E-9000 Tower with Version 2.0 902-928 MHz ISM Band Transmitter Manual/Specifications

Revision History

Rev	ECO No.	Date	Comments
1.0		99/05/10	Initial FCC submission document

Table of Contents

1.0 Purpose

The purpose of this report is to provide a more detailed description of the connections, usage, schematics, and parts lists. This report is to be used in combination with the EMI TEST REPORT to be submitted to FCC for certification of the E-9000 product with V2.0 900MHz ISM band Transmitter.

2.0 Scope

The document although used primarily in combination with the EMI TEST REPORT for FCC certification submission, does contain information included in documents such as the users manual, and test procedures.

3.0 Test Description

3.1 Test Configuration

Unit Name – Processor, Monitor, Printer, Cable, Etc. (indent for features of a unit)	Style/Model/ Part No.	Serial Number	Obj. of test	120 V	220 V	Comments/FCC ID#
E-Zone Tower Unit	E-9000	001	■	■		

3.2 Equipment Description

Compact Entertainment System for Fitness Industry. Audio/video system with self-contained audio CD, audio cassette tape, and television with wireless headphone. The audio channel of one of the three sources is transmitted to wireless headphones.

3.2.1 Mode of Operation

The EUT unit that was used during the testing contained software that allowed the transmitter frequency, power output, and modulation to be changed manually. Other than allowing the transmit frequency, power output, and modulation to be selected manually, this software allowed the EUT circuits and functions to behave as they would in normal operation. The frequency was selected through the use of a Laptop at a remote end of a cable connected to the transmitter. The location of the Laptop was such that it did not interfere with the emission measurements made at the test site. Special software that ran on the Laptop was used to send commands to the Transmitter in order control the setting of the frequency, output power, and modulation. The laptop and special software used on the laptop would not normally be connected to the EUT and was only used in order to allow modifications of power output and modulation during the tests for compliance. These settings would be loaded into a non-volatile EEPROM on a manufactured unit at test and calibration time (see additional information on manufacturing calibration procedure). Although the power output was able to be set manually, it was set so that it did not exceed the FCC allowable limit (see additional information on manufacturing calibration procedure). The modulation was also calibrated to give a standard deviation frequency under normal operating conditions (see additional information on manufacturing calibration procedure). The frequency was selected using the laptop, but could also have been selected through the on-screen display of the tower unit (either method of changing frequency accomplishes an identical result).

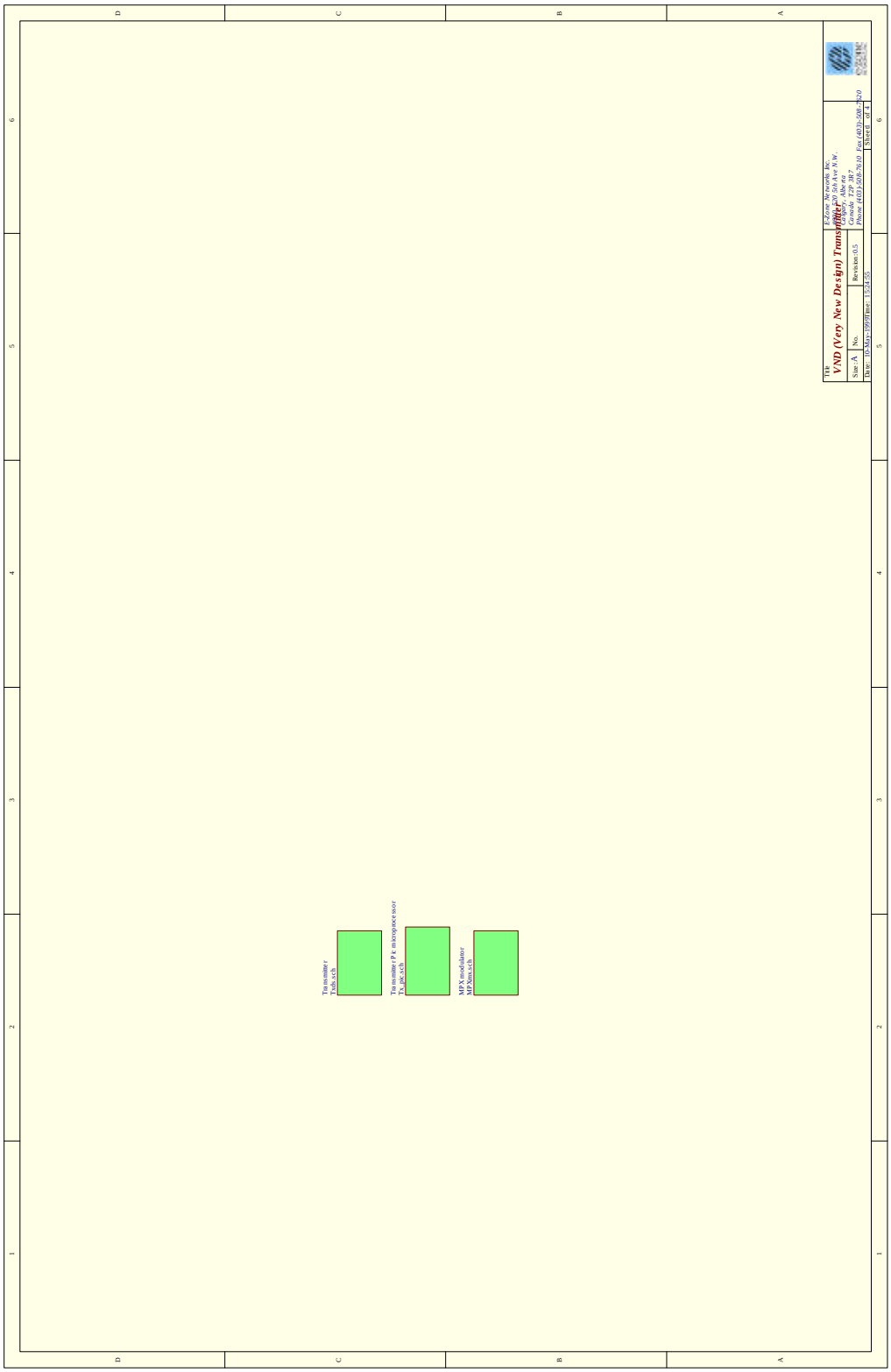
In order to modulate the carrier of the transmitter a Video signal generator was used to generate a video NTSC signal. This NTSC signal also incorporated a 1KHz full amplitude audio tone. The TV audio path was selected and the 1KHz tone was directed to the EUT transmitter for modulation.

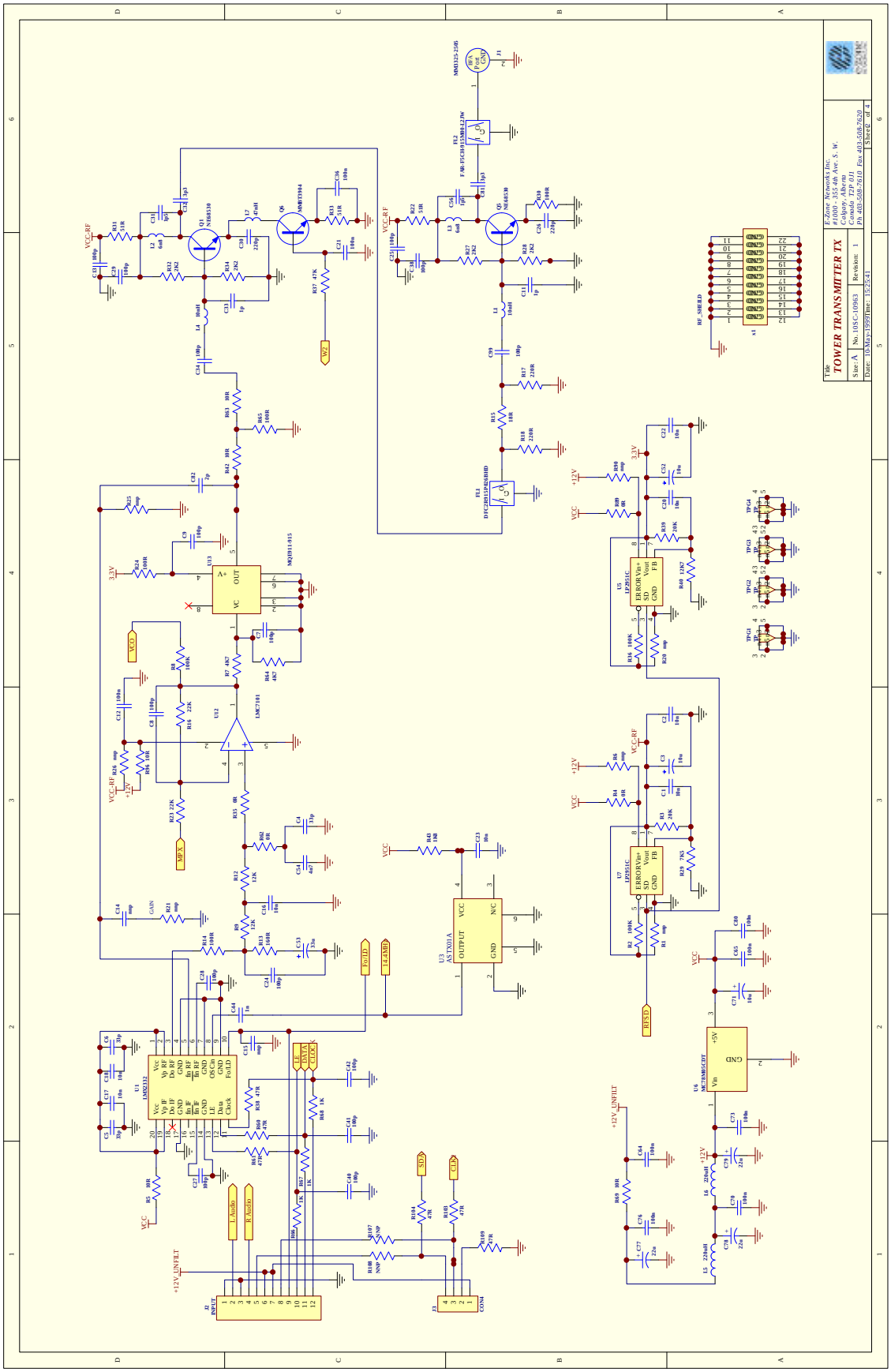
3.3 Antenna Requirement – per 15.203

The Antenna is internal and can not be removed or changed by the operator.

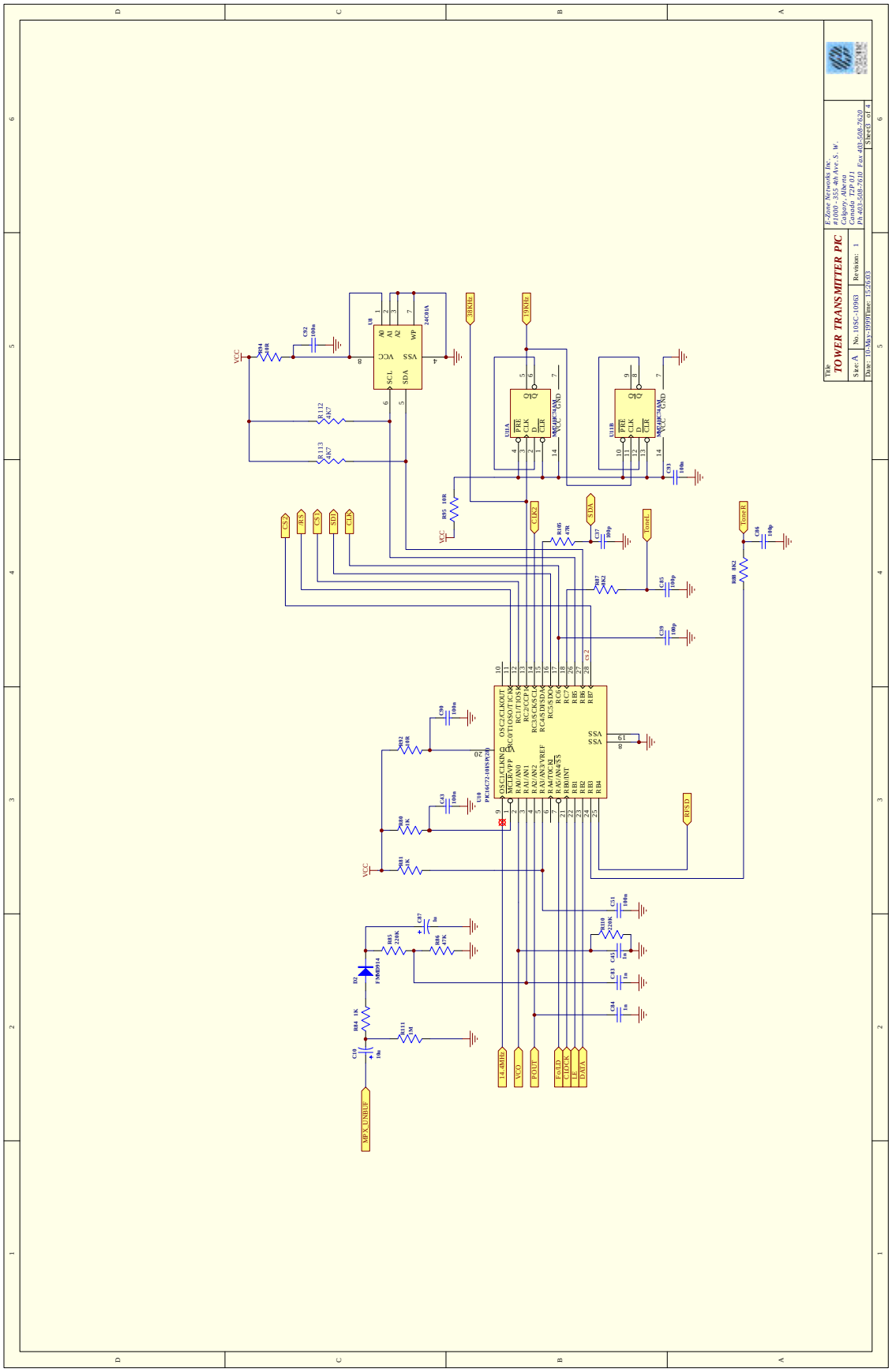
3.4 Schematics

3.4.1 902MHz – 928MHz ISM band Transmitter V2.0 Schematics





e-zone NETWORKS INC	Calgary Alberta Canada	Title: E-9000 Tower with V2.0 TX Manual/Specifications		
		Document No. 308A08-B	Sheet 7 of 60	Rev. 1.0



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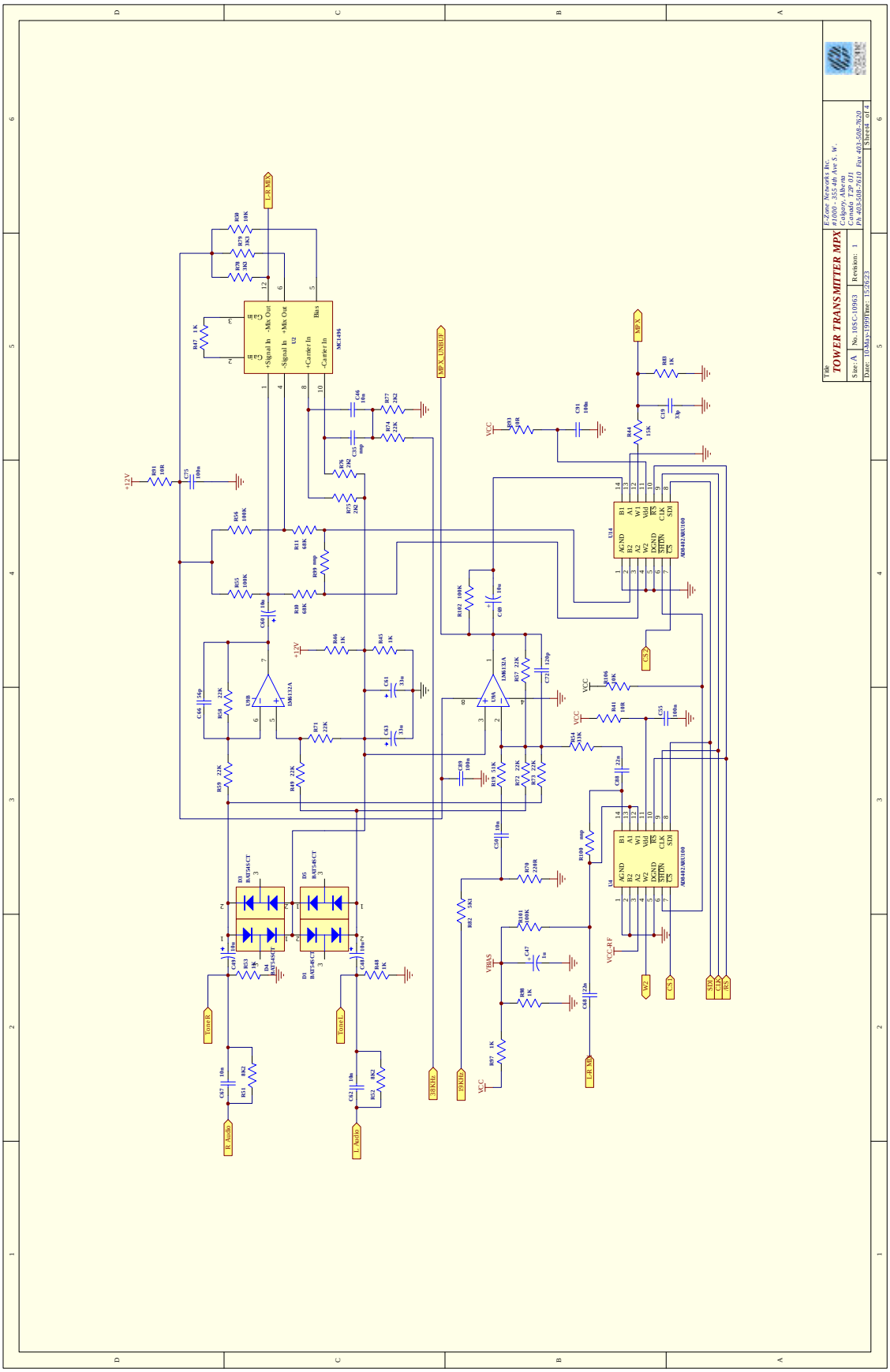

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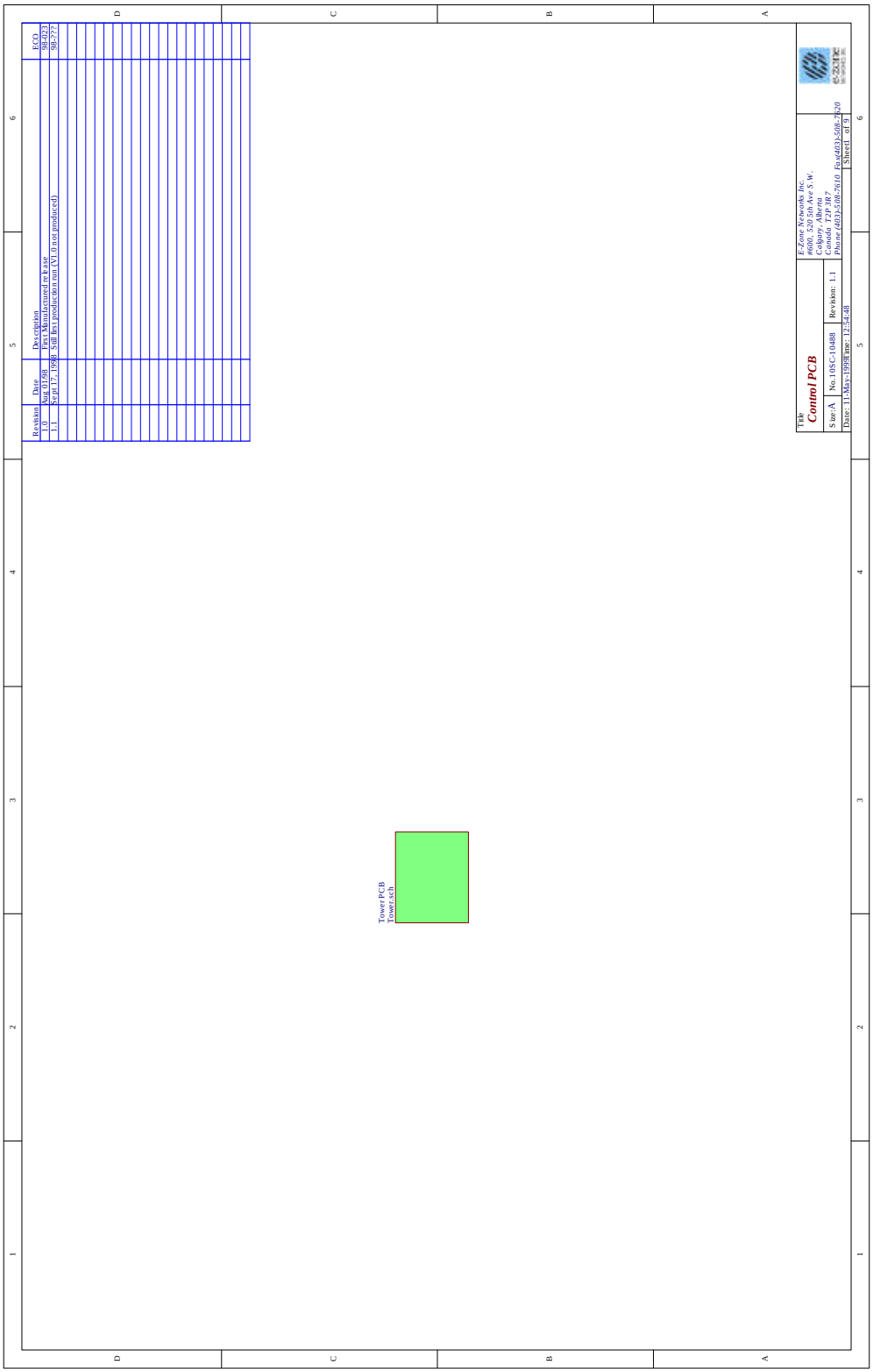
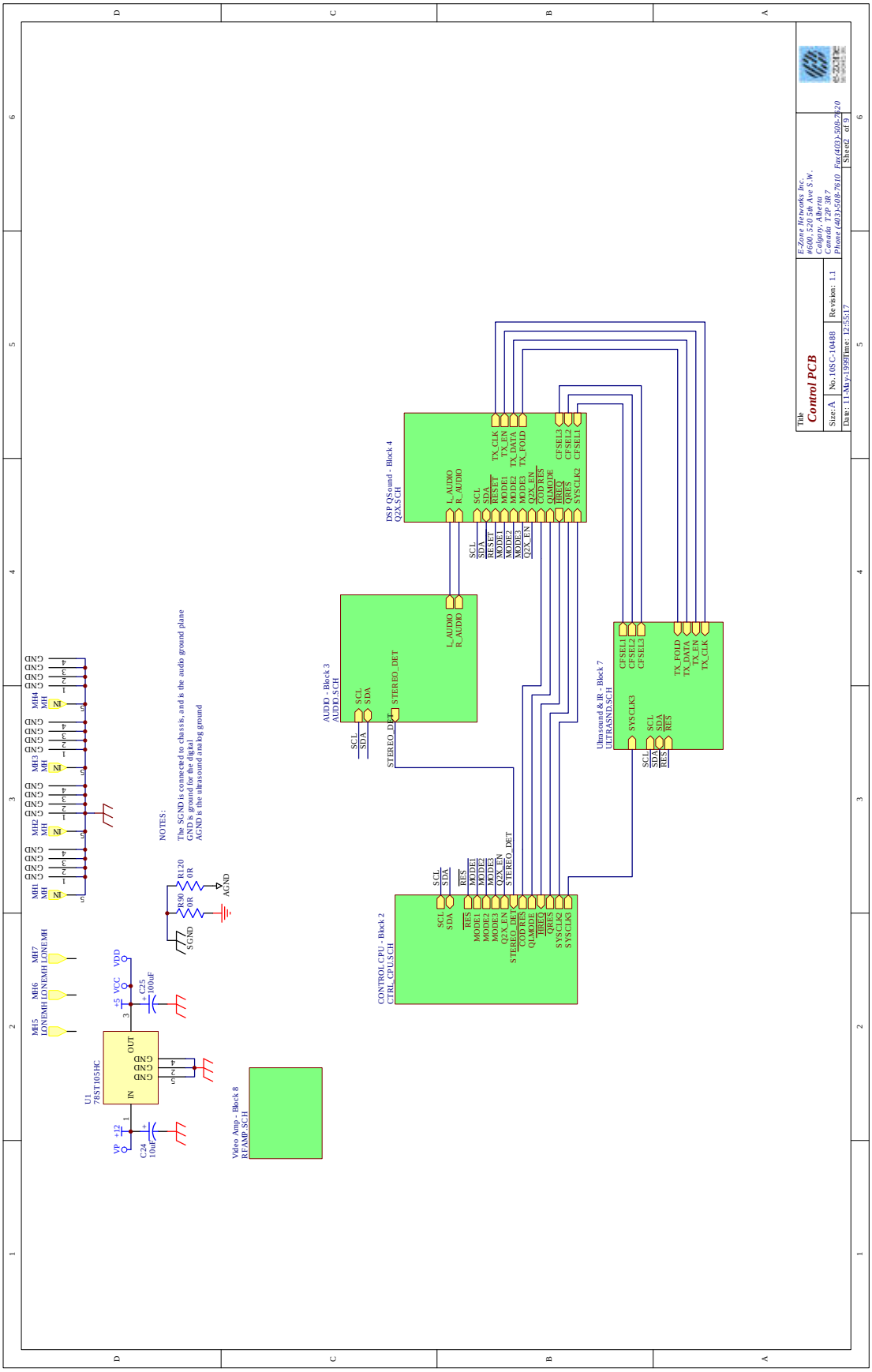
3.4.2 Tower Control Board Schematics





