DSP-59

Audio Noise Reduction Filter

Operating Manual

Timewave Technology Inc.

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Rev. 2.00

1. Introduction to the DSP-59

The DSP-59 is an audio noise filter developed and optimized for the radio amateur market. The DSP-59 filters noise and reduces interference to improve radio reception. The DSP-59 uses digital signal processing technology to implement algorithms that perform five basic filter functions: 1) Random noise reduction, 2) Adaptive multi-tone notch filtering (Tone noise reduction), 3) Highpass filtering, 4) Lowpass filtering, 5) Bandpass filtering. Switch-selectable combinations of these basic functions make up the five operating modes of the DSP-59.

RANDOM/TONE NOISE REDUCTION

The noise reduction functions of the DSP-59 operate by examining a characteristic of signals and noise called *correlation,* and dynamically filtering out the undesired signals and noise. The degree of correlation is relative. Random noise such as white noise or static is uncorrelated. Speech is moderately correlated. Repetitive noise such as a heterodyne is highly correlated. The DSP-59 measures correlation and filters out signals and noise that are outside its correlation thresholds. There is little degradation of the desired speech signal. The amount of noise reduction varies according to the correlation characteristics of the noise. Typical noise reduction ranges from 5 dB to 20 dB for random noise and up to 50 dB for heterodynes.

HIGHPASS/LOWPASS FILTERS

There are many uses for the wide selection of Highpass/Lowpass filter combinations that the DSP-59 offers. For instance, a broadband SSB audio signal may be very difficult to copy because of a poor signal-to-noise condition. Removing the high frequency components of the baseband that do not contribute significantly to the speech intelligibility with a Lowpass filter will remove noise and therefore improve signal quality. Another example of how the flexibility of the DSP-59 audio filter can improve baseband audio performance is with SSB signals corrupted with in-band and adjacent channel interference from other signals that overlap the desired signal. The steep skirts of the Highpass and Lowpass filters allow the interference to be eliminated with minimal impact on the desired signal. Finally, the sixty-four selectable Highpass and Lowpass filter combinations also allow enhanced filtering for data modes such as packet, wide shift RTTY or facsimile. The Highpass filter adjustment range is from 200 to 1500 Hz. and the Lowpass range is from 1800 to 4200 kHz.

BANDPASS FILTERS

Narrow band signals like CW and RTTY require bandpass filters with steep skirts and linear phase response. Linear phase response maximizes the usable signaling rate for a given bandwidth and minimizes ringing often heard on extremely sharp filters. The DSP-59 has fifty-six CW filters with skirts so steep that a signal literally falls off the edge of the pass band as you tune through a CW signal. Bandwidths for these filters range from 50 Hz. to 600 Hz., and center frequencies from 400 to 1000 Hz. The narrow filters are useful for trying to dig out extremely weak signals from the noise and QRM. The wider filters allow easy tuning and listening to multiple CW signals simultaneously. The DSP-59 also has four RTTY/AMTOR bandpass filters centered at 2210 Hz. The selectable bandwidth of this filter provides optimum filtering for 170 Hz. and 200 Hz. shift RTTY signals of various baud rates.

2. SPECIFICATION

AUDIO INPUT

input range	300 mV to 3 V rms
impedance	10 k Ohms

AUDIO OUTPUT

Speaker output power	1.6 Watts into 8 Ohms at 13.8 VDC 3.2 Watts into 4 Ohms at 13.8 VDC
Line output level	1.0 V peak maximum into 10 k Ohms
Distortion	less than 1% at rated output

