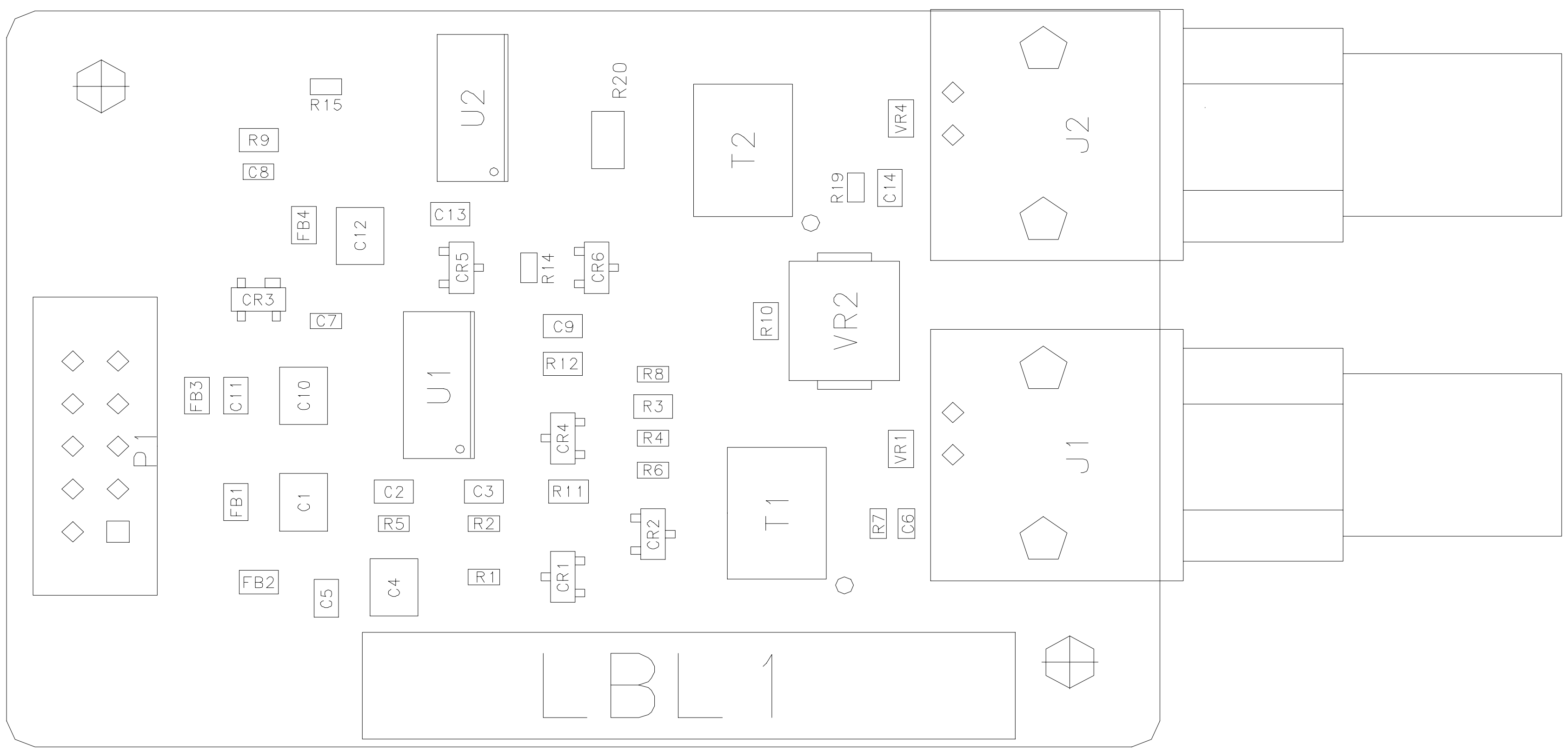

33220-66503
A3 Component Locator

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Binder Edge (LH Page) ⇨
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Manual Part Number

33220-90010, February 2003
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Edition

Edition 1, February 2003

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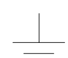
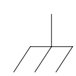


Earth ground symbol.



Chassis ground symbol.

WARNING

Only qualified, service-trained personnel who are aware of the hazards involved should remove the cover from the instrument.

WARNING

For continued protection against fire, replace the line fuse only with a fuse of the specified type and rating.