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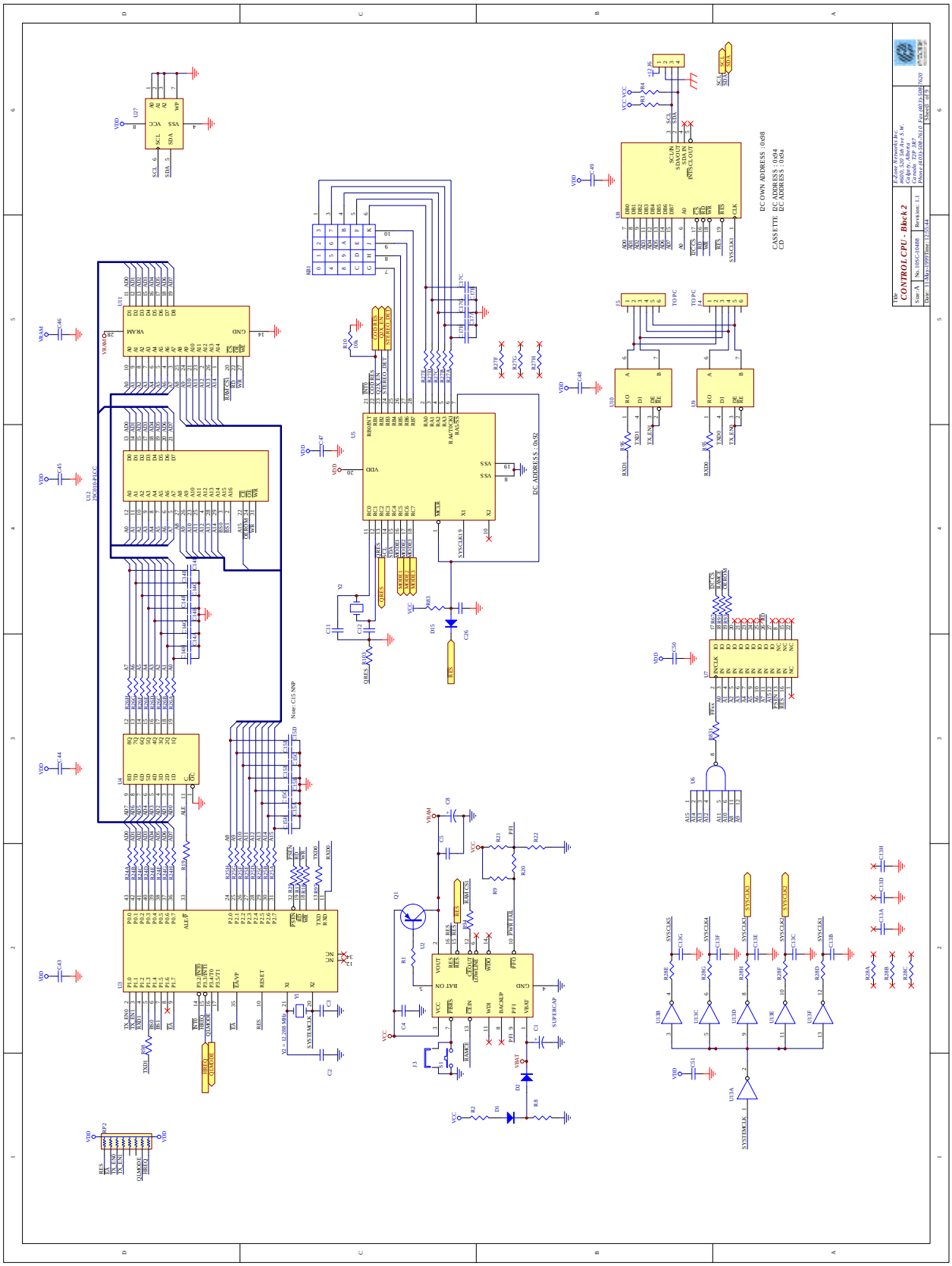

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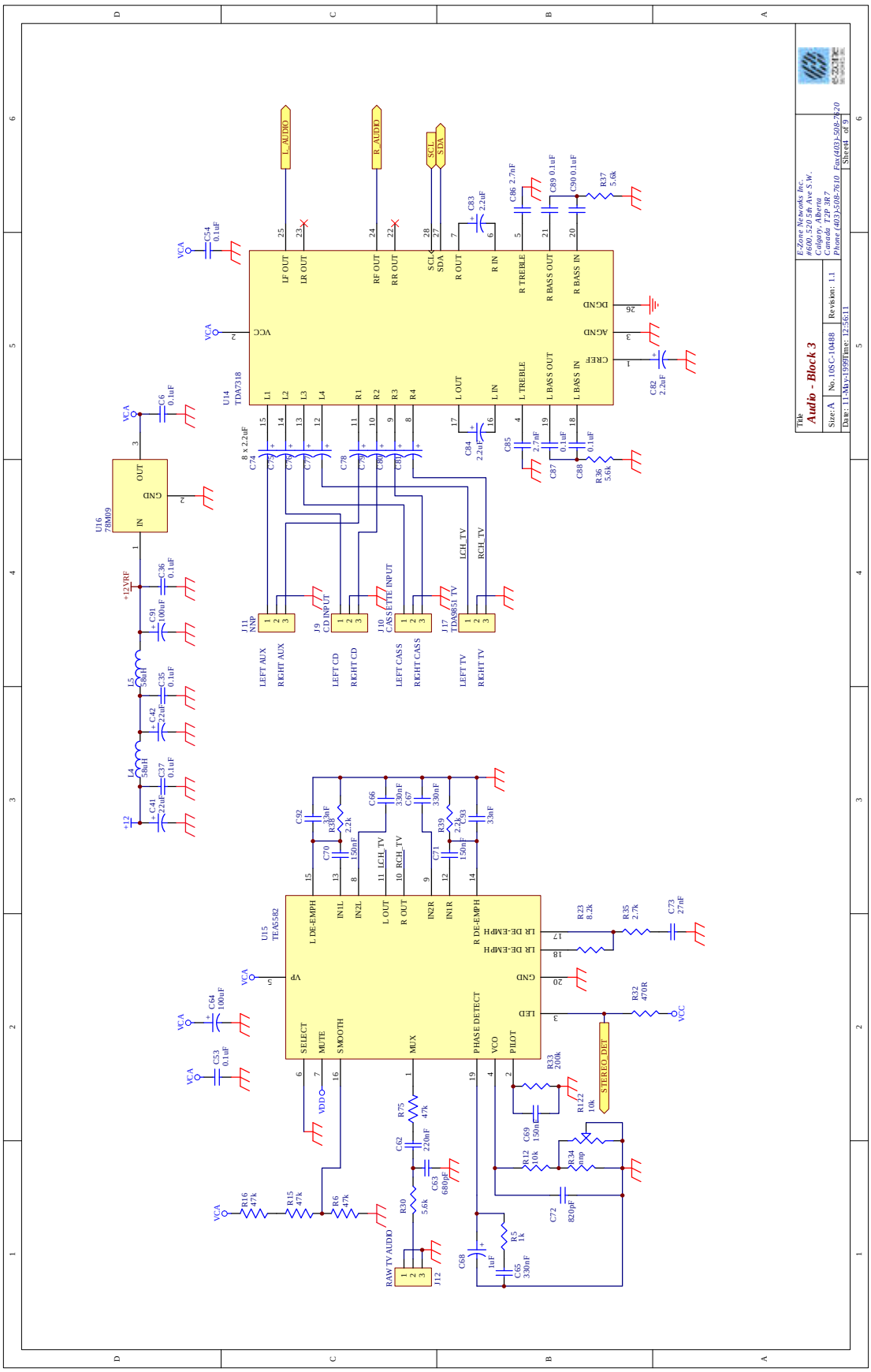

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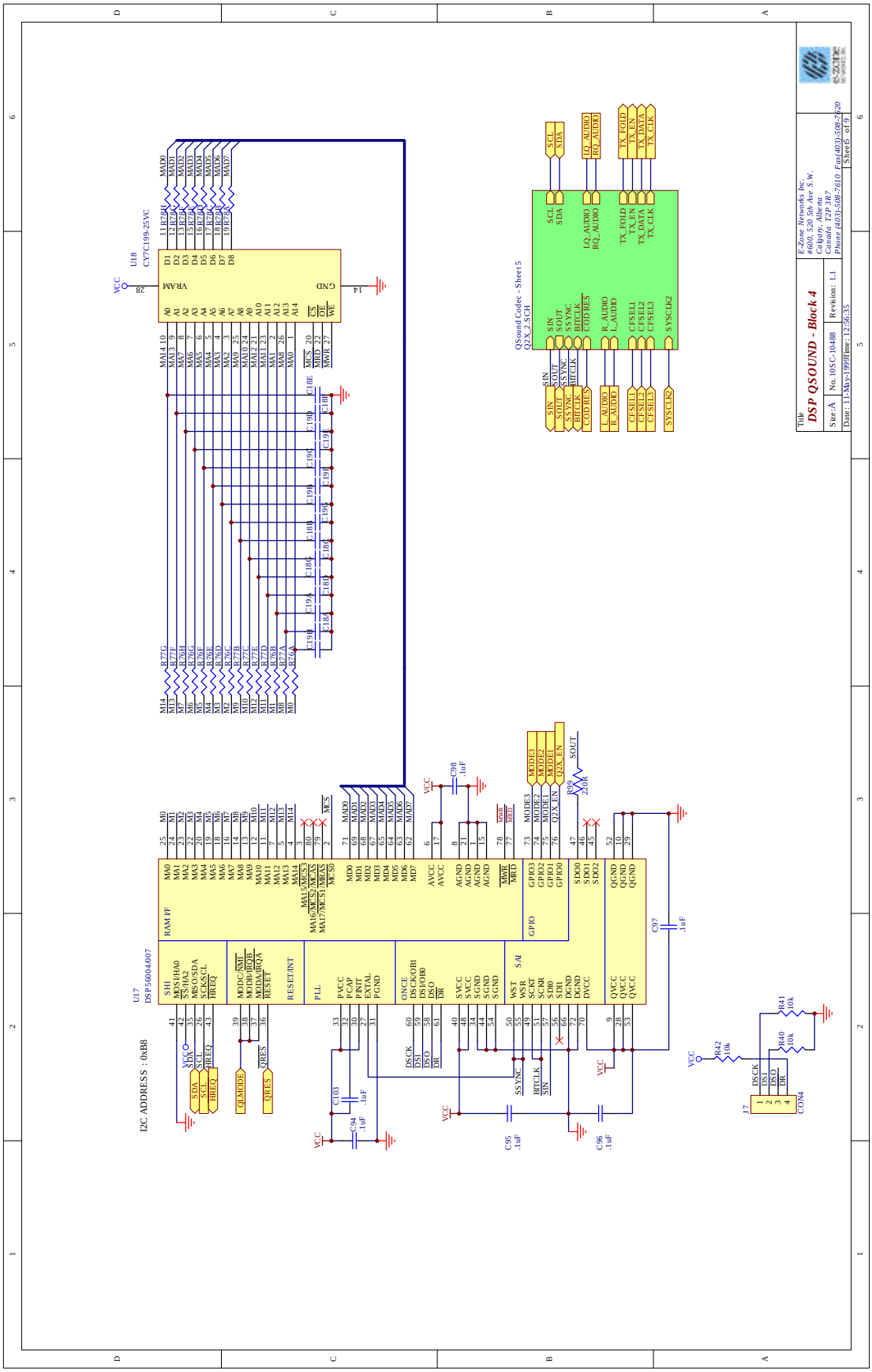

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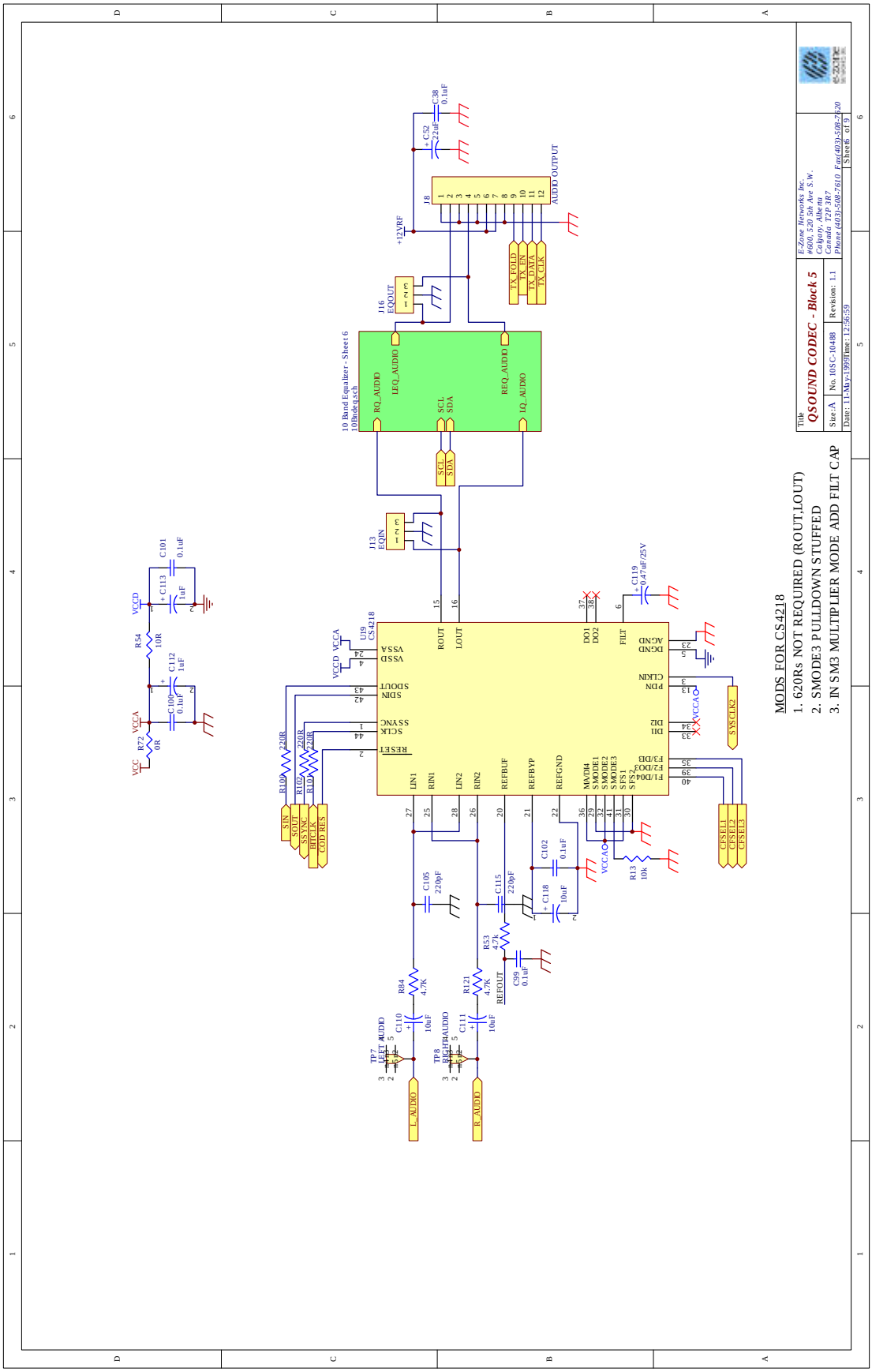

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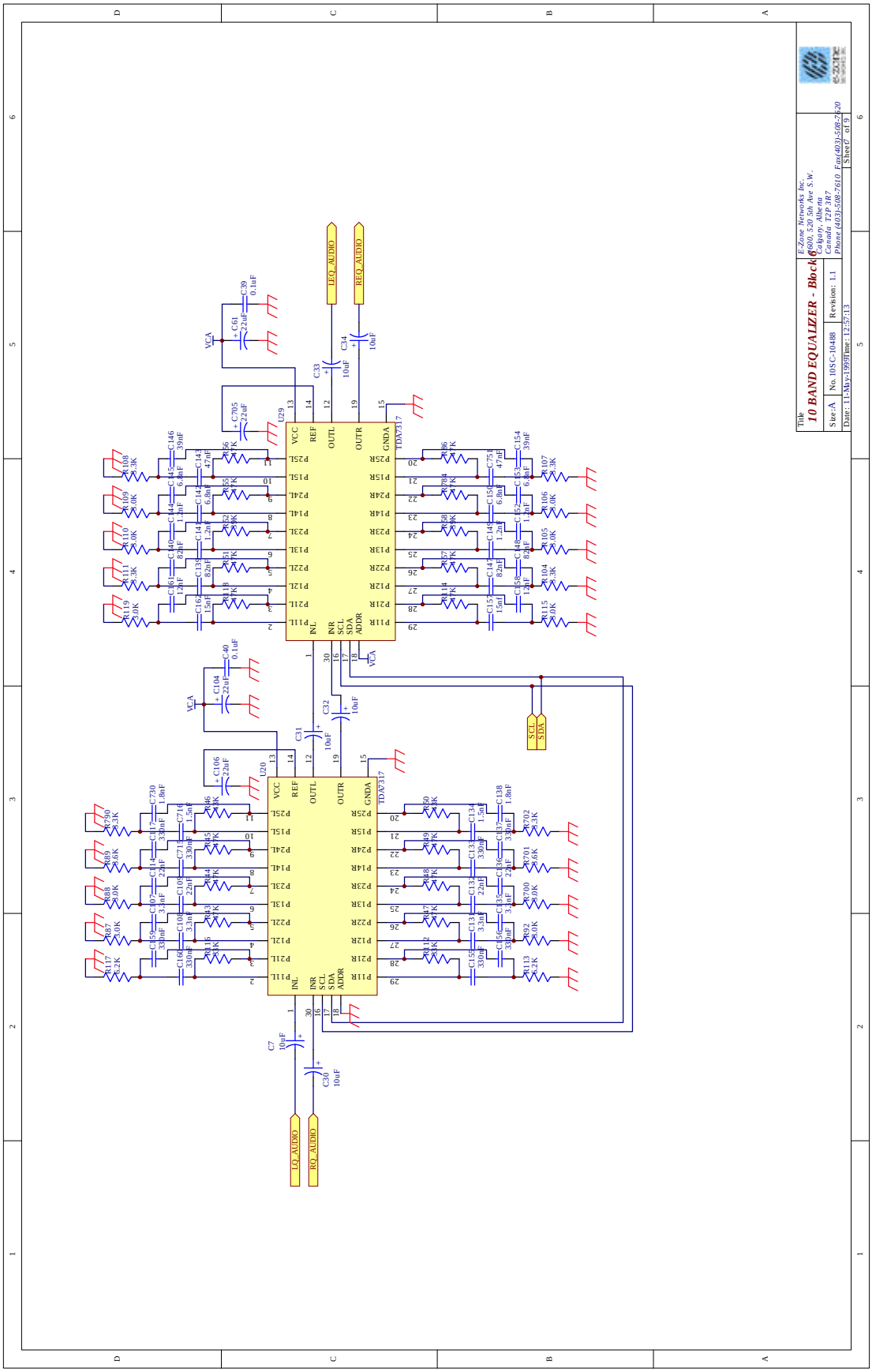

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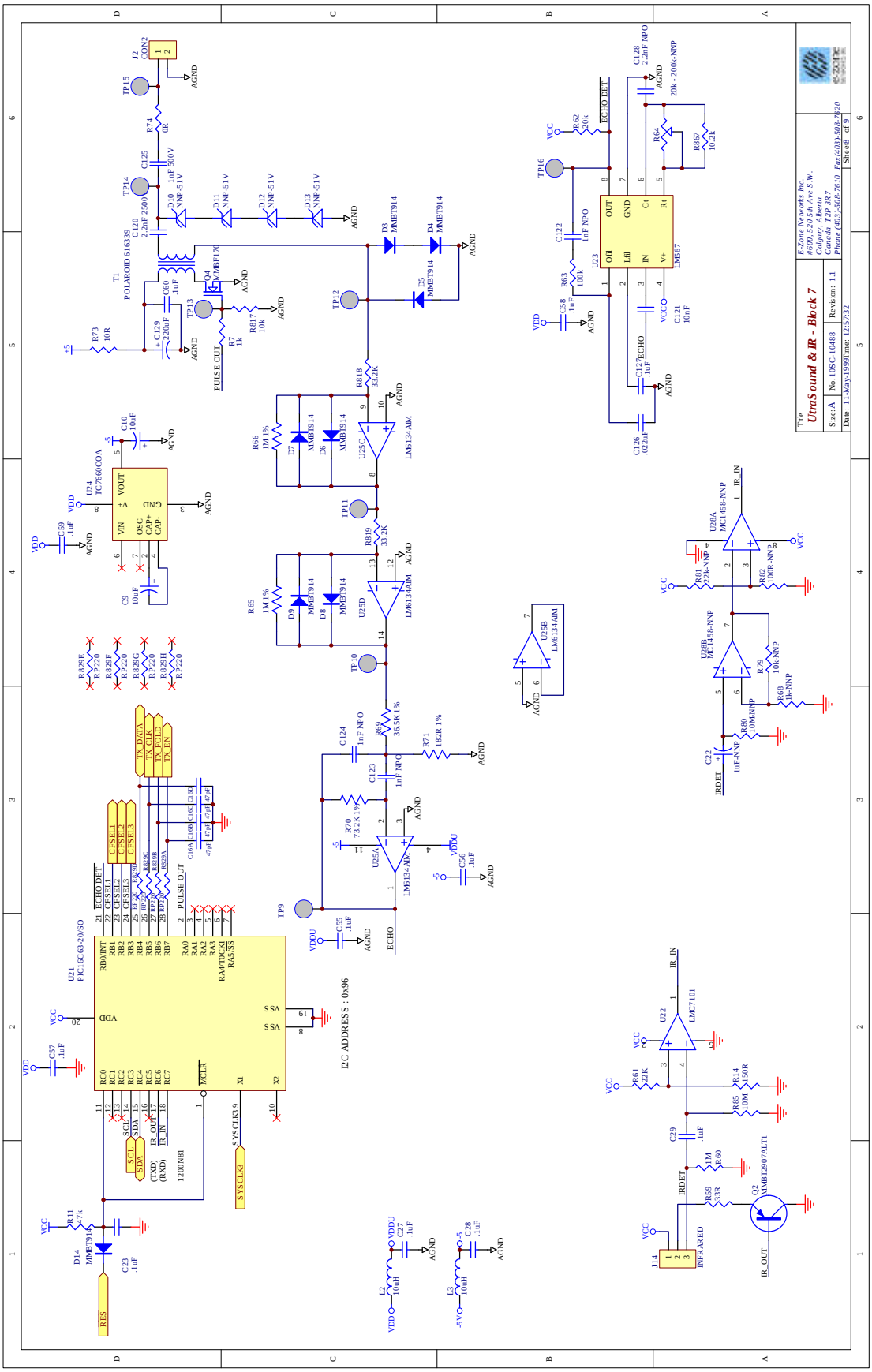