FILTERS

	Freq. range	Attenuation	Type	Delay
Random Noise Reduction	200 Hz-4.2 kHz adjustable	Up to 20 dB, varies with noise characteristics	Adaptive	10 ms. max.
Tone Noise Reduction	300 Hz.-4.2 kHz adjustable	Up to 50 dB, adjustable, varies with noise characteristics	Adaptive	10 ms. max.
Highpass	200,300,400,500, 800 Hz. 1.0, 1.2, 1.5 kHz	Up to 60 dB at 180 Hz outside the passband	FIR Linear phase	10 ms max
Lowpass	1.8, 2.1, 2.4, 2.7, 3.0 3.4, 3.8, 4.2 kHz	60 dB at 180 Hz outside the passband	FIR Linear phase	10 ms. max
Bandpass	Center Freq. = 400, 500, 600, 700, 800, 900 Hz, 1.0, 2.21 kHz. Bandwidth = 50, 100, 150 200, 250, 300, 400, 600 Hz.	60 dB at 50 Hz outside the passband, except 40 dB at 100 Hz outside 2.21 kHz filter passband	FIR Linear phase	30 ms. max.

SIGNAL PROCESSING

A-D/D-A Converter	16 bit, linear, sigma-delta
Signal Processor	16 bit, 94 ns Analog Devices ADSP-2105

CONTROLS

FRONT PANEL

- Volume/power on-off
- Mode Select
- HP cutoff freq. / BP bandwidth / Tone threshold
- LF cutoff freq. / BP center freq.
- Normal level LED (yellow)
- Overload LED (red)
- Headphone Jack — 0.125 in (3.5) mm phone jack - use stereo headphones (or mono with adapter)

REAR PANEL

Audio Input	0.25 in. (6.3 mm) phone jack - use mono plug
Audio Input Sensitivity	Screwdriver adjust
Speaker Audio Output	0.25 in. (6.3 mm) phone jack - use mono plug
Line Audio Output	0.25 in. (6.3 mm) phone jack - use mono plug
PTT & PTT sense	5 pin Circular DIN (180 degree) female

DIMENSIONS

Size	7.5 in. wide x 8 in. deep x 1.75 in. high (190 mm wide x 203 mm deep x 45 mm high)
Weight	2.2 lb. (1 Kg)

POWER

12-16 VDC @ 1000 ma.

3. Installation

To install a DSP-59 in a station, an operator must: 1) Provide power to the DSP-59, 2) Make audio input and output connections to the DSP-59, 3) Connect the optional Aux. I/O input which provides a mute on push-to-talk and bypass functions, dependent on the Selector switch setting on the front panel of the DSP-59. A typical DSP-59 installation is shown below in Figure 3.1.

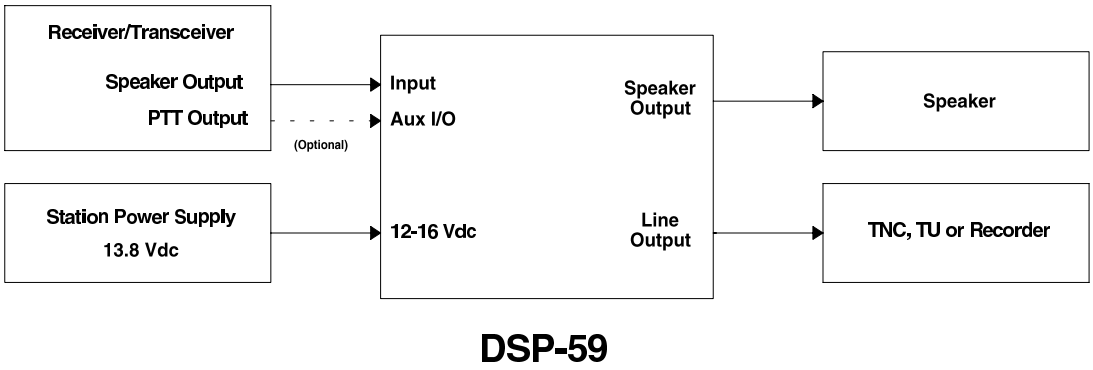


Figure 3.1

POWER SUPPLY

The DSP-59 requires a power source of 12 to 16 Volts dc. at 0.5 Amperes*. **The center pin of the power connector is POSITIVE (+).**

Acceptable power sources include:

- 13.8 volt dc. transceiver power supply (recommended power source for the DSP-59 because it is better regulated than most plug-in wall outlet supplies)
- Radio Shack 273-1653 12 Vdc. @ 1 Ampere plug-in wall supply
- Radio Shack Model 273-1652 12 Vdc. @ 500 mA. plug-in wall supply*

*NOTE: If a 4 Ohm speaker is used or the operator is going to monitor audio through the headphone jack, Timewave recommends an 800 mA. (or greater) power supply for optimal performance. Switching power supplies generate excessive noise and should not be used.

AUDIO INPUT

The audio input of the DSP-59 is the 0.25 inch INPUT connector on the rear panel. The DSP-59 requires an audio source capable of supplying 300 mV to 3 volt rms into a 10k-Ohm load. The mating connector to the DSP-59 audio input is a 0.25 inch mono phone plug. The tip of phone plug carries the signal, and **the sleeve is ground return for the audio input only. Do not connect the audio output ground return or the power supply ground return to the audio input phone jack. An improper ground connection may result in degraded performance of the DSP-59** (or any similar piece

of quality audio equipment). If you are connecting the DSP-59 to the speaker output of your transceiver, Timewave recommends shunting a 22 Ohm resistor across the input phone plug at the DSP-59 side of the cable. This makes the DSP-59 look like a speaker load which improves performance with some transceivers.

An audio input level adjust potentiometer is located on the back panel of the DSP-59 next to the audio input jack. It is recommended that the following procedure be implemented when the DSP-59 is initially set-up to adjust the input level adjust. This procedure is applied specifically to the typical installation where the input to the DSP-59 is the speaker output of the receiver/transceiver. If this type of configuration is not implemented, the level adjust procedure must be changed accordingly. First, place the DSP-59 selector switch into the Bypass mode. Then tune the radio to a strong signal and set the radio output level gain control to a convenient midrange position. Then, adjust the input level control on the rear panel of the DSP-59 so the **overload** indicator LED on the front panel **rarely flashes** and the threshold indicator LED is always flashing with normal audio input levels. Proper adjustment ensures optimum signal-to-noise ratio and minimum distortion.

AUDIO OUTPUT

The DSP-59 has three audio outputs:

1. On the lower left hand corner of the DSP-59 front panel is a 3.5 mm headphone jack connected for stereo headphones. Use of mono headphones requires a stereo-to-monaural adapter. The DSP-59 speaker output is muted when a headphone plug is inserted.

2. The 0.25 inch mono Line Output phone jack on the rear panel of the DSP-59 provides a line level output signal appropriate for use with a modem, a packet TNC, or a tape recorder. The line level output is fixed and is **not** controlled by the front-panel gain control. The maximum output level is 1 volt rms into a 4.7 k-Ohm load.

3. The 0.25 inch mono Speaker Output phone jack on the rear panel of the DSP-59 provides adequate output to drive a 4 or 8 Ohm speaker. The front panel gain control adjusts the audio level from this output. The maximum output power is approximately 3.2 watts into a 4 Ohm speaker, or 1.6 watts into an 8 Ohm speaker.

AUX. I/O (Mute on Push-to-Talk/Bypass Connections)

The DSP-59 has an optional Aux. I/O connector that provides the DSP-59 mute or bypass capability from either a push-to-talk relay closure or driven output of a transceiver/transmitter. The operation of the Aux. I/O is dependent on the operational setting of the Selector switch on the DSP-59 front panel. Table 3.1 defines how the operational settings change the function of the Aux. I/O and the purpose for providing these functions. Figure 3.2 details the pin out of the AUX. I/O connector. Figure 3.3 illustrates four different wiring connections for the Aux. I/O connector that allow flexible interfacing to various types of push-to-talk circuits.