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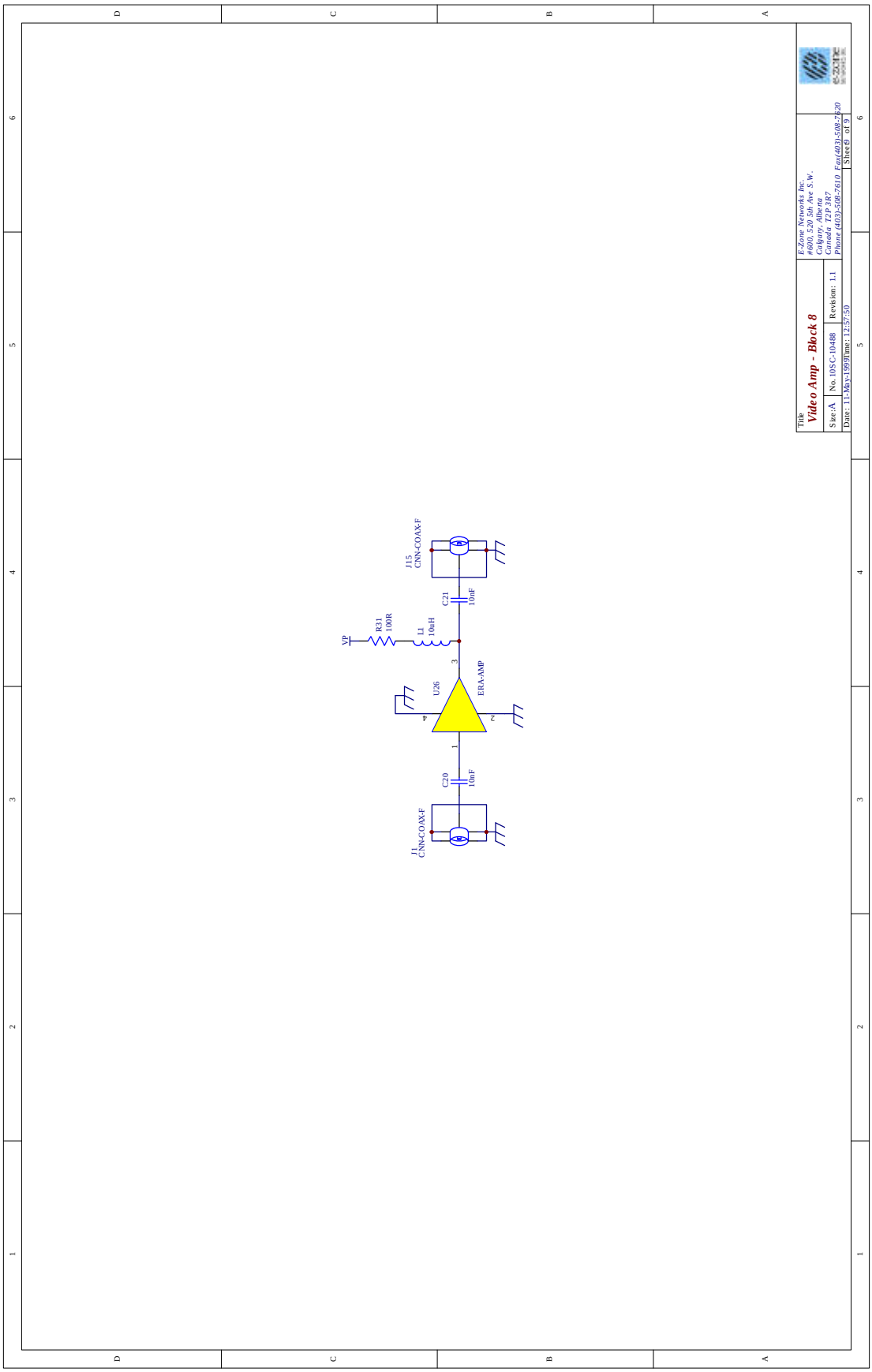
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Video Amp - Block 8
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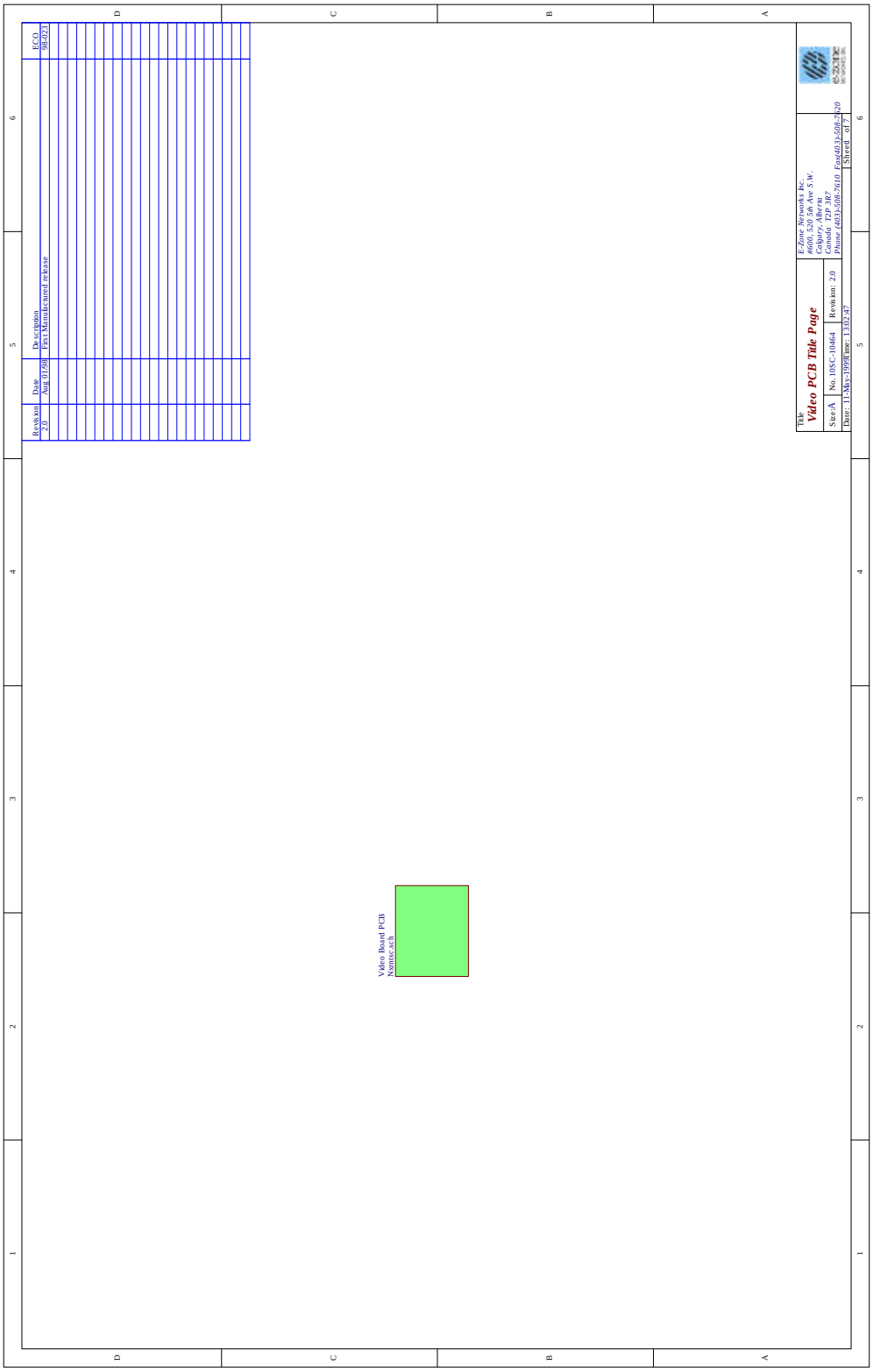
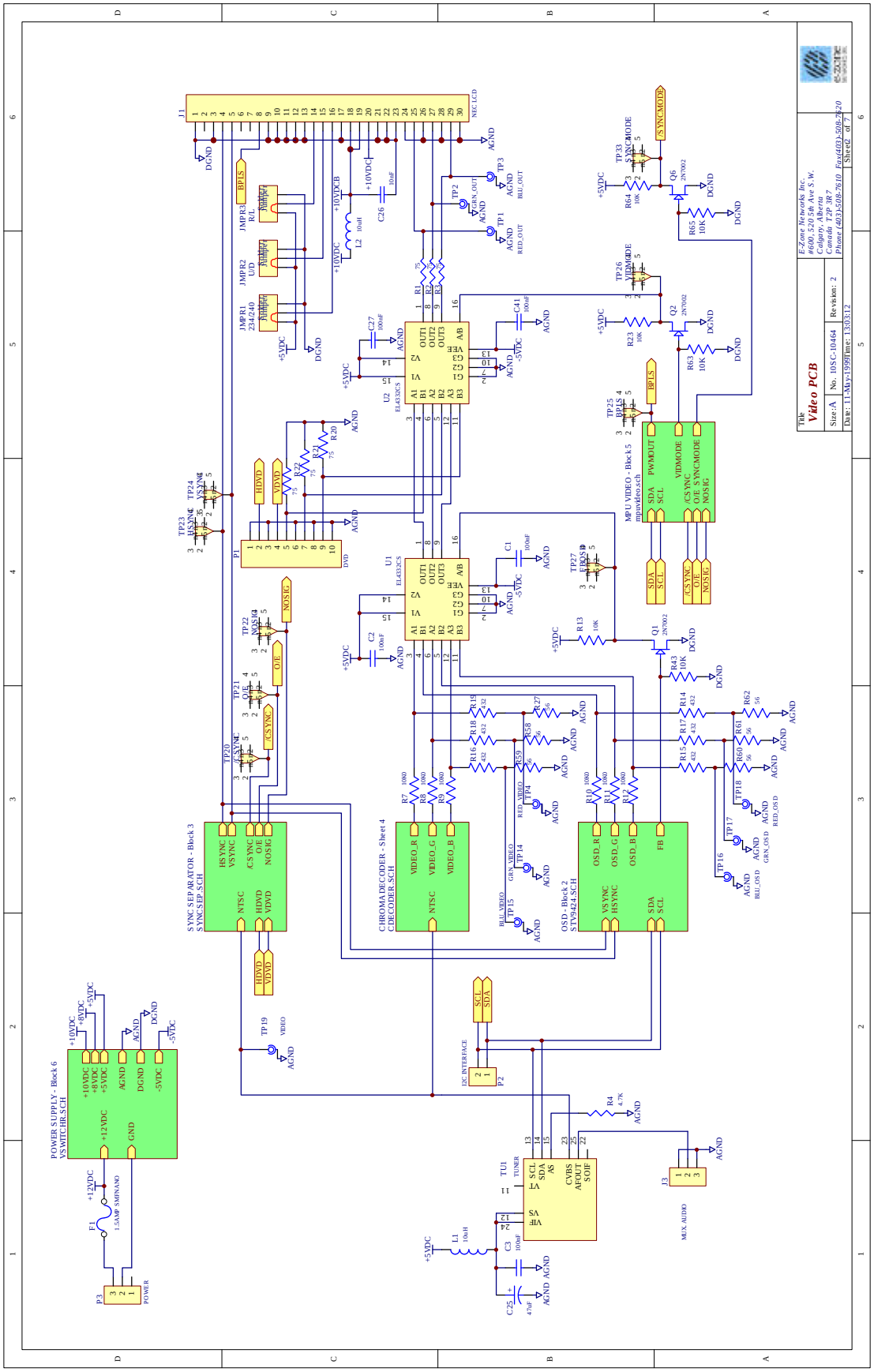
No. 10SC-10488
Revision: 1.1
Date: 11-May-1999
Time: 12:57:50
E-Zone Networks Inc.
#600, 520 5th Ave S.W.
Calgary, Alberta
Canada T2P 3R7
Phone (403)-508-7610 Fax (403)-508-7620
Sheet 6 of 9
J15
CNN-COAX-F
C21
10nF
VP
R31
100R
L1
10uH
3
U26
ERA-AMP
4
2
1
C20
10nF
J1
CNN-COAX-F

3.4.3 Video board Schematics





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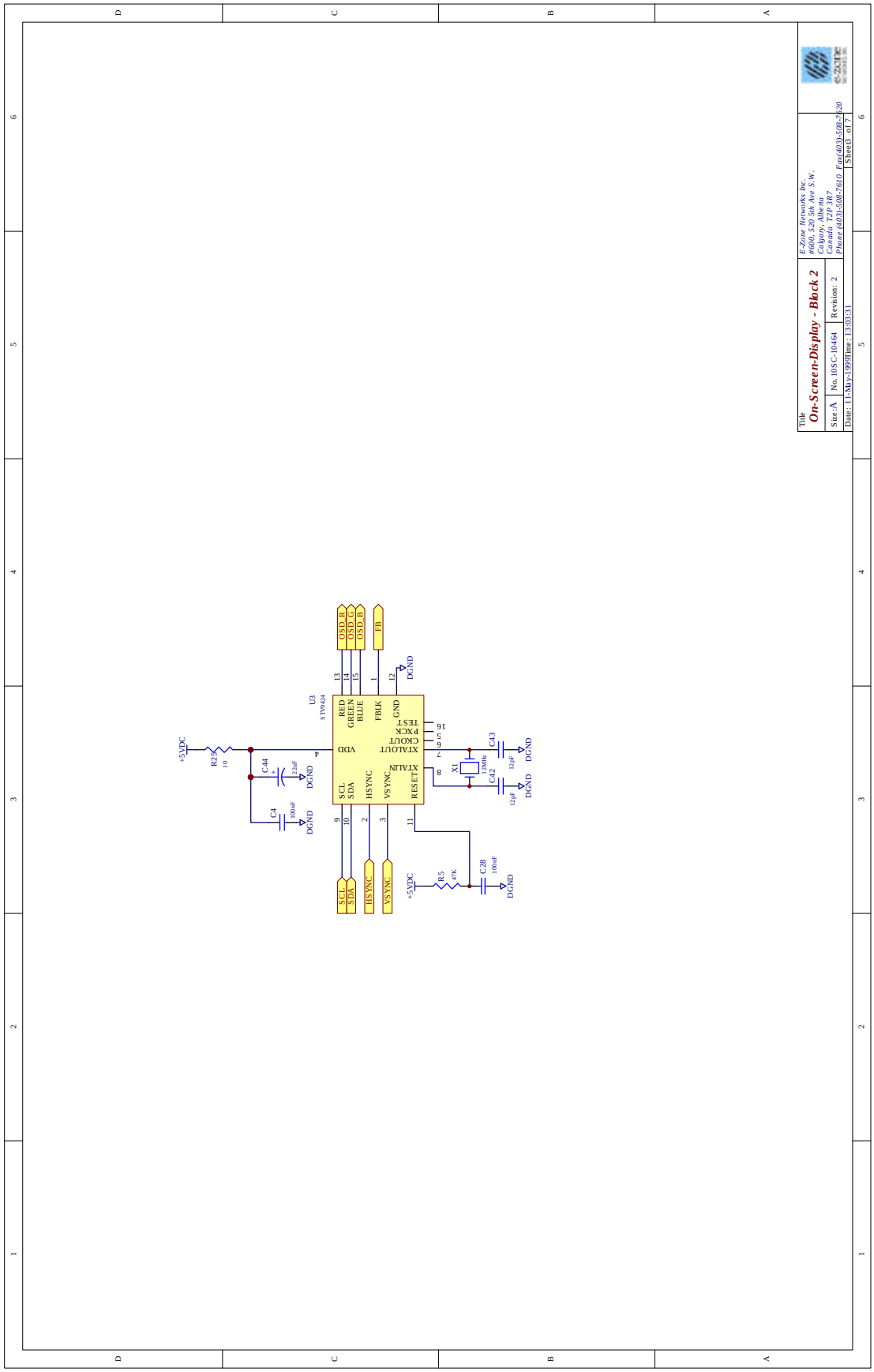
		Document No. 308A08-B	Sheet 20 of 60	Rev. 1.0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No. 10SC-10464
Revision: 2
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Sheet 3 of 7
E-Zone Networks Inc.
#600, 520 5th Ave S.W.
Calgary, Alberta
Canada T2P 3R7
Phone (403)-508-7610 Fax(403)-508-7620
U3
STV9424
OSD_R
OSD_G
OSD_B
FB
DGND
RED
GREEN
BLUE
FBLK
GND
TEST
PXCK
CKOUT
XTALOUT
VDD
XTALIN
RESET
SCL
SDA
HSYNC
VSYNC
+5VDC
R23
10
C44
22uF
C4
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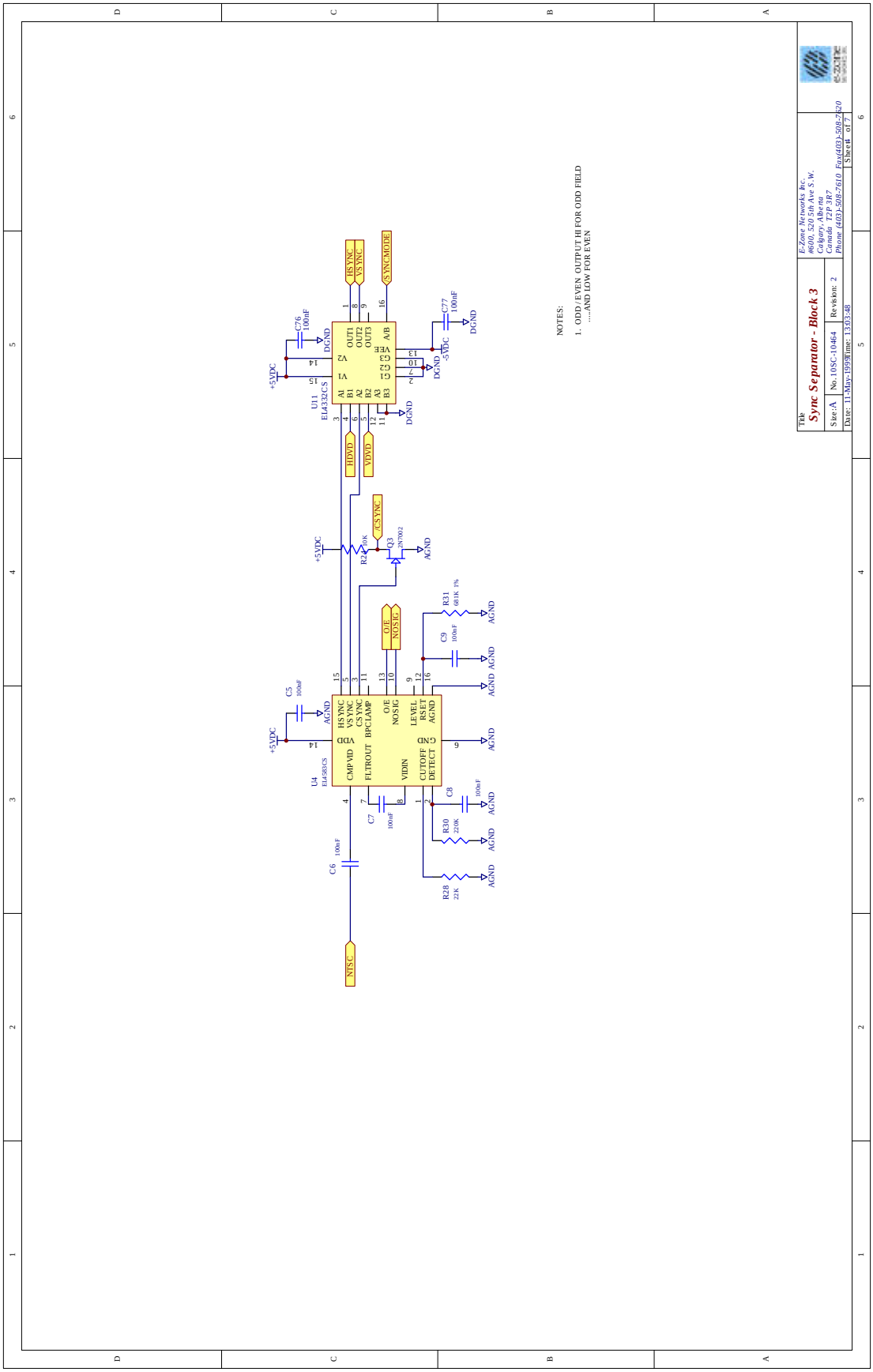
R5
47K
C28
100nF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1. ODD /EVEN OUTPUT HI FOR ODD FIELD
....AND LOW FOR EVEN
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Sheet 4 of 7
E-Zone Networks Inc.
#600, 520 5th Ave S. W.
Calgary, Alberta
Canada T2P 3R7
Phone (403)-508-7610 Fax(403)-508-7620
HS YNC
VS YNC
CS YNCMODE
/CS YNC
O/E
NOSIG
NTSC
+5VDC
-5VDC
DGND
AGND
U11
EL4332CS
U4
EL4583CS
Q3
2N7002
R24 10K
R31 681K 1%
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C76 100nF
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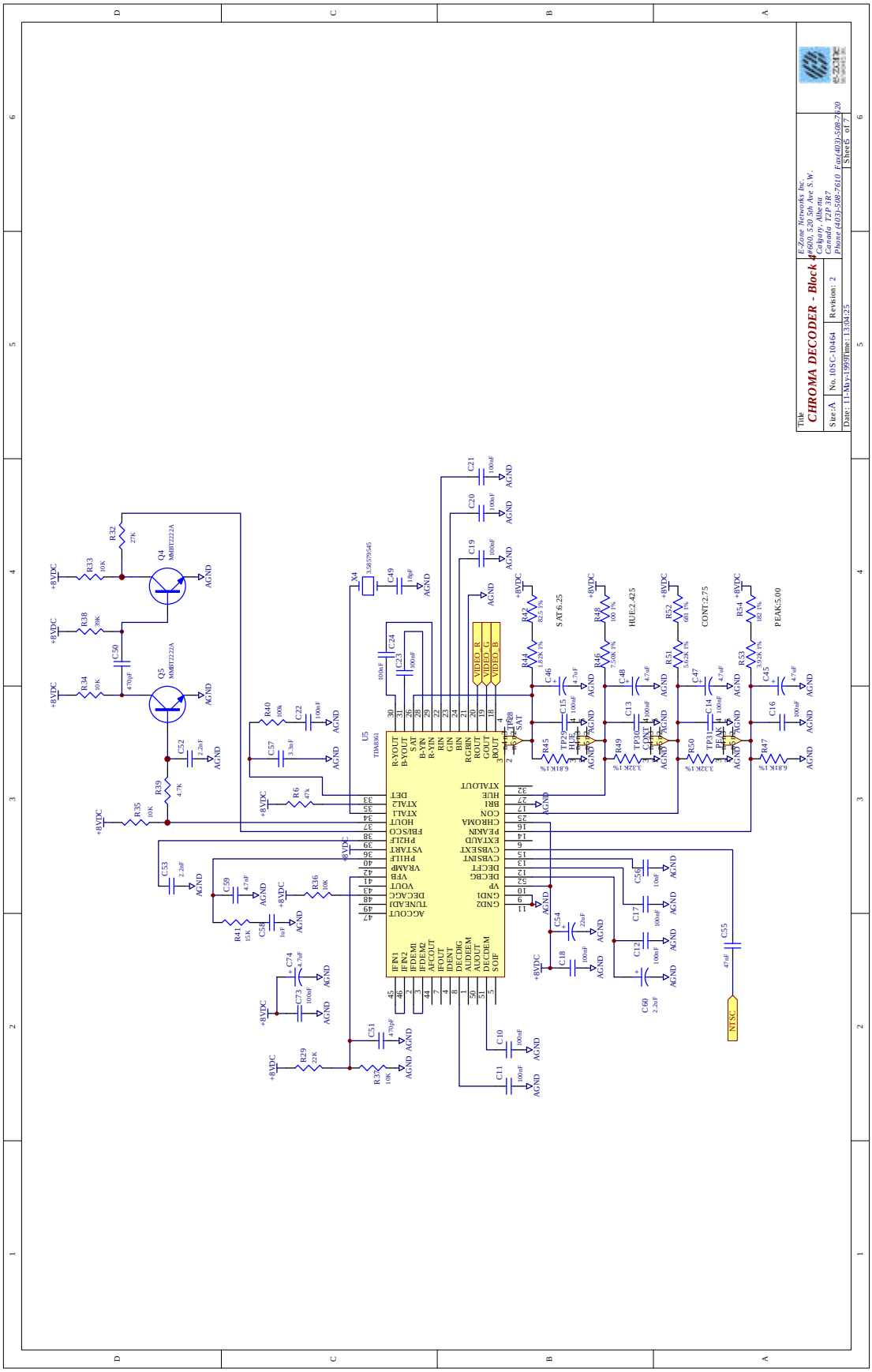