AUX. I/O Operation

DSP-59 Operating Mode	AUX. I/0 function	Purpose for AUX. I/O function
Bypass	no effect	---
All operating modes except Bypass and Bandpass (BP)	mutes DSP-59 audio output	Mutes DSP-59 audio on a push-to talk
Bandpass (BP)	switches DSP-59 to Bypass Mode	allows transceiver CW sidetone to pass through the DSP-59 and to be heard during transmit

Table 3.1

AUX. I/O Pin Connections

Pin Number	Description
1	PTT Sense - active high/low
2	DSP-59 common (ground)
3	PTT input
4	+5V pull-up
5	PTT return

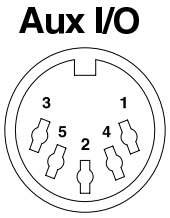
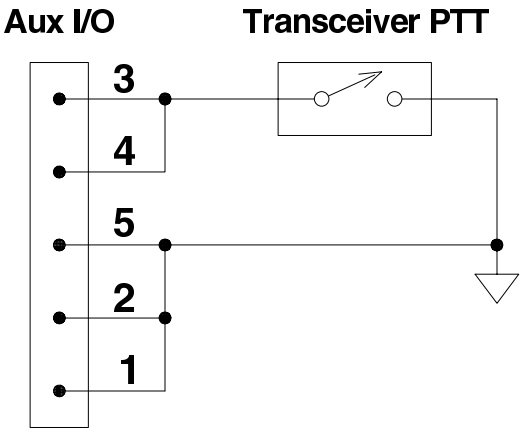
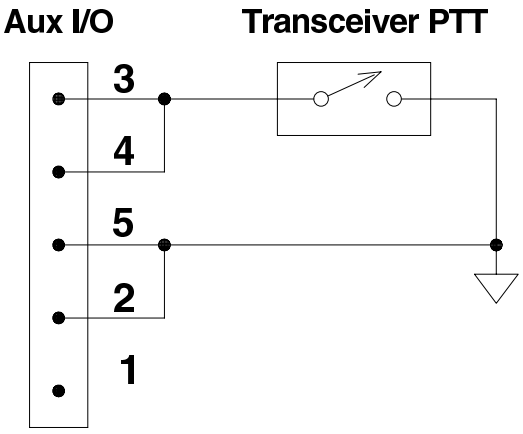


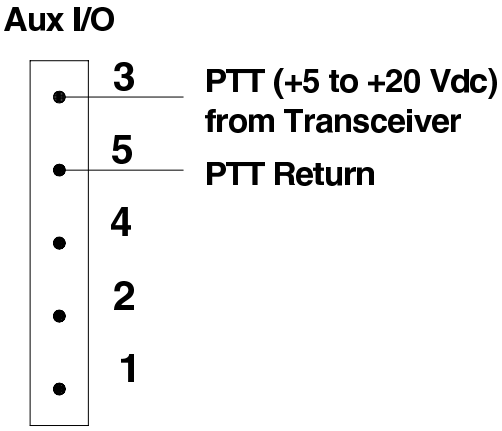
Fig. 3.2



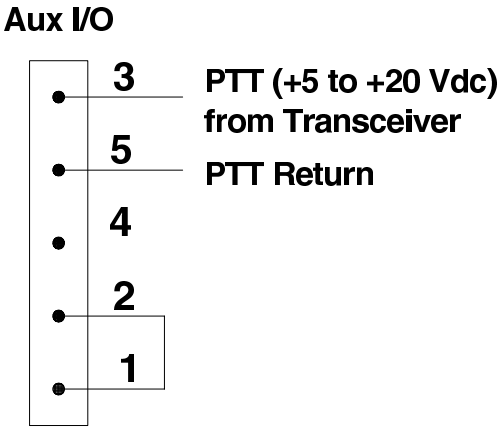
Aux I/O Wiring for PTT Mute/Bypass from Normally Open Contact



Aux I/O Wiring for PTT Mute/Bypass from Normally Closed Contact



Aux I/O Wiring for PTT Mute/Bypass from Transceiver with Powered PTT Output (Active High)



Aux I/O Wiring for PTT Mute/Bypass from Transceiver with Powered PTT Output (Active Low)