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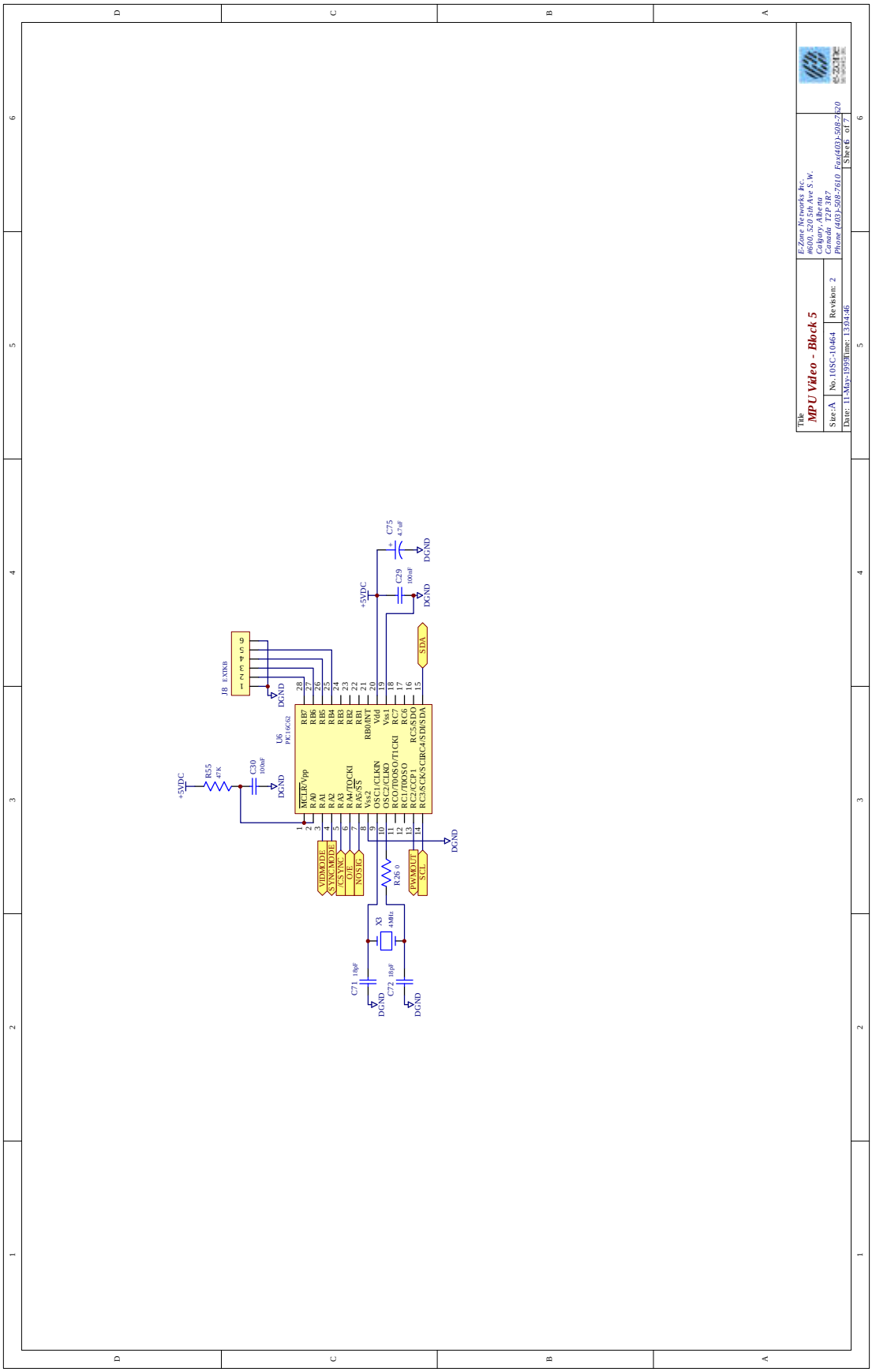
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Revision: 2
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Sheet 6 of 7
E-Zone Networks Inc.
#600, 520 5th Ave S. W.
Calgary, Alberta
Canada T2P 3R7
Phone (403)-508-7610. Fax(403)-508-7620
J8 EXTRB
U6 PIC16C62
+5VDC
R55 47K
C30 100nF
C75 4.7uF
C29 100nF
X3 4MHz
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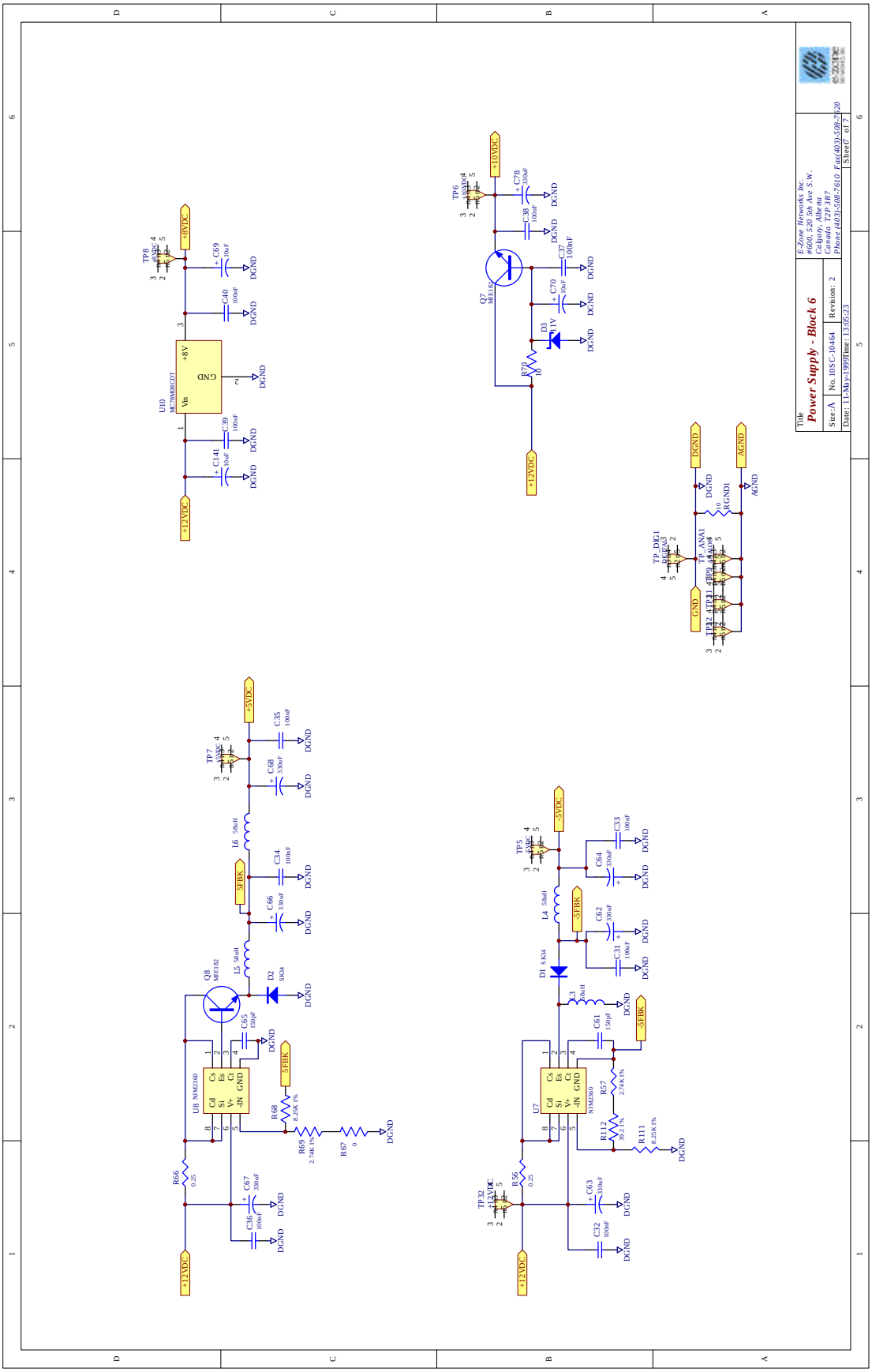
SCL
VIDMODE
SYNCMODE
NOSYNC
PWMOUT
DGND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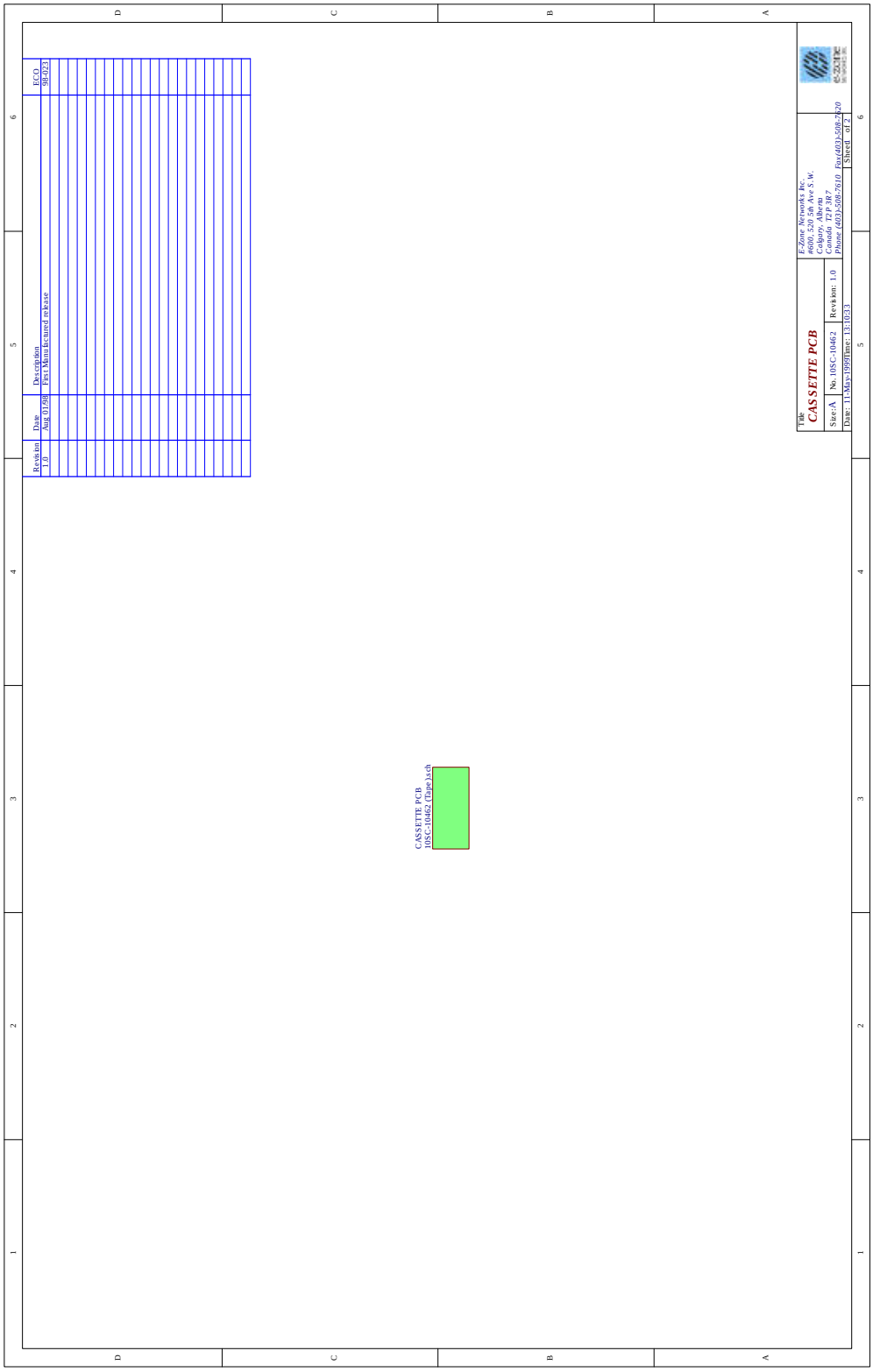
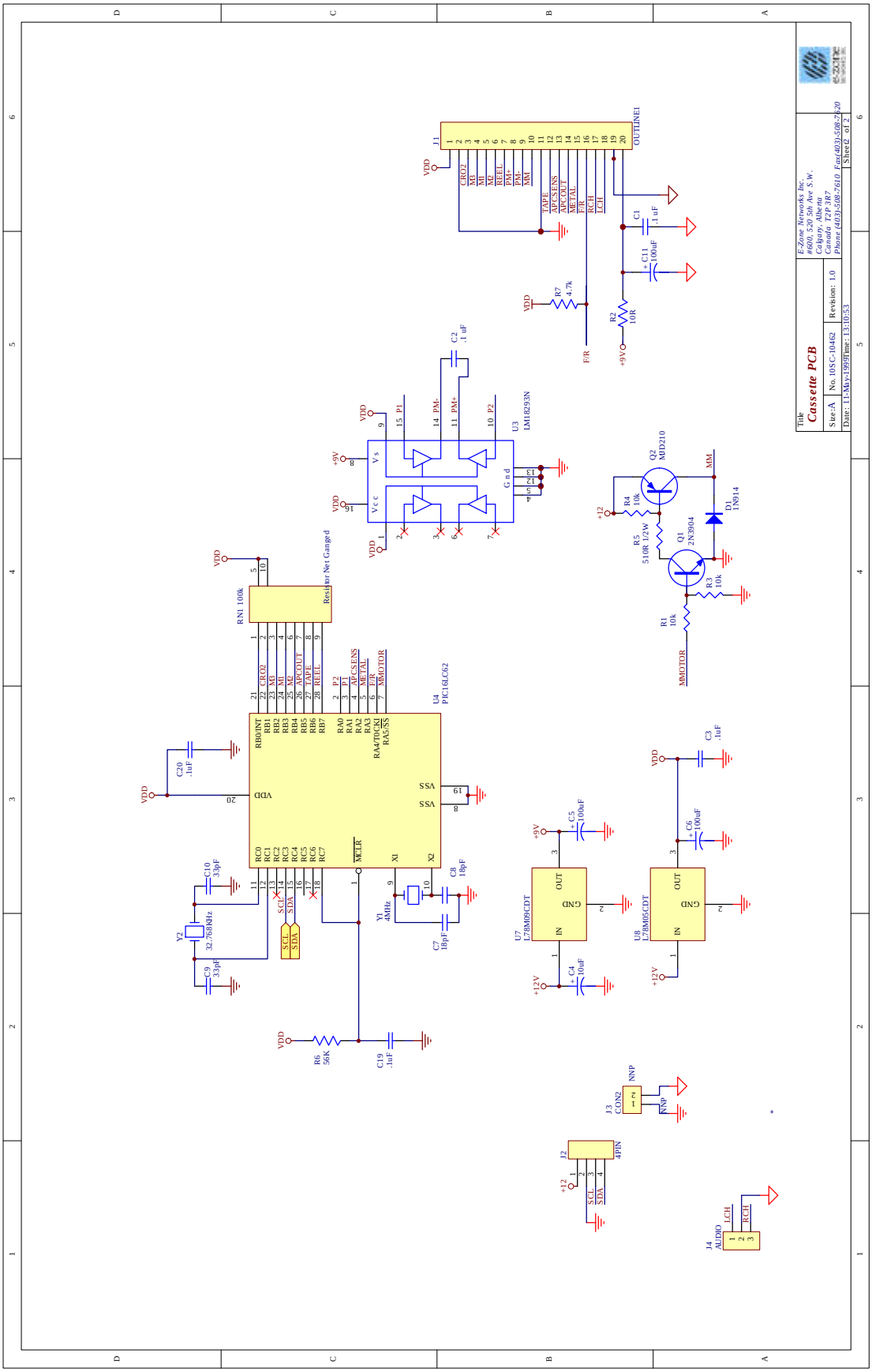
Sheet 6 of 7
E-Zone Networks Inc.
#600, 520 5th Ave S.W.
Calgary, Alberta
Canada T2P 3R7
Phone (403)-508-7610 Fax (403)-508-7620
+5VDC
+12VDC
+10VDC
-5VDC
-12VDC
DGND
AGND
U10 MC78M08CDT
U8 NJM2360
U7 NJM2360
Q8 MJE182
Q7 MJE182
D1 SK34
D2 SK34
D3 11V
L6 58uH
L5 58uH
L4 58uH
L3 58uH
+5FBK
-5FBK
R66 0.25
R67 0
R68 8.25K 1%
R69 2.74K 1%
R57 2.74K 1%
R112 39.2 1%
R111 8.25K 1%
R56 0.25
R70 10
R10 10

3.4.4 Cassette Board Schematics





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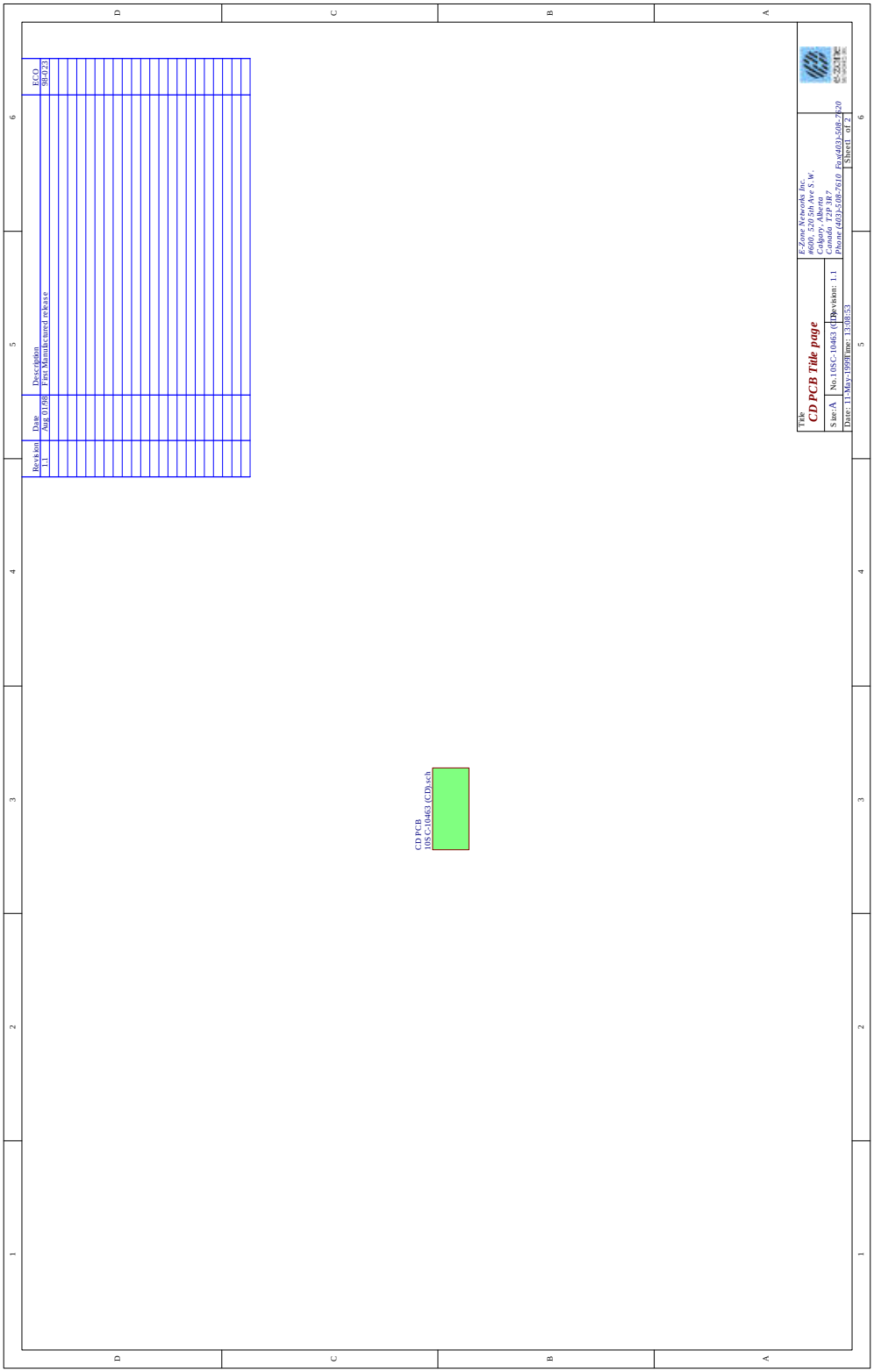
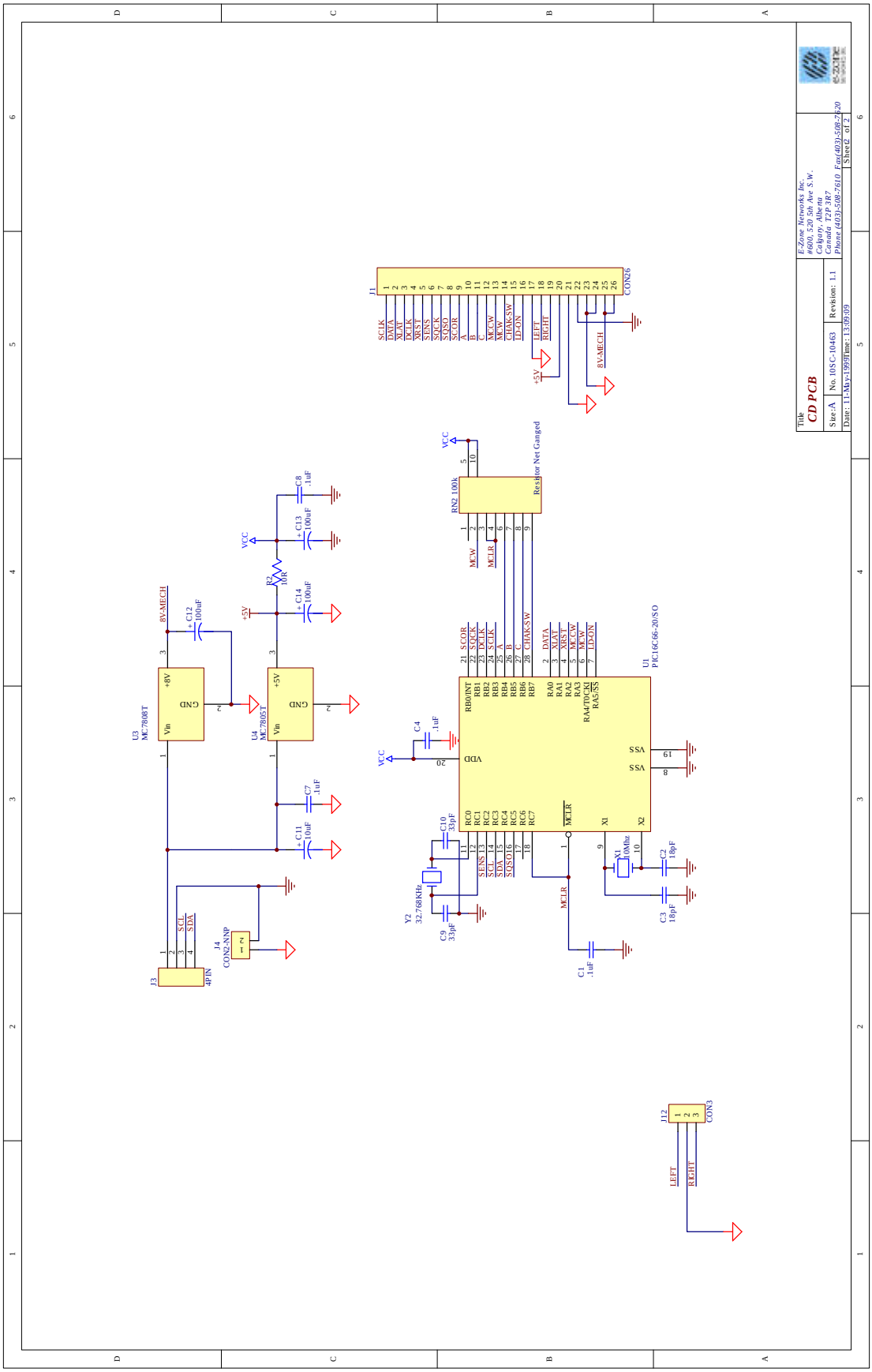
3.4.5 CD Board Schematics





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3.4.6 Circuit Description – per 2.1033(b)4

The E-Zone Tower Unit consists of several integrated components:

LCD color display:

The display is a standard commercially available LCD color display unit that is used to display NTSC TV video information. This display is connected electrically to the Video interface board by a thin ribbon cable.

Video interface board:

This interface board provides all of the drive circuitry needed to interface to the LCD color display. This board also contains circuitry needed to convert the incoming cable TV signal into the signal required to drive the LCD color display. This board contains an off-shelf Phillips TV turner module. This turner module is used to select the received TV station signal (utilizing I2C interface command sequence) and down-convert it to a NTSC standard base-band video signal. This base-band signal is then in-turn converted to the RGB and sync signals, which are used to drive the LCD.

Control board:

This board contains the majority of the digital circuitry. This board contains the master microprocessor that is used to control the other boards and processors and devices on this unit. All the control needed to communicate with other processors and devices on this board and other boards are accomplished through the I2C command bus. This board also contains a clock circuit, which is based on a 12.288MHz crystal all of the clocks on this board are derived from this clock frequency.

This board contains the DSP and audio processing circuitry.

This circuitry has several functions:

- It allows the selection of several audio sources such as the CD, Tape, or TV.
- It provides the capability to adjust the frequency response of the audio signal using a 10 band digitally controlled equalizer.
- The DSP contains a proprietary 3D audio processing algorithm that provides the listener with an increased audio depth of field when using headphones.

This board also contains 2 other slave Microchip PIC slave processors. These processors receive all of their commands from the main processor on this board through the I2C interface command bus. These processors provide the following functions:

- One processor provides the necessary logic to scan the front panel keyboard and provide support glue logic required in the DSP audio processing section.
- The second processor provides the necessary logic required for IR communication to the headphone unit. This processor also has the capability to provide the data, clock, and enable signals needed to program the synth. that selects the frequency of the 902-928MHz transmitter. Selection of the frequency of the 902-928MHz transmitter will only be done this way if an old Version 1.0 transmitter is used with this control board (this is to remain backwards compatible with the first generation 902-928MHz transmitter). The transmitter that is used in this submission for certification is the V2.0 transmitter. This new V2.0 transmitter can also be programmed in the same fashion as the V1.0 transmitter, but it will be more likely that it will be programmed through the use of its own PIC microcontroller contained on the V2.0 transmitter. The new

V2.0 transmitter responds to I2C commands to select the frequency of transmission.

Transmitter Module:

This module is the 902-920MHz ISM band transmitter used to transmit the audio signal to the headphone receiver device. This device is an integrated module that contains all of the circuitry needed to create the carrier and modulate the carrier from the base-band stereo audio signal. The 902-928MHz carrier is developed from a 14.4MHz TCXO oscillator on the board. This 14.4MHz oscillator is multiplied to the desired frequency using the LMX2332 PLL and VCO. The loop response of the VCO/PLL is set slow enough that the VCO can be modulated with an MPX type FM stereo signal. This MPX type stereo signal is created using a separate analog base-band processor section on the transmitter module board. This circuit limits the modulation signal if the input signal exceeds the recommended input signal range of the transmitter module. This circuit also provides the necessary 19KHz pilot tone required in the base-band MPX signal. The power supply within the transmitter module is regulated using a linear regulator. This allows the power supply to vary between 9V DC and 18V DC without affecting power or modulation.

Tape mechanism and Tape control board:

The tape mechanism is a standard off-the-shelf mechanism. This mechanism is controlled with the tape controller board. This board is a custom board created by E-Zone. This board consists of a PIC microcontroller, a 4.00 MHz crystal and 5v & 8v power supply regulators. The PIC received commands from the main control board (described above) through the I2C Command Bus.

CD mechanism and CD control board:

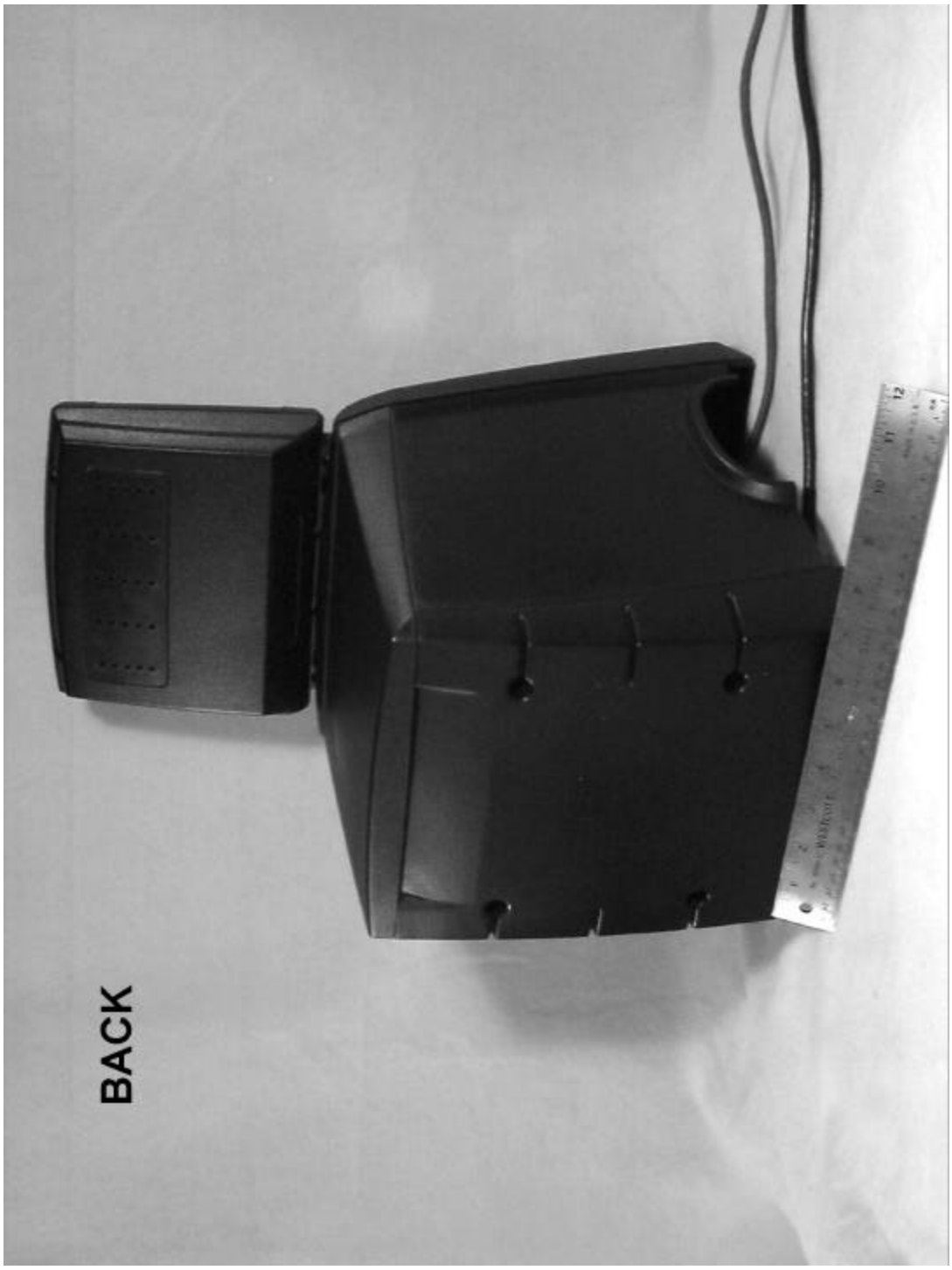
The CD mechanism is a standard off-the-shelf mechanism. This mechanism is controlled with the CD controller board. This board is a custom board created by E-Zone. This board consists of a PIC microcontroller, a 4.00 MHz crystal and 5V & 8V power supply regulators. The PIC received commands from the main control board (described above) through the I2C Command Bus.

Power Supply:

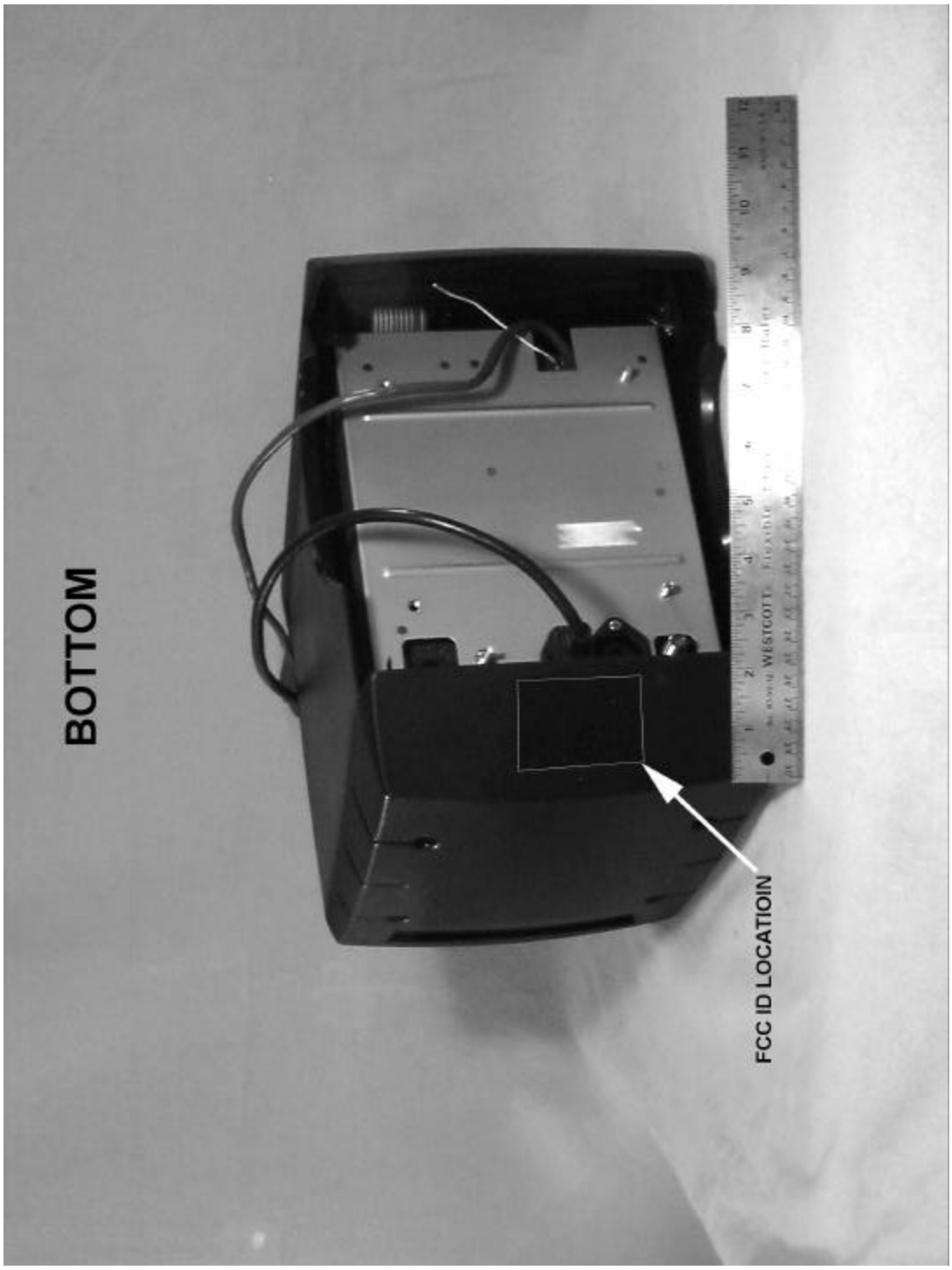
The power supply provides power to all of the boards and circuits in the tower. This power supply is an off-the-shelf commercially available off-line switch mode power supply. It provides 100-240 VAC to 12 VDC step down in a small self-contained unit.

3.5 Photograph of EUT – per 2.1033(b)(7)

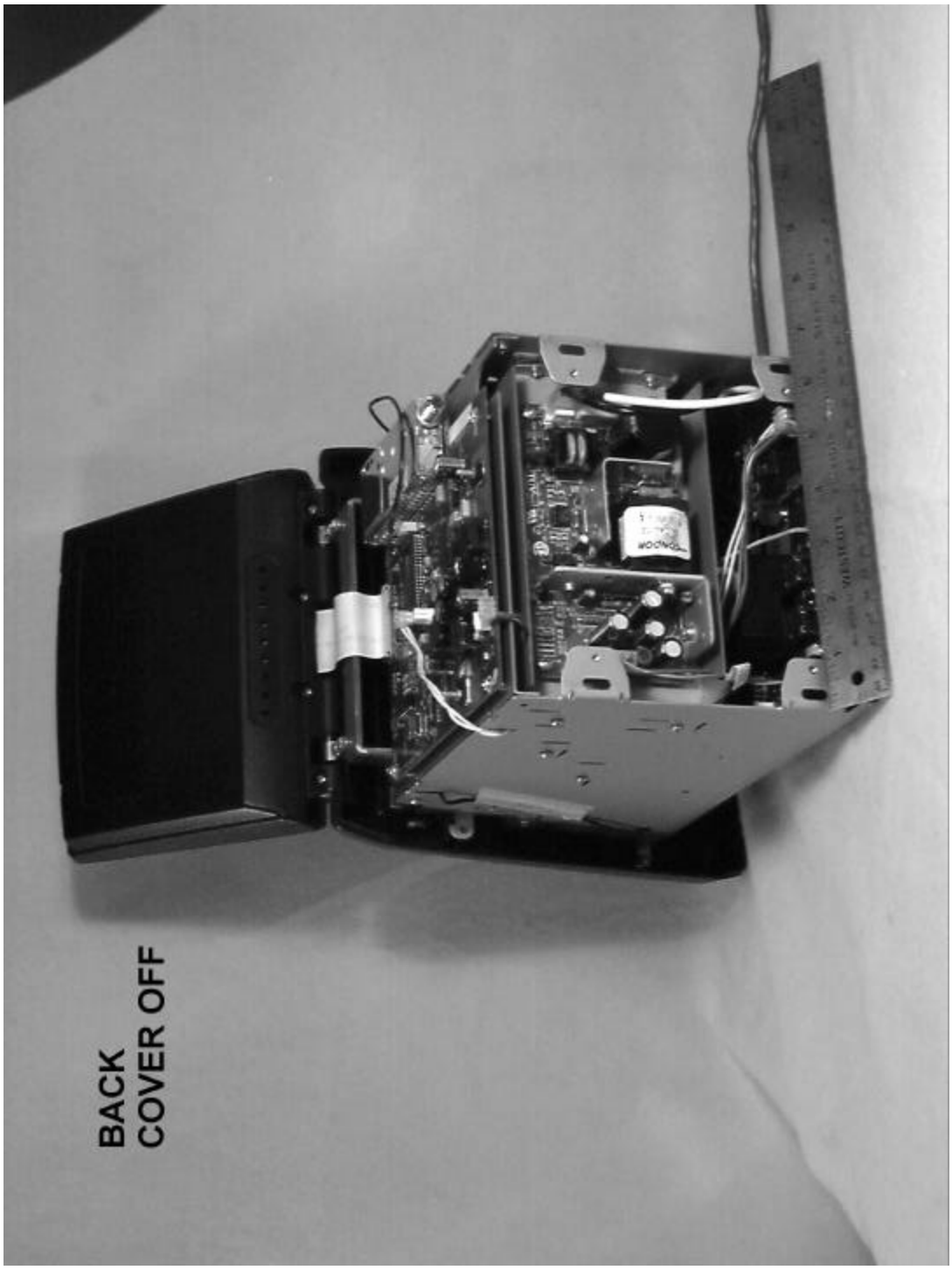
3.5.1 **E-ZONE TOWER UNIT (FRONT)**



3.5.2 **E-ZONE TOWER UNIT (BACK)**

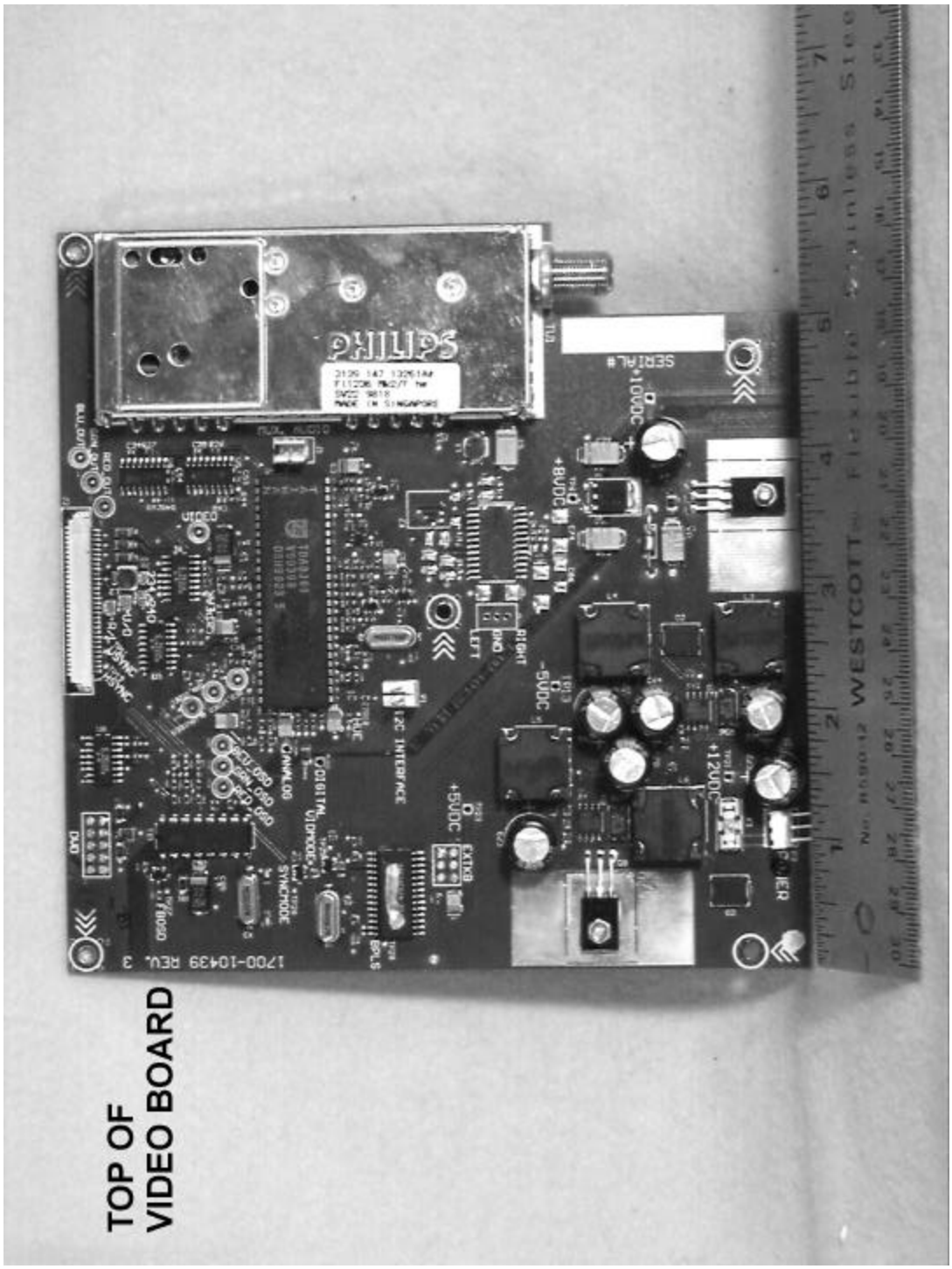


3.5.3 **E-ZONE TOWER UNIT (BOTTOM)**

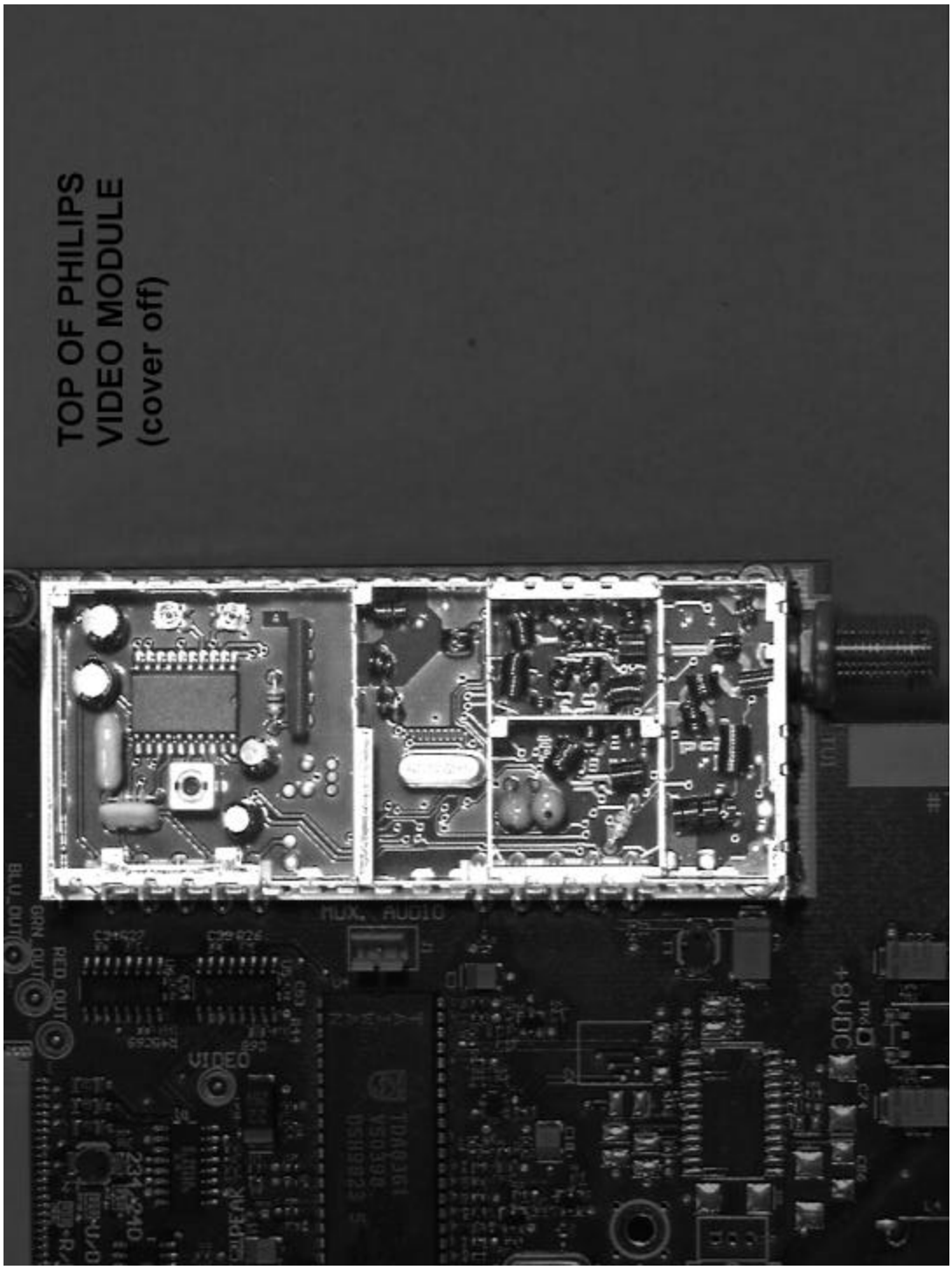


3.5.4 **E-ZONE TOWER UNIT (BACK COVER OFF)**

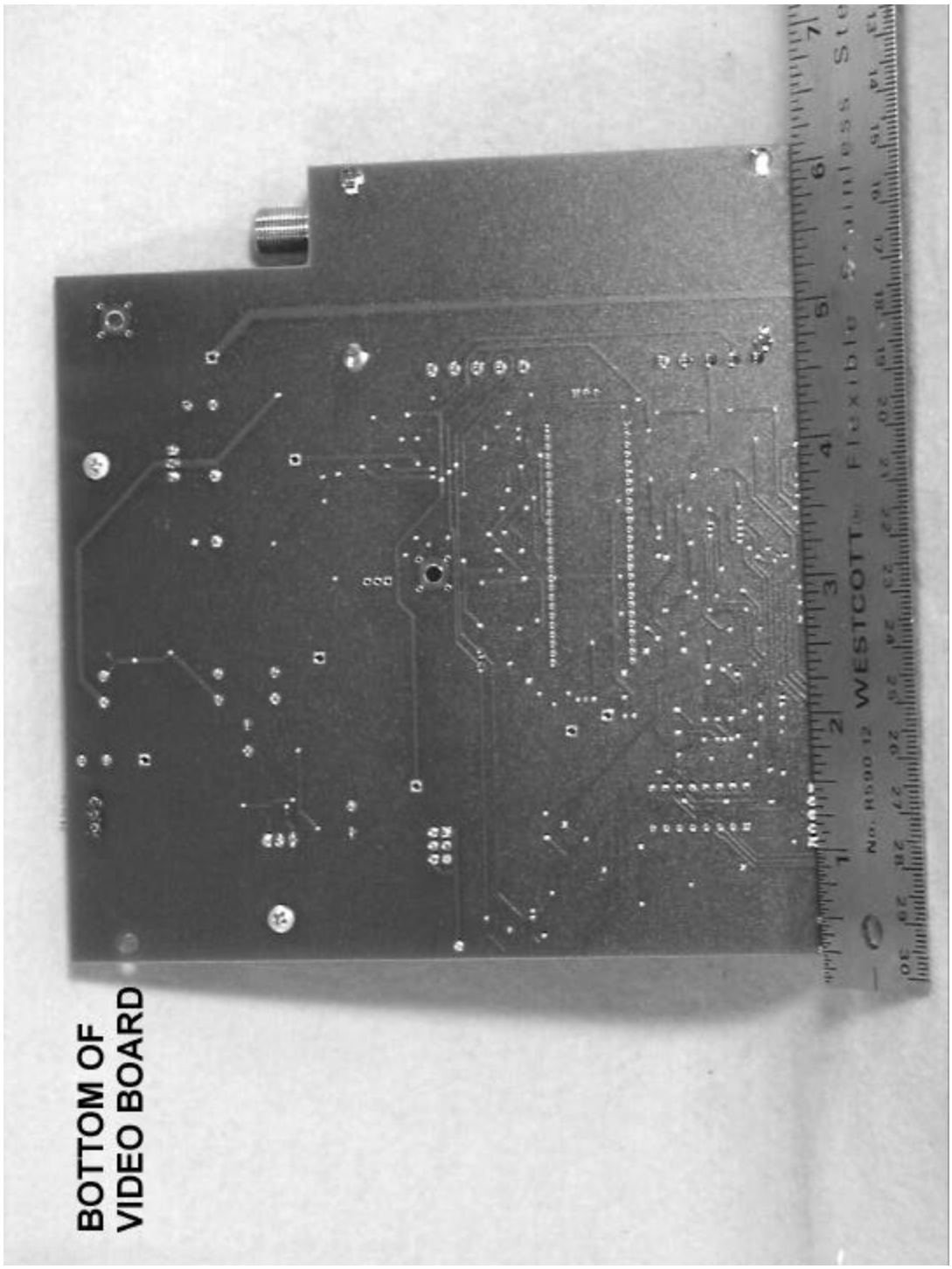
3.5.5 **E-ZONE TOWER UNIT (BACK COVER OFF DETAIL)**