AUX. I/O Connector Wiring Specification

Fig 3.3

4. Operation

Introduction
All operational control of the DSP-59 is provided by four knobs on the front panel of the DSP-59. These knobs apply power to the DSP-59, set audio output levels of the DSP-59, select the operating mode the DSP-59 will be operating in, and adjust operational parameters of the operating mode of the DSP-59

Power Switch/Gain Adjust Control
The leftmost knob on the front panel of the DSP-59, marked "Gain", is the power switch/gain adjust control. It is a volume control with a mechanical ON/OFF switch at one end of the controls adjustment. When turned all the way counter-clockwise, the DSP-59 is turned off. To turn the power on, rotate the power switch/gain adjust control knob clockwise until it clicks. Once the DSP-59 is on, the power switch/gain adjust control acts as a volume control for the rest of it's clockwise rotation. The further clockwise the knob is set, the greater the audio gain. To turn off the DSP-59, rotate the knob to its most counter-clockwise position until it clicks.

Selecting the mode
The knob on the front panel of the DSP-59 marked "Selector" is a six position switch that selects the operating mode of the DSP-59. By this selection, the fixed functions of an operating mode are specified, as well as two adjustable parameters that are select by the settings of the other two knobs. The selection of adjustable parameters is done using a color-coded scheme where the colors used in the name of the operating mode on the Selector switch correspond to an adjustable parameter on the other two switches. For example, if the Selector switch is in the HP(in blue)/LP(in black) with random noise reduction setting, then the adjustable parameters of this operating mode are the setting of the corner frequency for the high pass filter (marked in blue on the first parameter select knob on the DSP-59) and the corner frequency of the low pass filter (marked in black on the second parameter select knob). The fixed function of this operational setting is the correlation index of the adaptive random noise filter (If it were adjustable, a yellow C for correlation index would be in the name of the operating mode) The fixed functions and adjustable parameters of the six operating modes are described in detail in the following operating mode descriptions. Table 4.1 at the end of this section sums up the operating modes in tabular form.

Bypass - The Bypass mode completely bypasses the DSP circuitry of the DSP-59. The signals pass only through the audio input and output circuitry of the DSP-59. The DSP-59 must be powered to operate in the Bypass mode. This active bypass mode allows the DSP-59 signal processing functions to be switched in and out without changing gain settings to maintain a desired audio output level.

C/LP NRt - This mode includes simultaneous operation of an adjustable tone noise reduction filter, an adjustable Lowpass filter, and a fixed frequency 300 Hz Highpass filter. The correlation control adjusts the aggressiveness of the tone noise filter (Position 1 is most aggressive and position 8 the least aggressive). The Lowpass filter can be adjusted from 1.8 kHz to 4.2 kHz.

C/LP NRtr - This mode includes simultaneous operation of a fixed tone noise reduction filter, an adjustable random noise reduction filter, an adjustable Lowpass filter, and a fixed frequency Highpass filters. The correlation control adjusts the aggressiveness of the tone noise filter (Position 1 is most aggressive and position 8 the least aggressive). The Lowpass filter can be adjusted from 1.8 kHz to 4.2 kHz.

HP/LP NRr - This mode includes simultaneous operation of a fixed random noise reduction filter, an adjustable Highpass filter, and an adjustable Lowpass filter. The Highpass filter can be adjusted from 200 Hz to 1.5 kHz. The Lowpass filter can be adjusted from 1.8 kHz to 4.2 kHz.

HP/LP - This mode includes simultaneous operation of adjustable Lowpass and Highpass filters with no noise reduction. This mode of operation is particularly useful for providing pre-modem filtering for packet, slow scan TV, FAX, and wide-shift RTTY data.

BP - The Bandpass Filter mode is the only mode of the DSP-59 that does not combine multiple functions. In this mode of operation the center frequency of the bandpass filter and the bandwidth of the bandpass filter are selectable. The bandpass filters provided in this DSP-59 have extremely steep skirts and narrow bandwidths. Fifty-six of the filter combinations (those with center frequencies of 400 to 1000 Hz) are for CW operation. In the RTTY position (center frequency of 2.21 kHz), the four filter combinations with bandwidths of 250, 300, 400, and 600 Hz are specifically for RTTY (optimally 250 Hz) and AMTOR (optimally 300 Hz) operation.

MODE	FUNCTION				
	Random	Tone	Lowpass	Highpass	Bandpass
Bypass					
C/LP NRt		adj.	adj.	fixed (300 Hz)	
C/LP NRtr	adj.	fixed	adj.	fixed (300 Hz)	
HP/LP NRr	fixed		adj.	adj.	
HP/LP			adj.	adj.	
BP					adj.

Table 4.1

5. Troubleshooting

"Normal" LED does not flash on audio peaks.

Check audio input connections.
Check audio input level trimpot on the back panel of DSP-59.
Check power connection to DSP-59.

"Overload" LED flashes on audio peaks.

Reduce audio input level with receiver audio output level control
Reduce audio input level with DSP-59 audio input level trimpot on the back panel.
Check power connection to DSP-59.

No audio output

Check audio input connections.
Increase audio input level with receiver audio output level control
Increase audio input level with DSP-59 audio input level trimpot on the back panel.
Check audio output (speaker, line output, and headphone) connections.
Check audio output device (speaker, line output device, or headphone).
Check power connection to DSP-59.
Turn front panel audio level control clockwise.

If the DSP-59 does not seem to work correctly after carefully following the installation, operation and troubleshooting instructions in this manual, call, write or FAX the Timewave Customer Service Department for additional help.

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2401 Pilot Knob Road, St. Paul, MN 55120
612-452-5939 FAX 612-452-4571

6. Product Warranty

Timewave Technology Inc. products carry the following warranty:

Timewave hardware products are warranted against defects in materials and workmanship. If Timewave receives notice of such defects during the warranty period, Timewave shall, at its option, either repair or replace hardware products which prove to be defective.

Timewave software and firmware products which are designated by Timewave for use with a hardware product are warranted not to fail to execute their programming

instructions due to defects in materials and workmanship. If Timewave receives notice of such defects during the warranty period, Timewave shall, at its option, either repair or replace software media or firmware which do not execute their programming instructions

due to such defects. Timewave does not warrant that operation of the software, firmware, or hardware shall be uninterrupted or error free.

The warranty period for each product is one year from date of shipment.

Limitation of Warranty: The foregoing warranty shall not apply to defects resulting from:

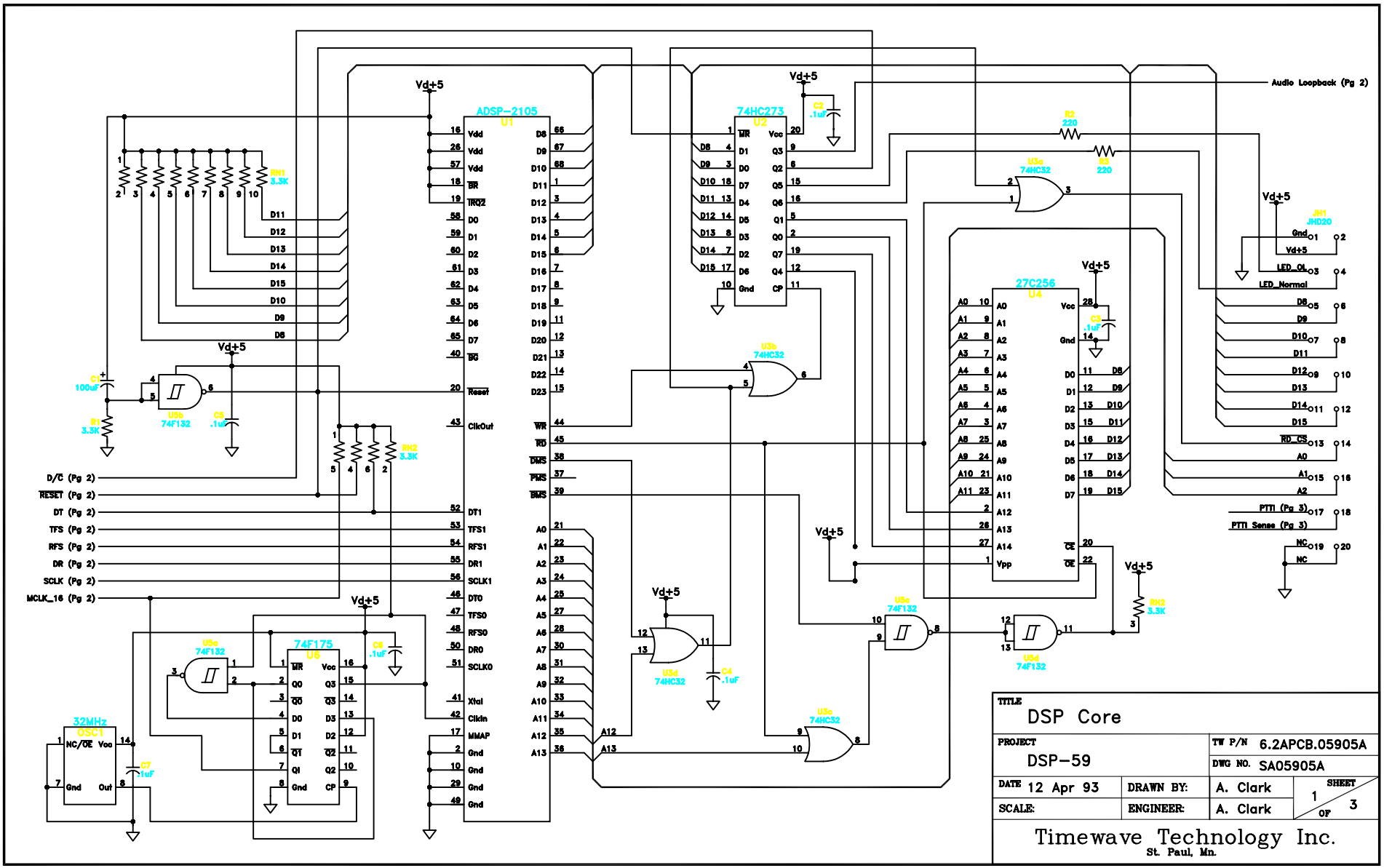
1. Improper or inadequate maintenance by the Buyer;
2. Buyer-supplied software or interfacing;
3. Unauthorized modification or misuse;
4. Operation outside the environmental specifications of the product;
5. Improper site preparation and maintenance.

Exclusive Remedies:

The remedies provided herein are the Buyer's sole and exclusive remedies. In no event shall Timewave be liable for direct, indirect, special, incidental or consequential damages (including loss of profits) whether based on contract, tort, or any other legal theory.

7. Schematic Diagrams

The following schematics are for the processor and front panel boards for the DSP-59. This circuitry is subject to change without notice.