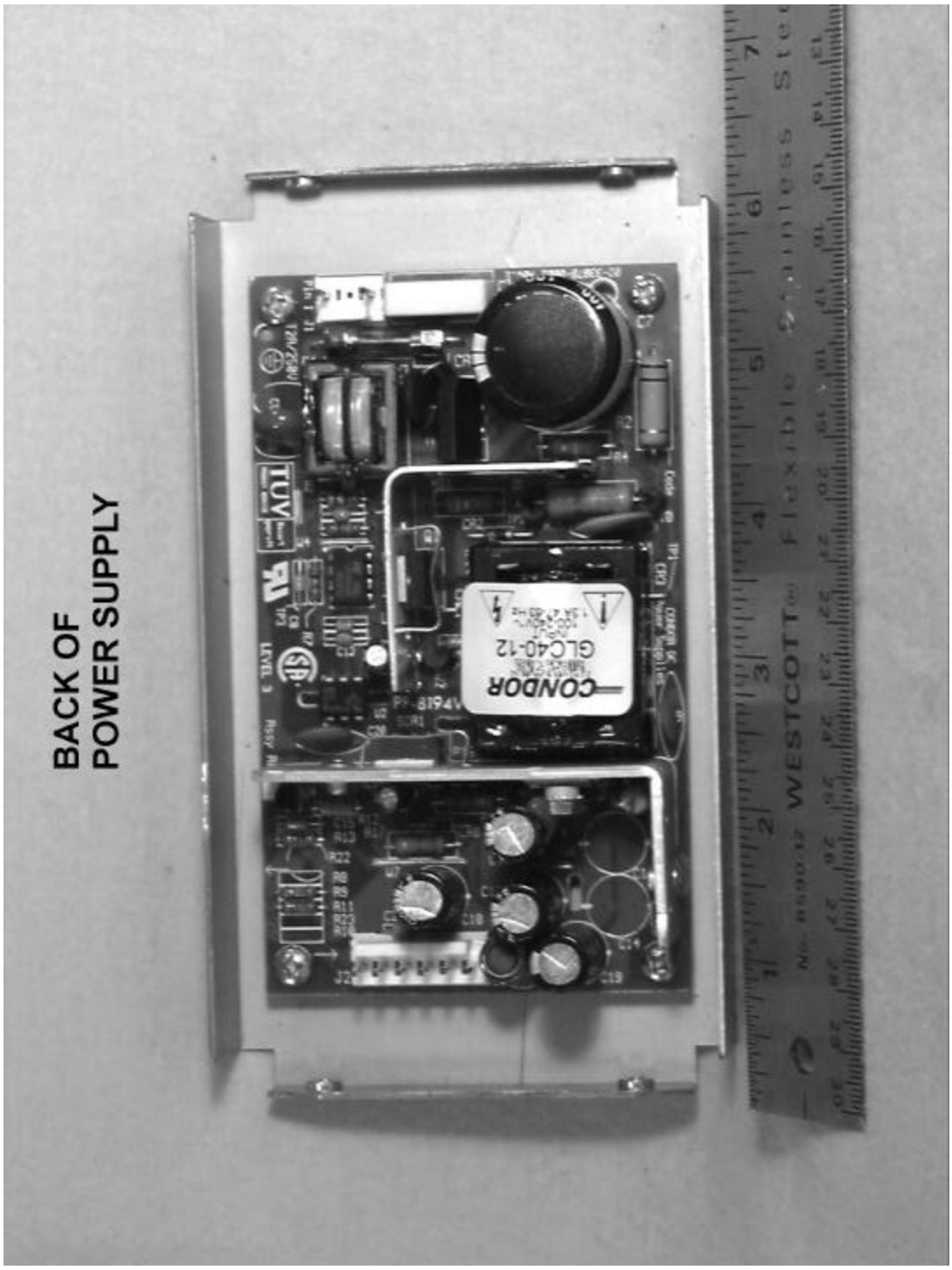
3.5.6 **TOP OF VIDEO BOARD**



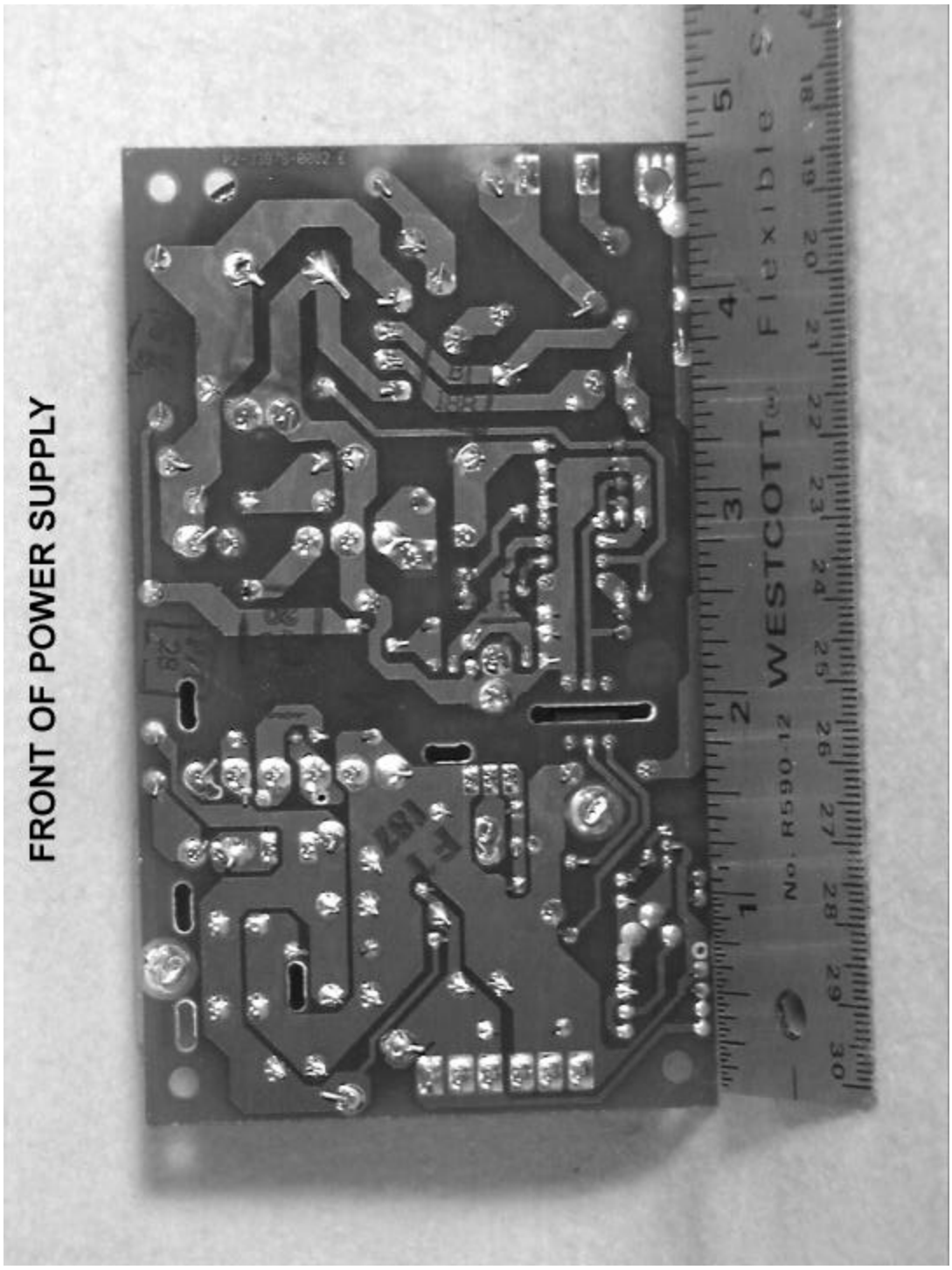
3.5.7 **TOP OF PHILLIPS VIDEO MODULE**
(cover off)



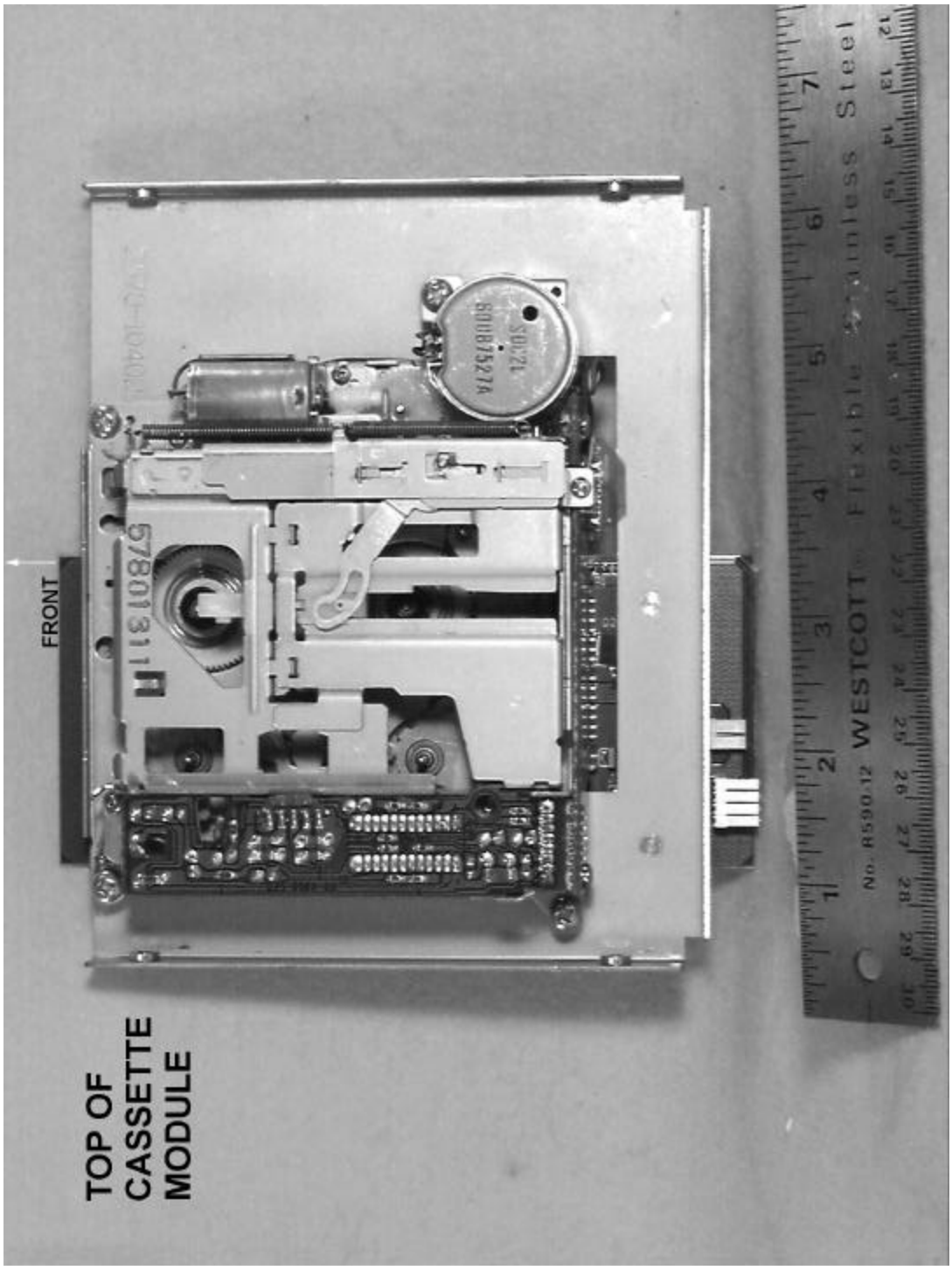
3.5.8 **BOTTOM OF VIDEO BOARD**



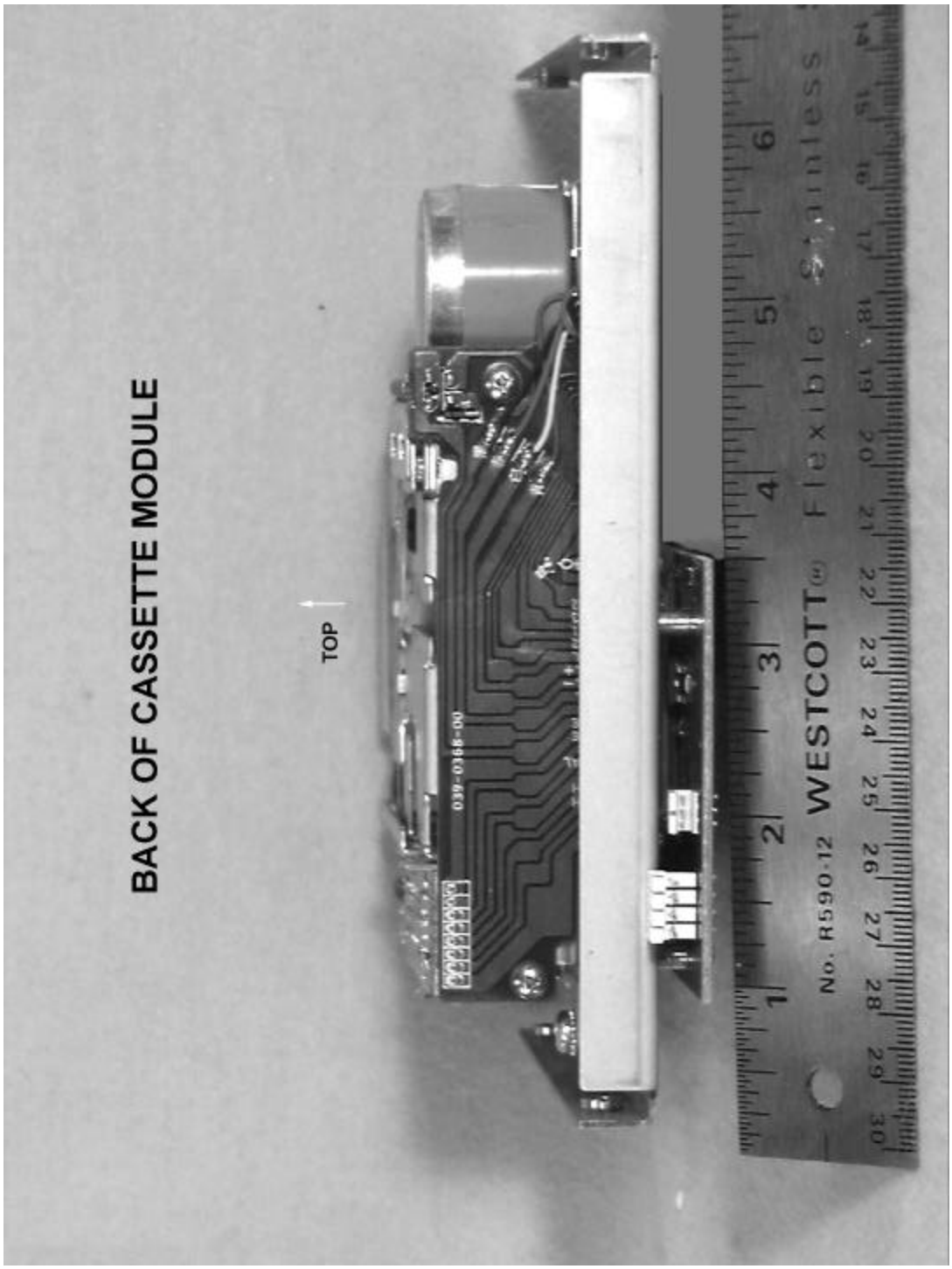
3.5.9 **BACK OF POWER SUPPLY**



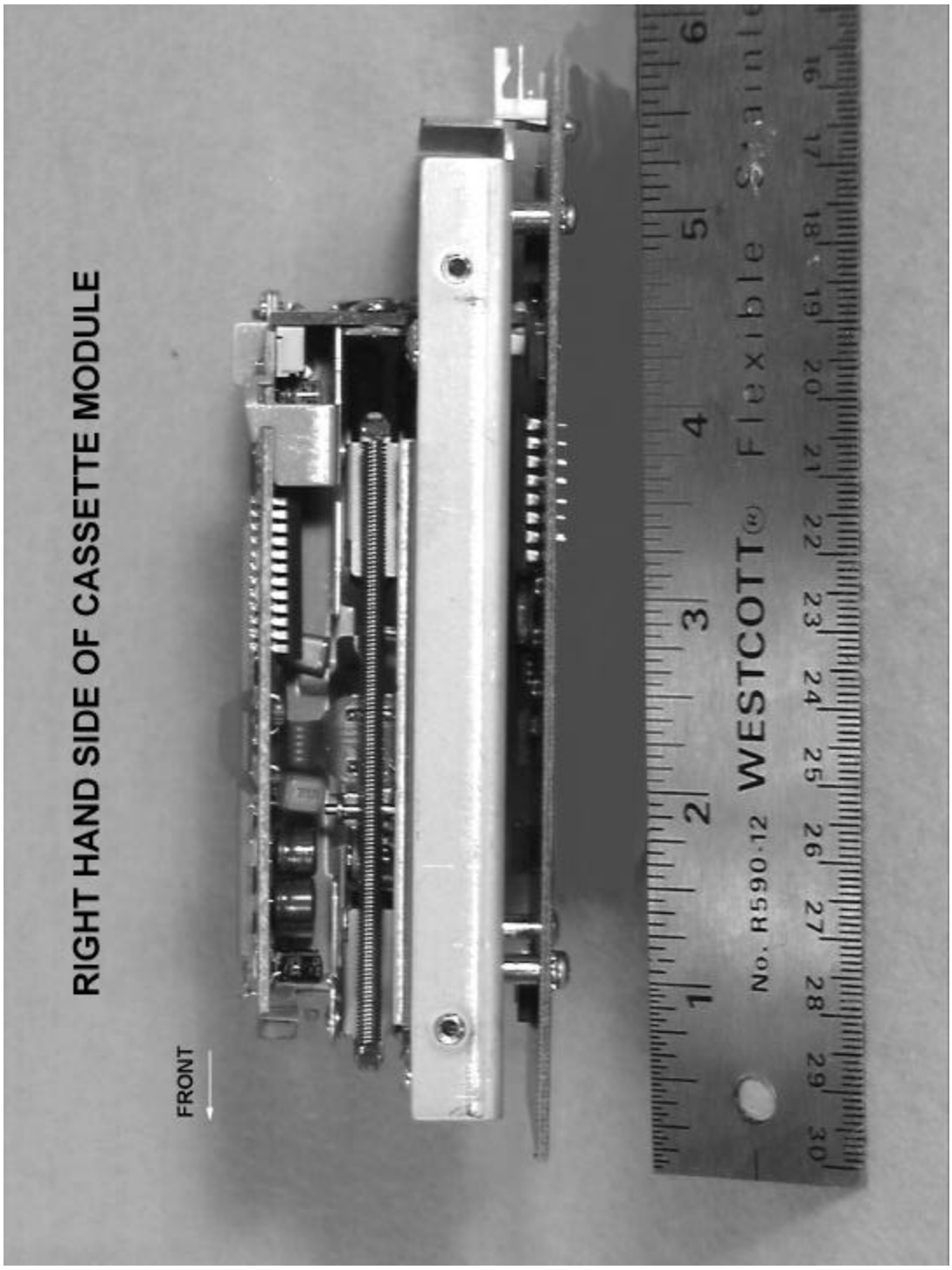
3.5.10 **FRONT OF POWER SUPPLY**



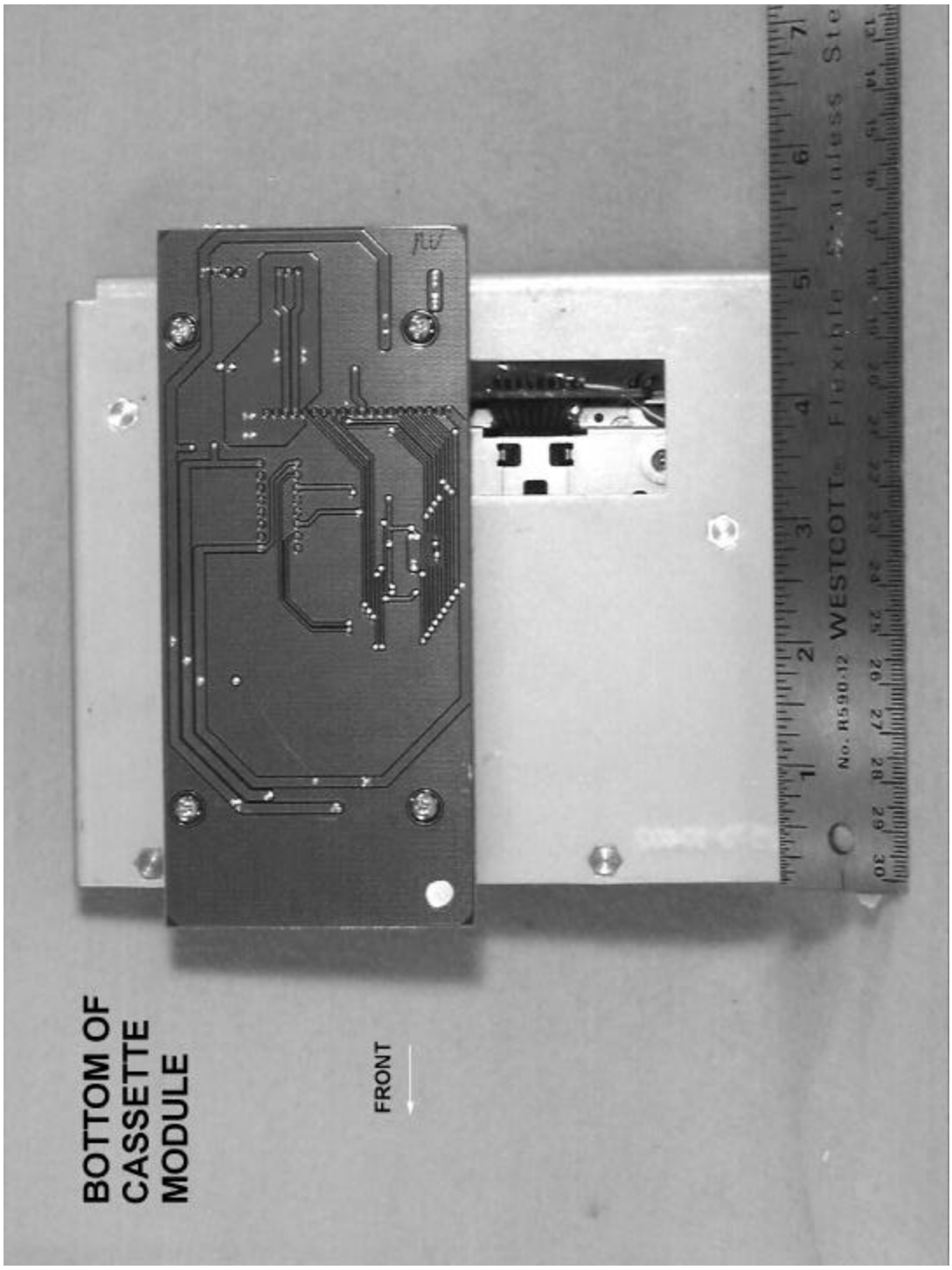
3.5.11 **TOP OF CASSETTE MODULE**



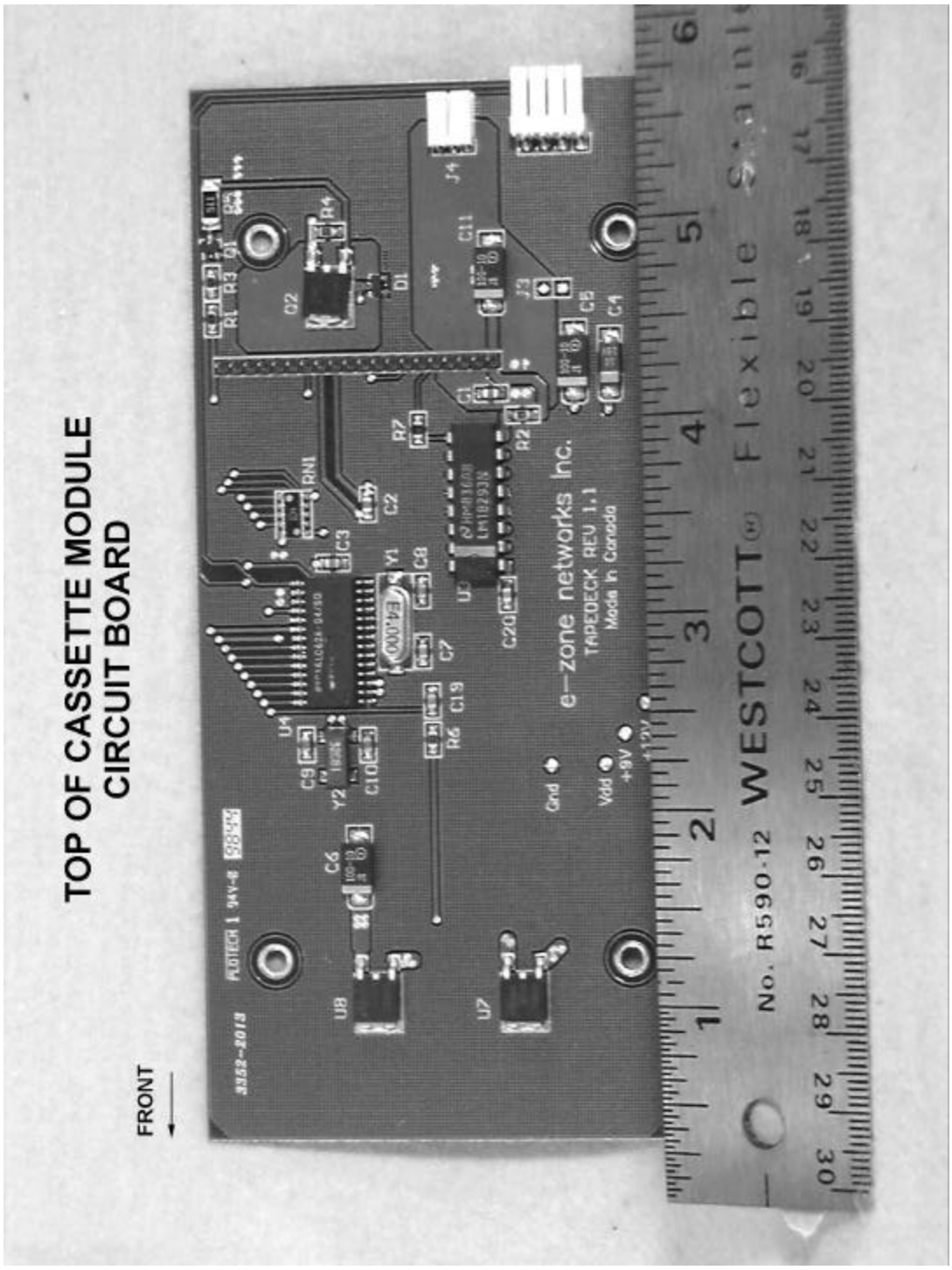
3.5.12 **BACK OF CASSETTE MODULE**



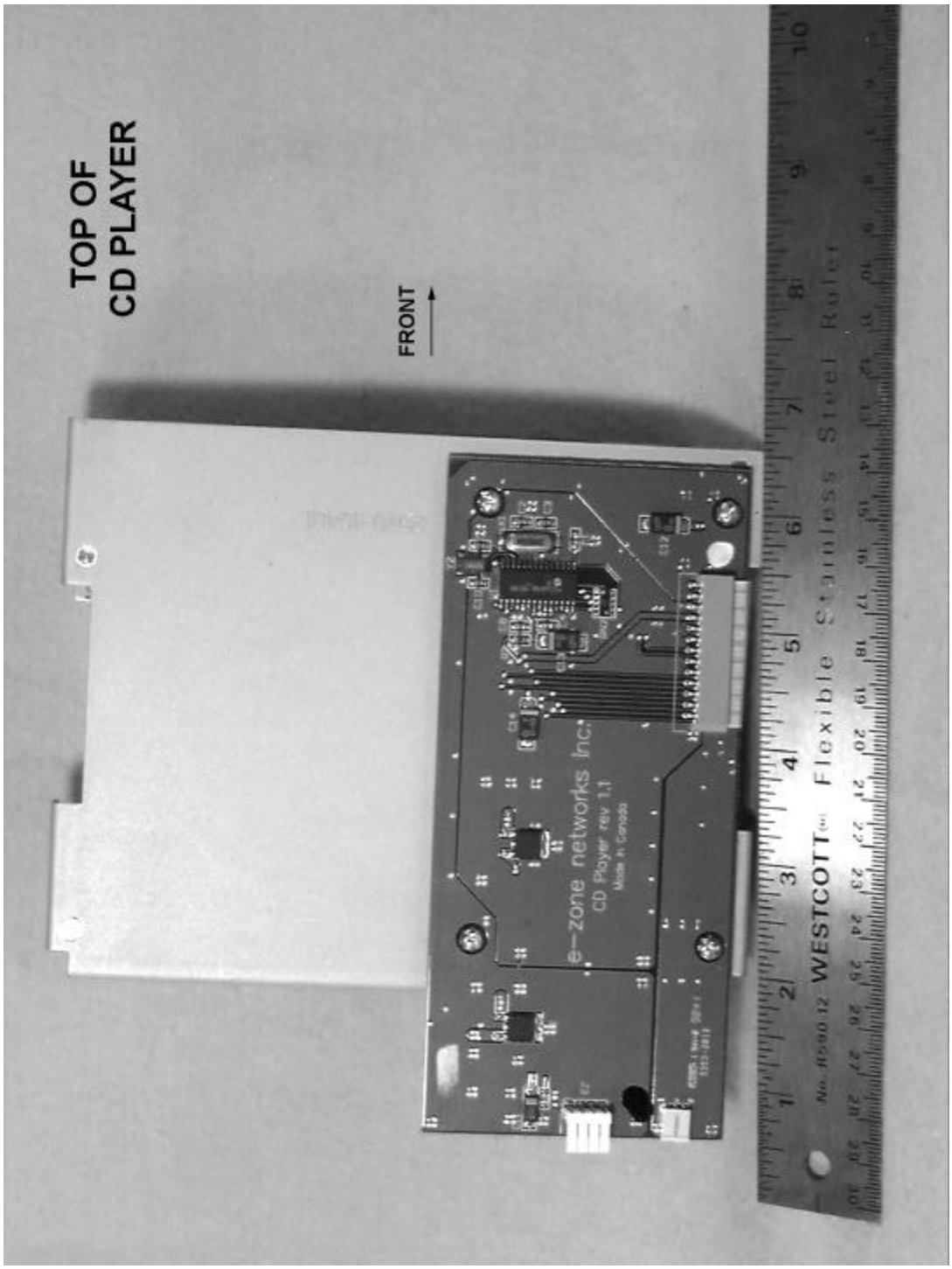
3.5.13 **RIGHT HAND SIDE OF CASSETTE MODULE**



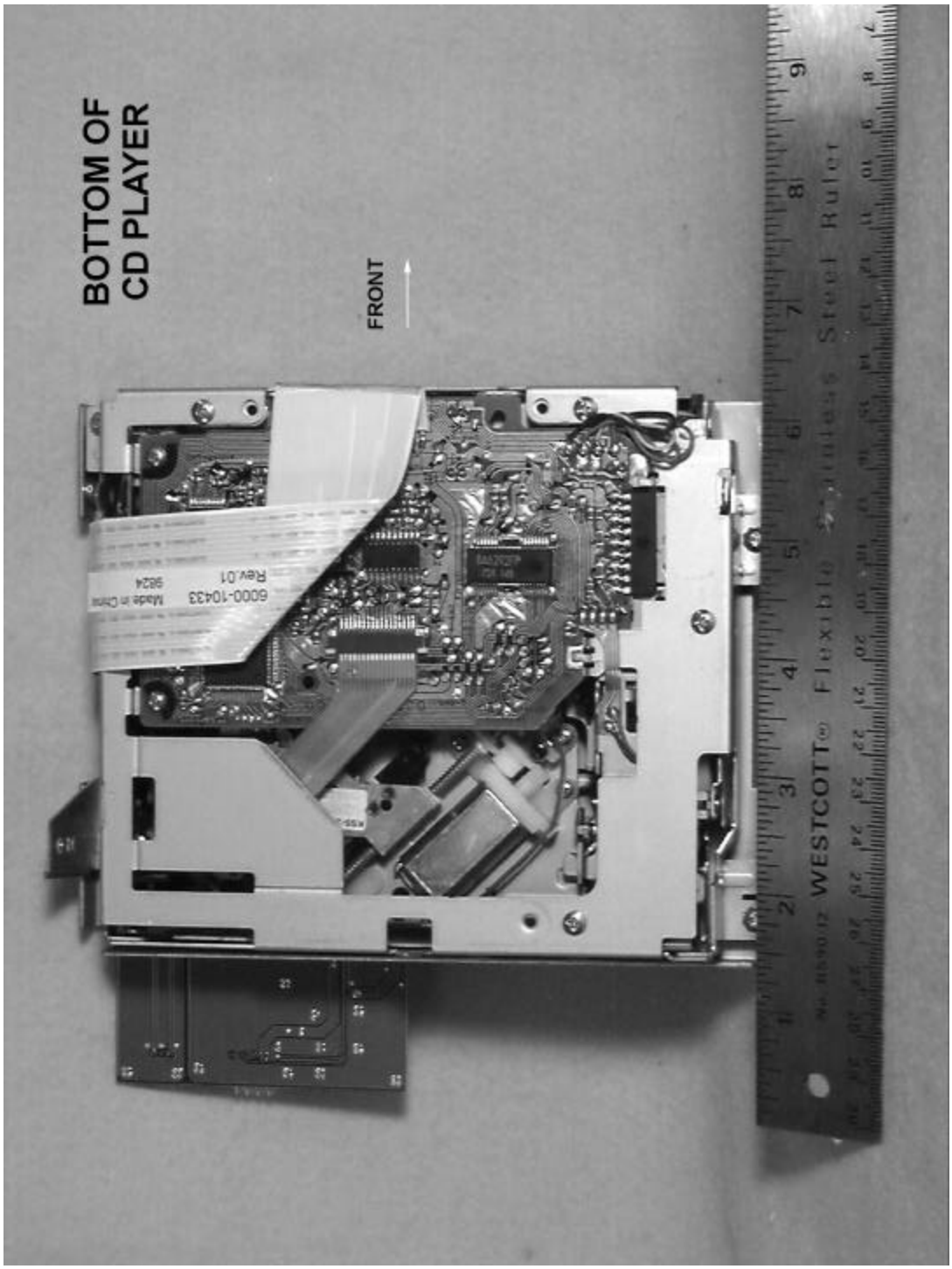
3.5.14 **BOTTOM OF CASSETTE MODULE**



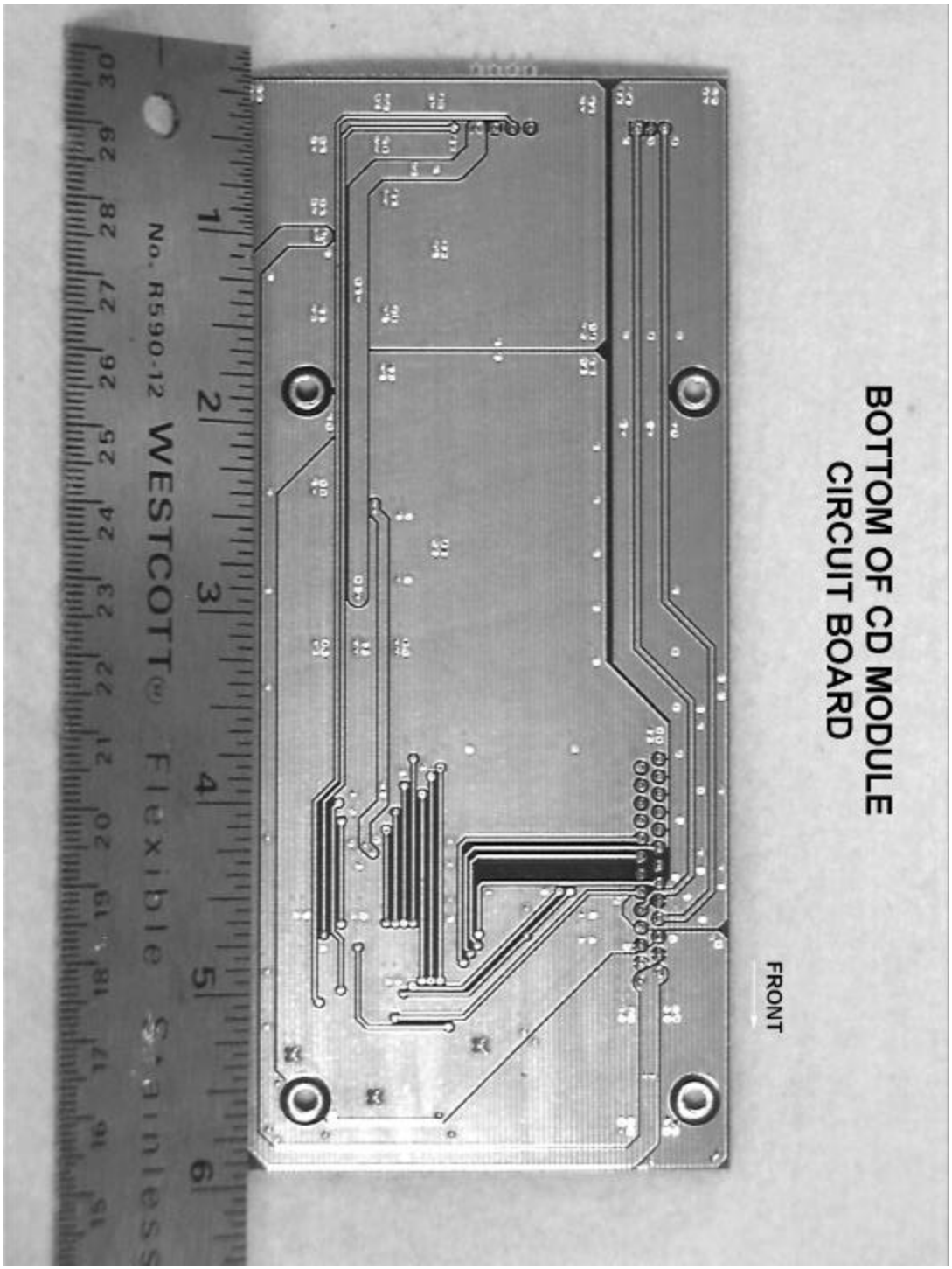
3.5.15 **TOP OF CASSETTE MODULE CIRCUIT BOARD**



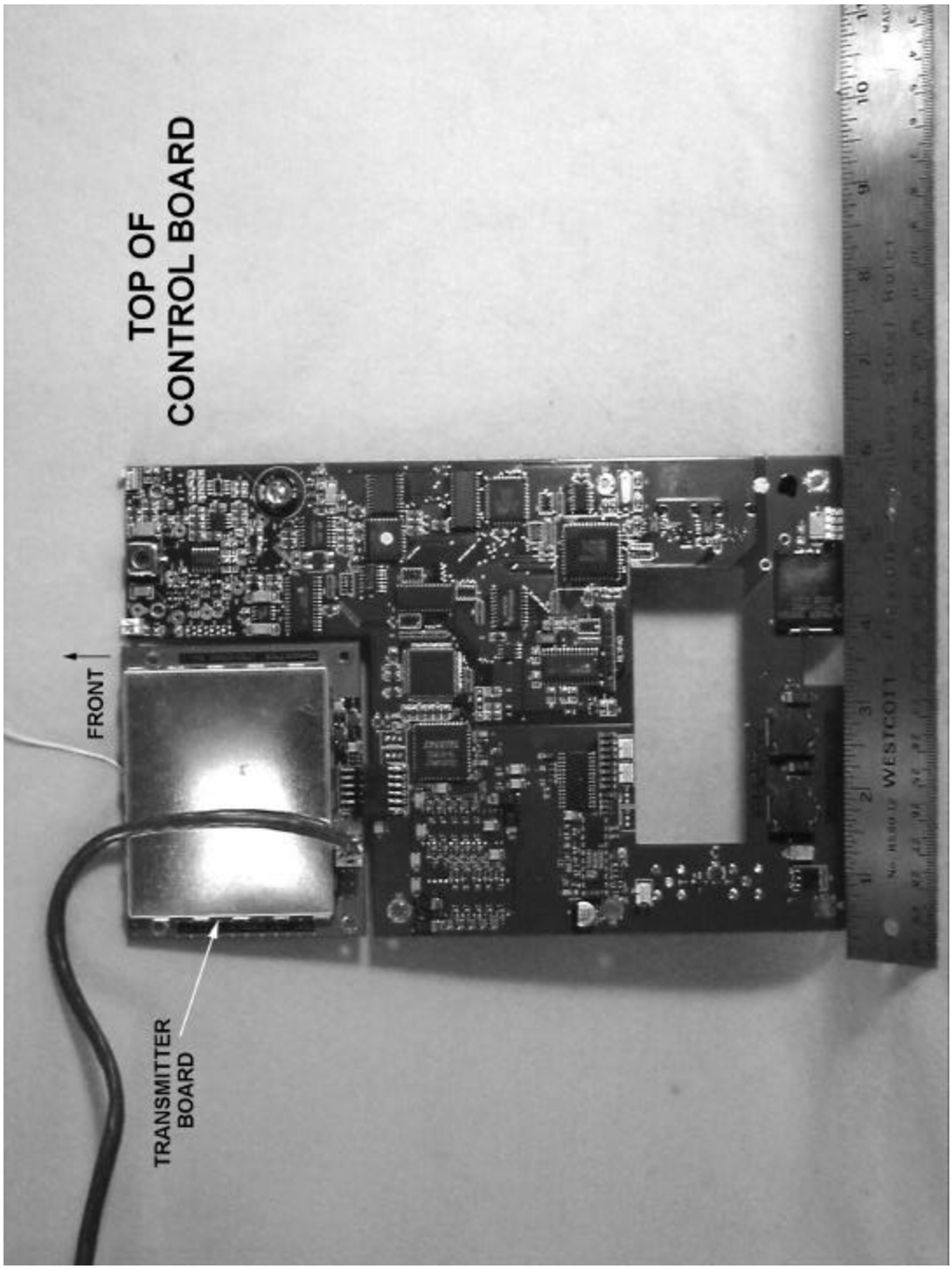
3.5.16 **TOP OF CD PLAYER**



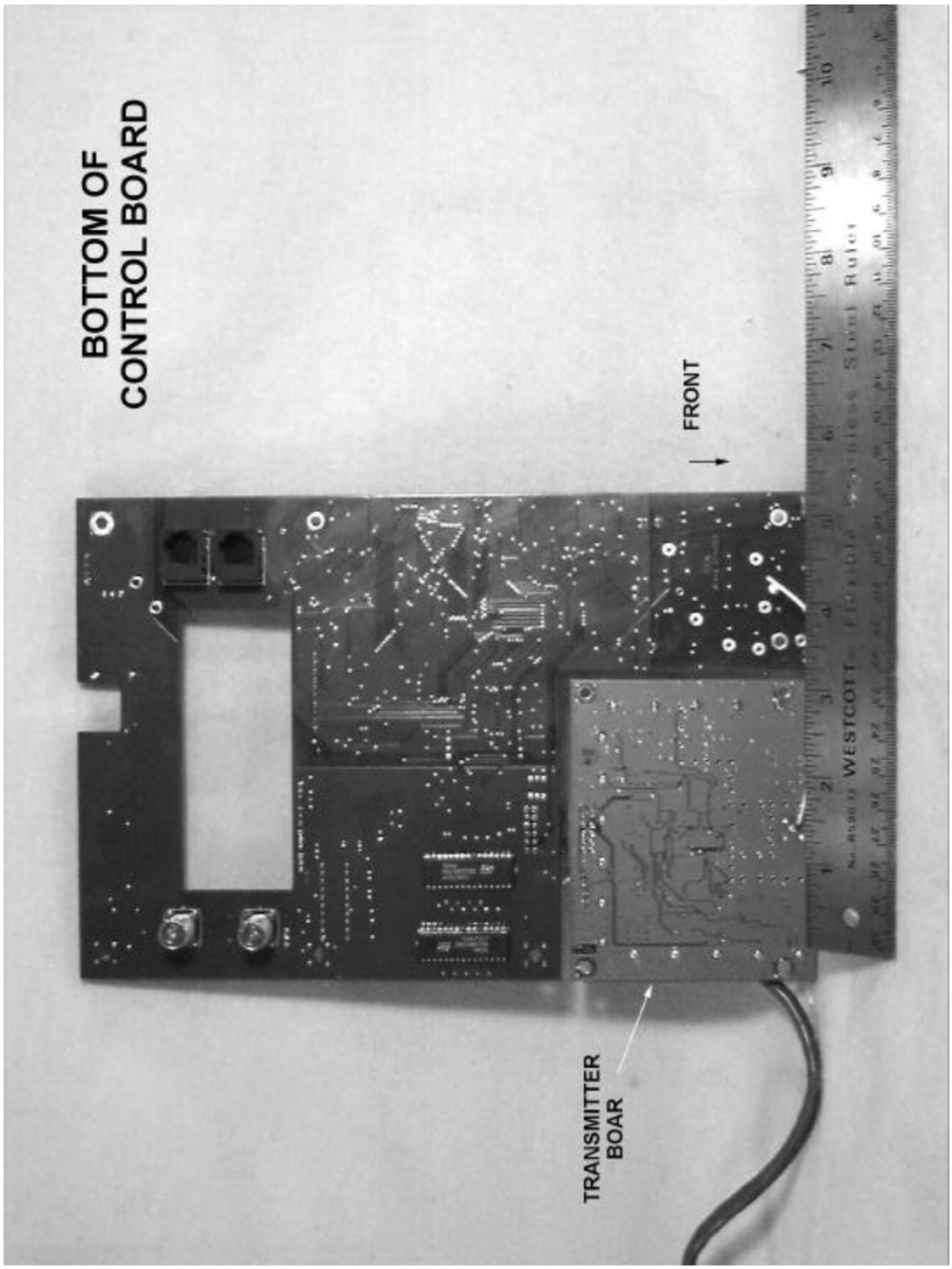
3.5.17 **BOTTOM OF CD PLAYER**



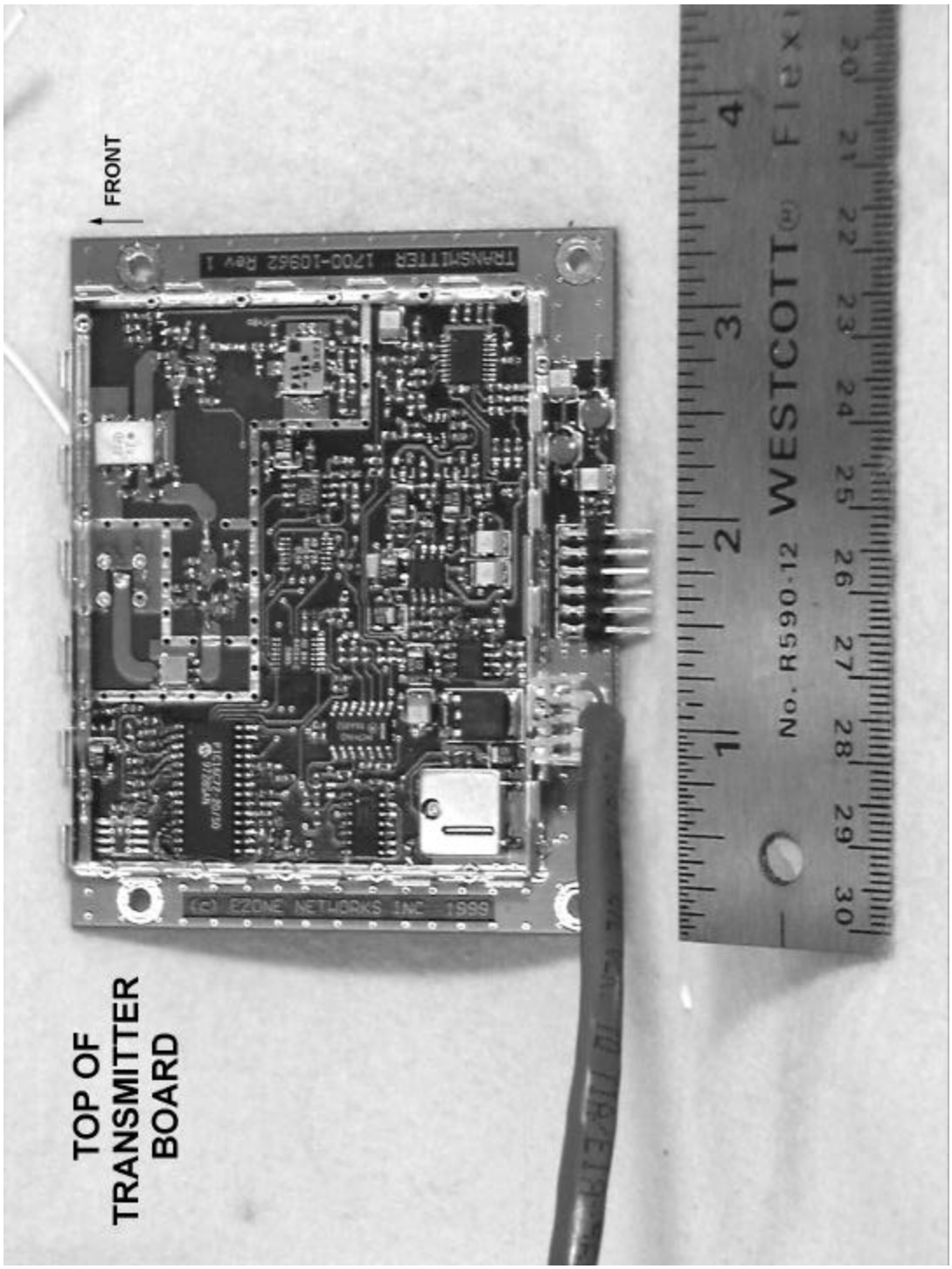
3.5.18 **BOTTOM OF CD MODULE CIRCUIT BOARD**



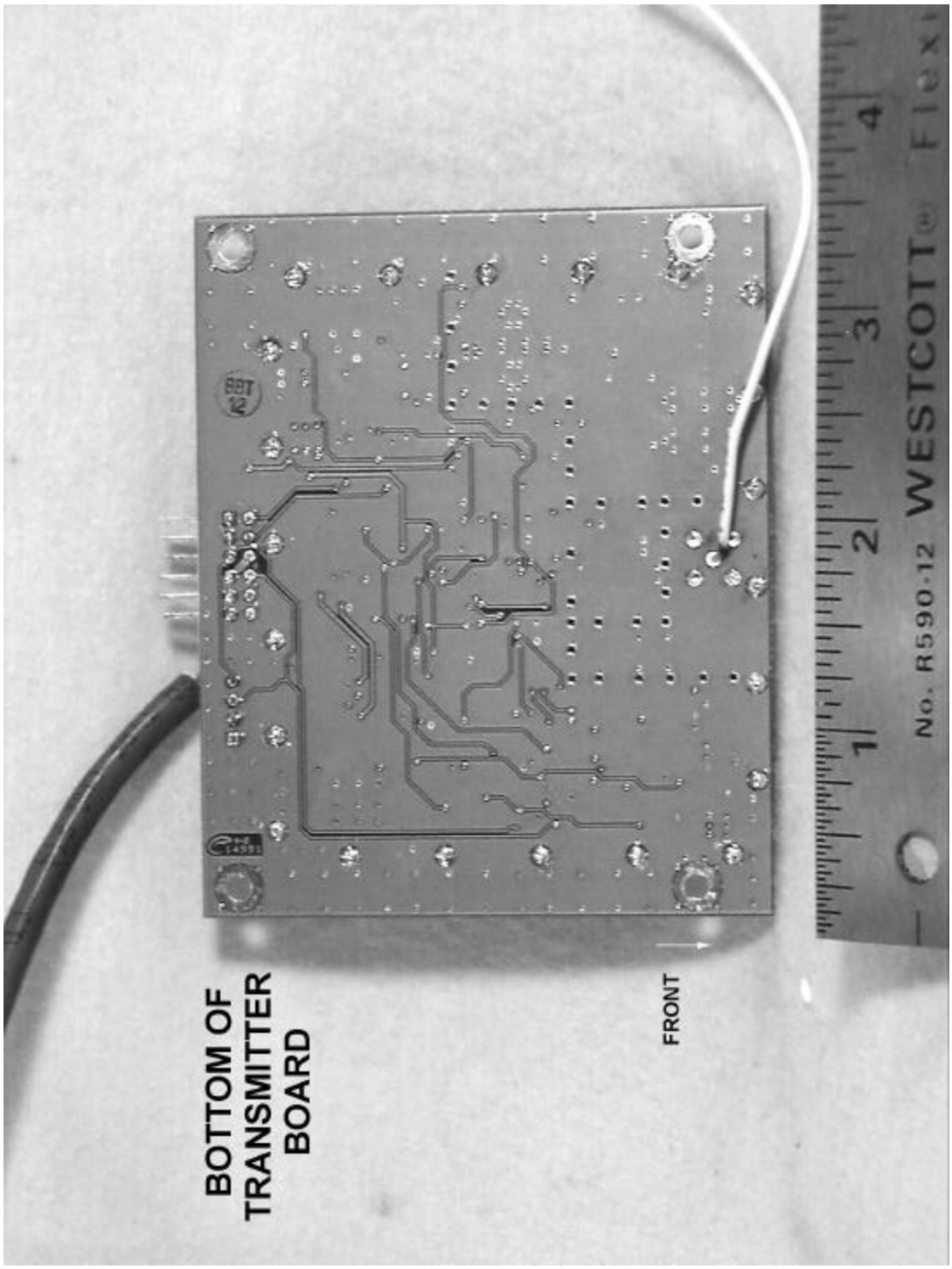
3.5.19 **TOP OF CONTROL BOARD**



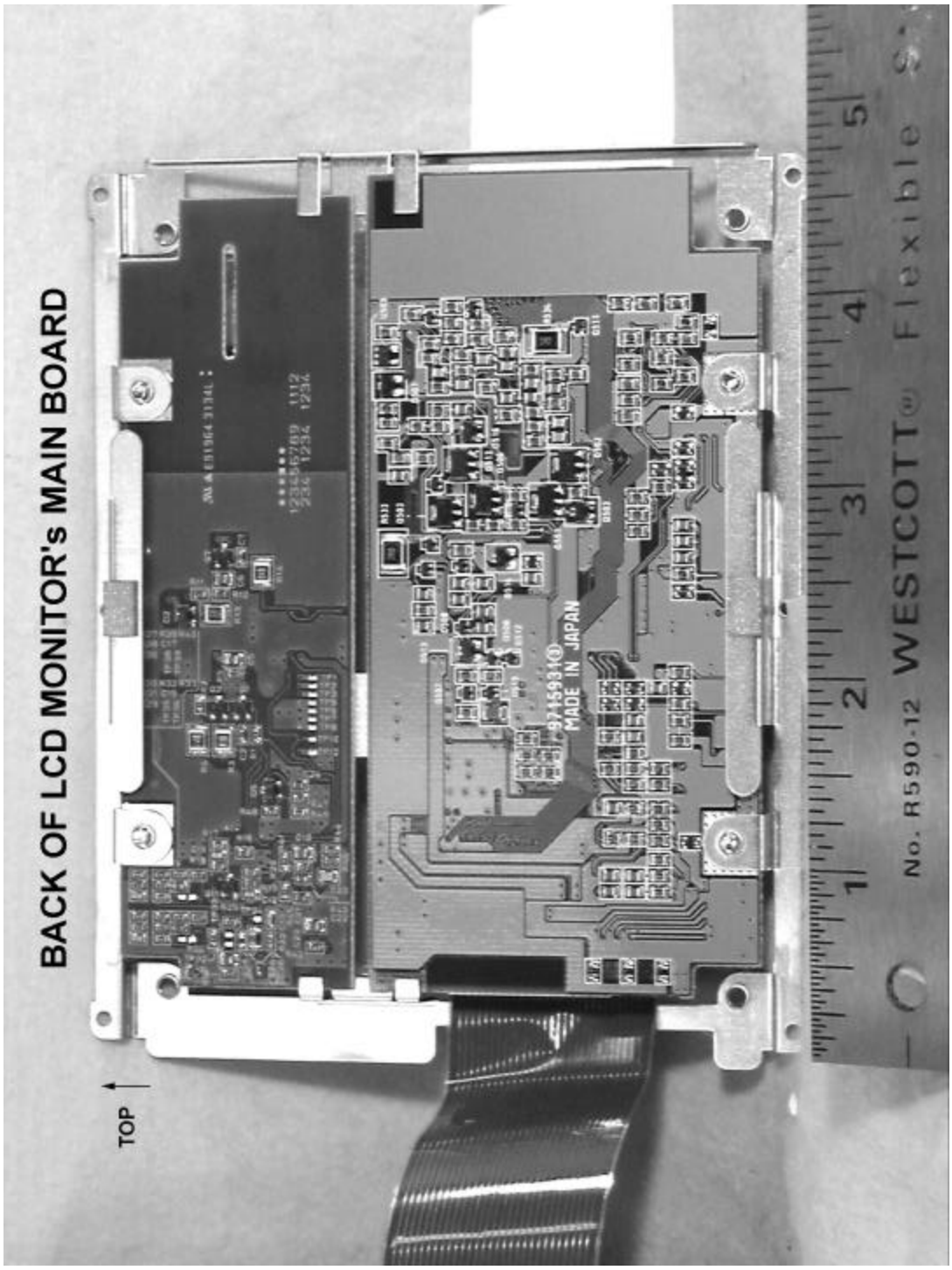
3.5.20 **BOTTOM OF CONTROL BOARD**



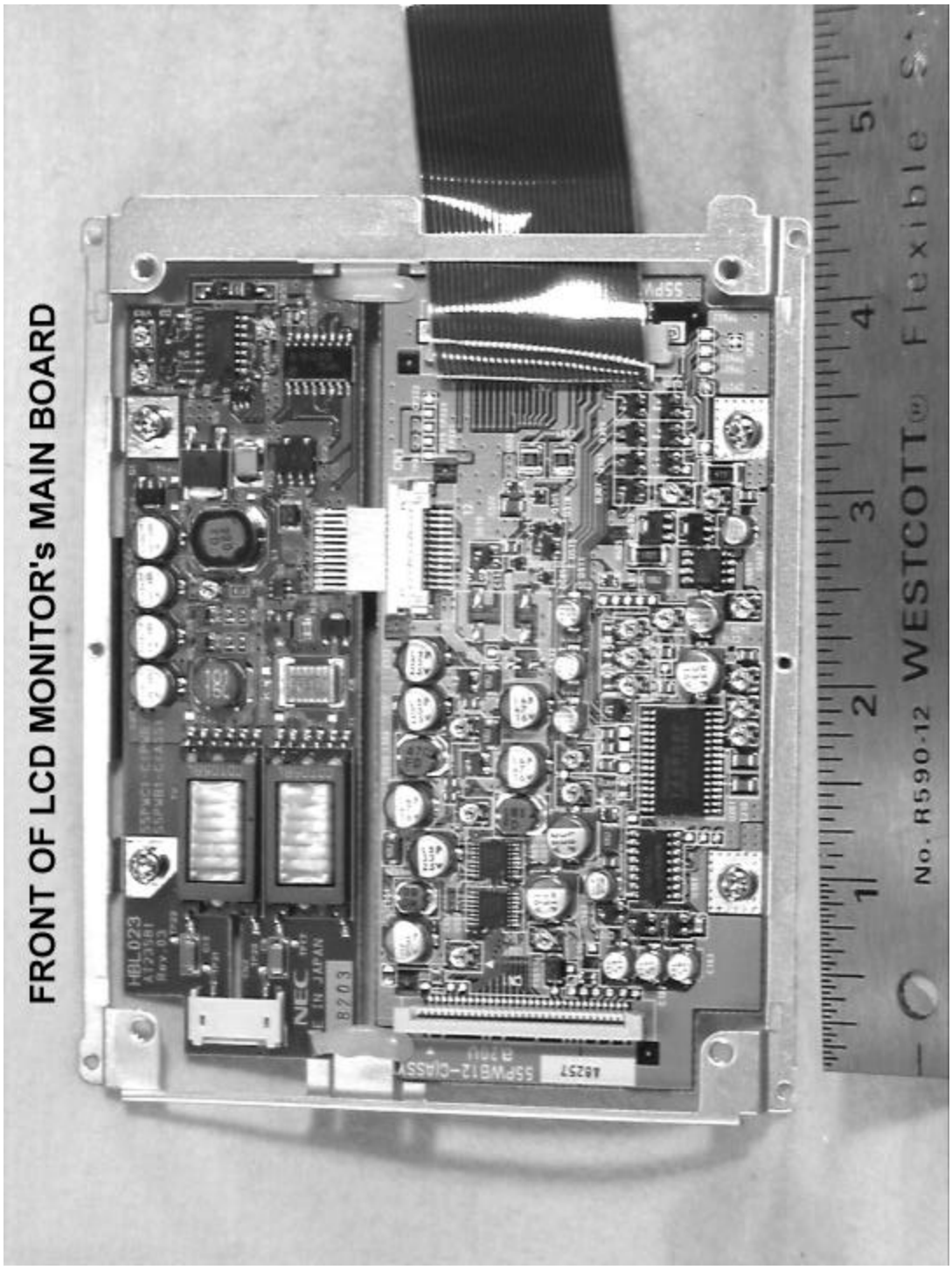
3.5.21 **TOP OF TRANSMITTER BOARD**



3.5.22 **BOTTOM OF TRANSMITTER BOARD**

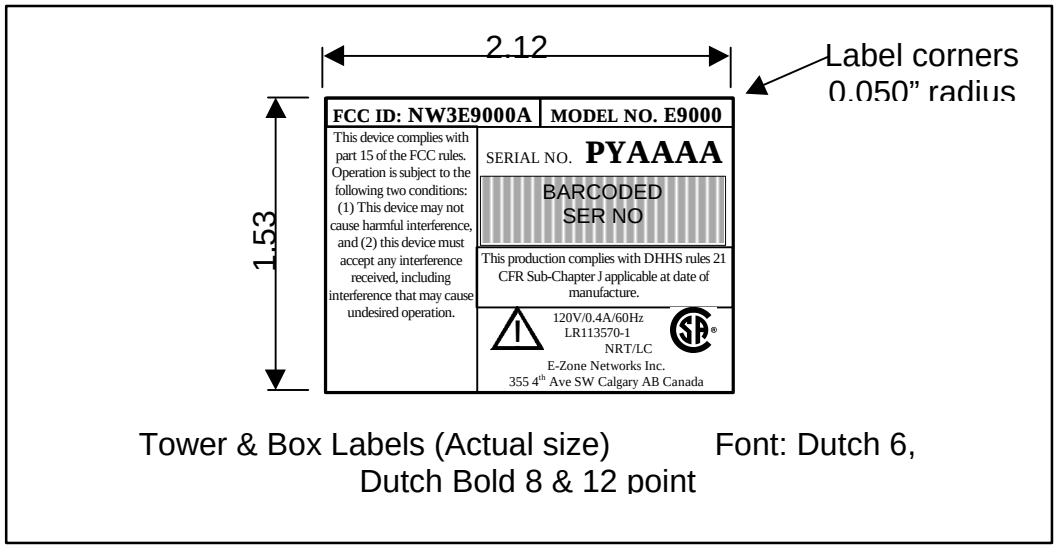


3.5.23 **BACK OF LCD MONITOR'S MAIN BOARD**



3.5.24 **FRONT OF LCD MONITOR'S MAIN BOARD**

3.6 Labeling Requirements – Per 2.1033(B)(7)



Tower & Box Labels (Actual size) Font: Dutch 6, Dutch Bold 8 & 12 point

The Label as shown above will be constructed as follows:

- **Material:**
  Label Stock — Polyester, White Gloss, Permanent Adhesive — Aurora Barcode P/No ETW-001
  Ribbon — Aurora Barcode P/No Sony TR4070 4.33" x 6000"

- **Registration:**
  Black Mark — 0.25" wide Black Stripe printed on reverse side of label stock, top of stripe to be positioned 0.10" +/-0.025" from top perforation.
- **Specifications:** Printing, base material and adhesive must be able to survive and maintain readability when used in an environment that will include higher than room ambient temperatures (to +40°C) and mild abrasion. Storage temperatures from –20°C to +80°C

The label will be placed on the bottom of the E-Zone tower as shown in the picture 3.5.3 E-ZONE TOWER UNIT (BOTTOM).

3.7 Typical Calibration procedure for Transmitter module.

3.7.1 TX software system overview

Contained within the transmitter module is a PIC microcontroller & EEPROM which is used to select frequencies, adjust output power, balance audio settings, and adjust modulation. This device provides an I2C serial interface to the main control board, several clocks for the MPX stereo baseband modulator, and signals that allow the RF section to be powered down when not needed. The EEPROM settings will be determined during calibration and automatically programmed at assembly time using a spectrum analyzer, or modulation analyzer like the HP8901B for calibration measurements and a PC type computer (to

program the EEPROM through the I2C bus). These EEPROM settings will, from that point on, be loaded into the digital POT's during power-up of the transmitter.

In addition to setting up of the transmitter's calibration pots during power up there are several other dynamic functions that the transmitter will perform; these are:

- During operation of the transmitter, it is possible to send an I2C command to the transmitter module's PIC microcontroller to allow RF power output to be attenuated by specific amounts. The attenuation settings available are measured from the maximum and they are –2dB, -4dB, -6dB, -8dB, -10dB, and –16dB. These settings are relative to the maximum transmit RF power setting (described below). The purpose of this ability to allow several output power settings is so that the transmitter can be tailored to the environment. For example when several transmitting and receiving devices are physically close together but occupying separate channels, lowering the output power can reduce inter-modulation effects in the receivers.
- It is possible to send an I2C command to the transmitter module's PIC microcontroller to disable the 19KHz pilot tone that is normally included with the MPX baseband modulating signal. The 19KHz pilot tone is only needed for stereo signal transmission. When there is no stereo signal available (typically TV audio is only mono), the 19KHz pilot tone would be turned off in the transmitter. The drop of the 19KHz pilot tone would be sensed in the headphone receiver circuitry. The result would enable mono only demodulation in the headphone. This has the effect to reduce background audio noise while in mono mode of the headphones by 6dB.
- It is possible to send an I2C command to the transmitter module's PIC microcontroller to power down the entire RF section. The purpose of this command would allow the tower unit to stop radiating a RF signal when there is no user listening to the tower.
- It is possible to send an I2C command to the transmitter module's PIC microcontroller to select the desired frequency of transmission of the tower. There are two possible ways that the frequency can be set on the transmitter module. 1) The transmitter module has PLL clock, data, and enable lines connected directly to the control board. This allows the control board to directly program the synth. IC. 2) The transmitter's PIC can also program the PLL clock, data and enable lines thus allowing the transmitter PIC to set the frequency of the transmitter (using an I2C command). The reason that there are two ways to set the transmitter frequency is that backwards compatibility is maintained
- When a set frequency command is sent through the I2C command bus to the transmitter module's PIC microcontroller, the transmitter has the ability to adjust calibration settings based dynamically on frequency. This is used to improve consistency and accuracy of frequency dependant components of the transmitter. These two main frequency dependant components are peak modulation, and output RF power. In an ideal transmitter these components are identical with respect to frequency, but in a real world transmitter this is not normally true. For example in a typical transmitter the output RF power can vary as much as 2-4dB across the frequency band. Also in an ideal transmitter the peak modulation with respect to modulation voltage is identical for all frequencies. In a typical transmitter that uses direct VCO modulation such as the transmitter used in this E-Zones design, the modulation can vary as much as 20% across the 902 to 928MHz band. In order compensate for these variances across

the frequency band, the PIC will make small attenuation adjustments to the output power to flatten the output power variances with respect to frequency (The typical improvements seen with these compensation abilities were +/- 2dB across the band before compensation, and +/- 0.3dB after compensation). The peak modulation variances are compensated similarly with respect to frequency (the typical modulation variances before compensation are +/-20%, and after compensation are +/-5%).

- When the frequency is set with the control board using the transmitter module's PLL clock, data and enable lines that are directly connected to the control board, the automatic compensation is disabled and a default calibration level is set for the RF power output and modulation settings which is common for any frequency. This feature allows backwards compatibility for older software that does not send I2C frequency set commands to the transmitter module's PIC microcontroller.

3.7.2 Output Power Calibration Procedure

3.7.2.1 Maximum allowable RF power output measurement determinations for calibration.

Actual radiated measurements were made at the Electronics Test Center (ETC) Open Area Test Site (OATS). (The ETC OATS site conforms to the requirements of ANSI C63.4 and CSA C108.8-M1938.) These measurements were recorded as follows:

Freq. (MHz)	Azimuth (deg)	Height (cm)	Polarity	SA Lvl (dBuV/m)	AF (dB)	CF (dB)	OF (dB)	Lvl (dBuV/m)	FCC Limit (dBuV/m)	P/F
902.214	139	113	Horz.	65.60	23.60	4.21	0.00	93.41	93.98	Pass
902.195	100	124	Vert.	64.10	22.81	4.21	0.00	91.12	93.98	Pass
914.983	138	297	Horz.	63.40	23.90	4.26	0.00	91.56	93.98	Pass
914.984	93	113	Vert.	65.00	22.87	4.26	0.00	92.13	93.98	Pass
927.797	140	277	Horz.	63.20	24.30	4.31	0.00	91.81	93.97	Pass
927.796	91	117	Vert.	64.80	23.01	4.31	0.00	92.12	93.97	Pass

* Data collected from submitted test report document.

After this data was collected, the 902.214MHz frequency was selected for measurement because it appears to be worst case condition (closest to the FCC limit). The transmitting tower was set up to emulate the exact same calibration settings used for the FCC official test. The output power was measure at the antenna port of the transmitter at 902.214MHz frequency using an Anritsu MS2661B spectrum analyzer. The 93.41dBuV/m radiated measurement value translates into a measured value of 3.32dBm into 50ohms at the antenna port of the transmitter. Although 3.32dBm value should theoretically be below the 93.98dBuV/m radiated I felt that an actual maximum calibration level should be below this 3.32dBm level. This would allow for typical errors in accuracy of the measurement instruments, and method of measurement. I therefore chose a value of 1.32dBm to be my maximum RF power output that transmitter should be calibrated to at the antenna port. This should allow 2dB of headroom and still remain below the allowable FCC limit.

3.7.2.2 RF output power calibration procedure.

1) Set up the D-pot (Digital Pot) settings on the transmitter to approximate normal settings.

2) Set up the transmitter module to transmit a RF modulated signal (1KHz tone L+R and 19KHz pilot tone turned on).

3) Measure the RF antenna port output power at 6 frequencies (902,907,912,917,922,927) in the 902-928MHz ISM band.

4) At each band, adjust the power D-Pot so that the output power is 1.32dBm at each frequency. Store these values into a table within the EEPROM of the transmitter module. This table of D-Pot settings will be used to determine the power output D-pot settings when frequency compensation is enabled. Power output D-pot settings at frequencies that reside between calibrated table frequencies will be linearly interpolated between them.

5) Determine the lowest D-Pot setting of the 6 frequencies measured. Store this value into the EEPROM. This value will be the default D-Pot power setting when frequency compensation is disabled, or during power-up of the transmitter. (This D-Pot setting equates to the maximum RF output power frequency within the 902-928MHz band.)

6) All RF output power calibration settings have been measured and stored in EEPROM at this point.

7) Cycle the power on the transmitter (This should make the transmitter accept its new EEPROM default settings). Disable the frequency compensation. Measure the RF output power at the antenna port at 6 frequencies again. Enable the frequency compensation. Measure the RF output power at the antenna port at 6 frequencies again. Verify that all of the output power values measure 1.32dBm +/- 0.5dBm.

3.7.2.3 Peak modulation calibration procedure.

1) Set up the transmitter module to transmit a RF signal with only the 19KHz pilot tone modulation present.

2) Measure the peak modulation of the RF signal at 6 frequencies (902,907,912,917,922,927) in the 902-928MHz ISM band

3) At each band, adjust the MPX D-pot (modulation) so that the peak modulation of the modulated RF signal is 7.5KHz at each frequency. Store these values into a table within the EEPROM of the transmitter module. This table of D-Pot settings will be used to determine the MPX D-Pot settings when frequency compensation is enabled. MPX D-Pot settings that reside between calibrated table frequencies will be linearly interpolated between them.

4) Determine the average of the six D-Pot settings. Store this value into the EEPROM. This value will be the default D-Pot setting when the frequency compensation is disabled, or during power-up of the transmitter.

5) Set up the transmitter module to transmit a RF signal with the 19KHz pilot tone, and a 1KHz tone in both L and R inputs. The 1KHz tone inputs should be inverted between L and R inputs (180 degrees out of phase from each other). The 1KHz tone amplitudes should be set to 4Vp-p.

6) Set the frequency of the transmitter to 915MHz.

7) Adjust the L-R D-Pot setting so that the maximum deviation is 75KHz.

8) Store this value into the EEPROM. This value will be used as the default D-Pot setting for the L-R D-Pot.

9) All Modulation calibration settings have been measured and stored in EEPROM at this point.

10) Cycle the power on the transmitter (This should make the transmitter accept its new EEPROM default settings). Disable the frequency compensation. With no audio input into the transmitter, measure the peak deviation at each of the 6 frequencies within the 902-928MHz ISM band. Verify that they are 7.5KHz +/-0.6KHz at all 6 frequencies. Enable the frequency compensation. Again with no audio input into the transmitter, measure the peak deviation at each of the 6 frequencies within the 902-928MHz ISM band. Verify that they are 7.5 +/- 0.1KHz peak deviation at all 6 frequencies.