ADSP-2105
U1
74HC273
U2
27C256
U4
74F175
U6
74F132
74HC32
32MHz
OSC1
JH1
JHD20
RN1
3.3K
RN2
3.3K
R2
220
R3
220
C1
100uF
C2
.1uF
C3
.1uF
C4
.1uF
C5
.1uF
C6
.1uF
C7
.1uF
R1
3.3K
Vd+5
Audio Loopback (Pg 2)
D/C (Pg 2)
RESET (Pg 2)
DT (Pg 2)
TFS (Pg 2)
RFS (Pg 2)
DR (Pg 2)
SCLK (Pg 2)
MCLK_16 (Pg 2)
PTT1 (Pg 3)
PTT1 Sense (Pg 3)
LED_OL
LED_Normal
RD_CS
TITLE
DSP Core
PROJECT
DSP-59
TW P/N 6.2APCB.05905A
DWG NO. SA05905A
DATE 12 Apr 93
DRAWN BY: A. Clark
SCALE:
ENGINEER: A. Clark
SHEET 1 OF 3
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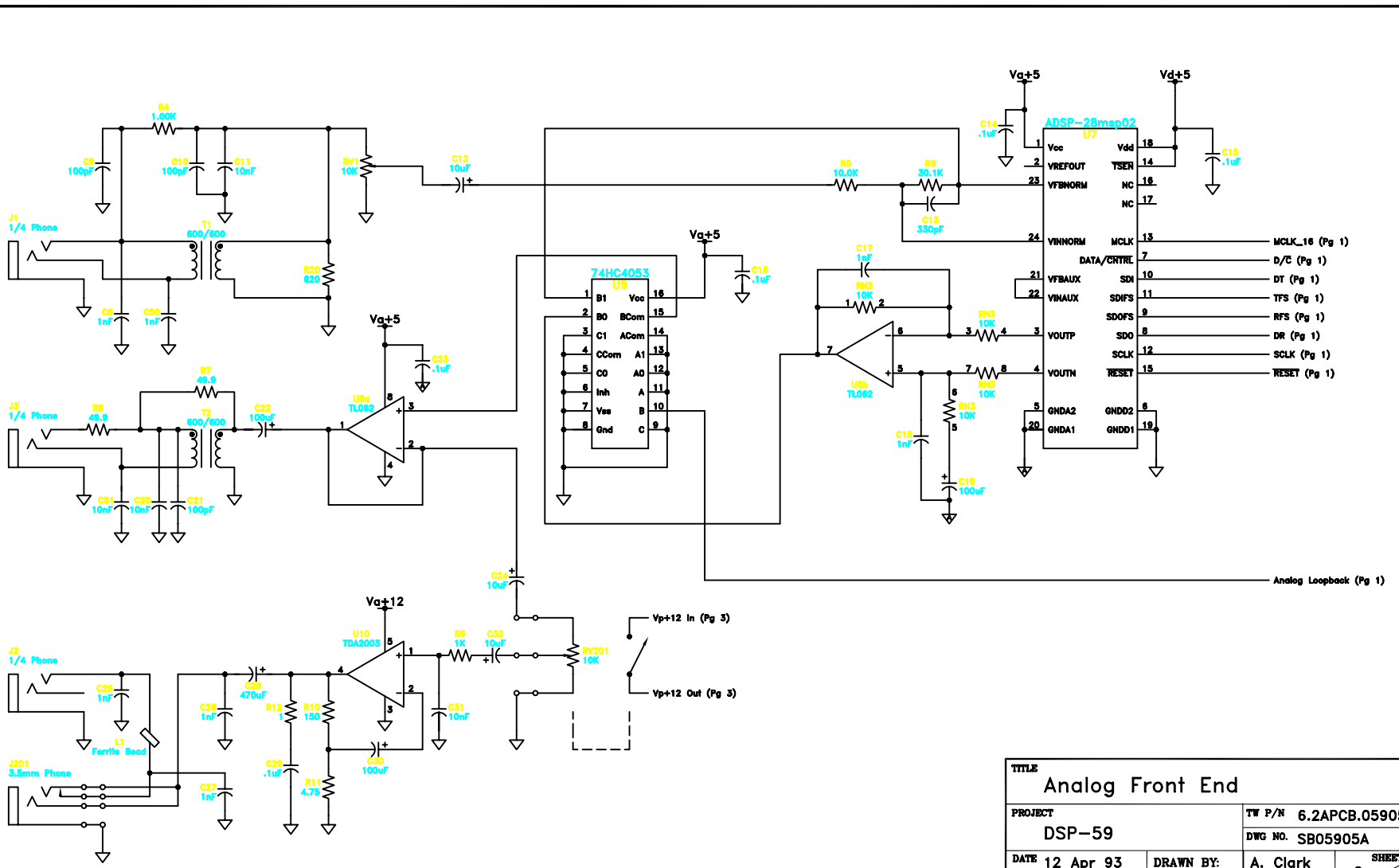

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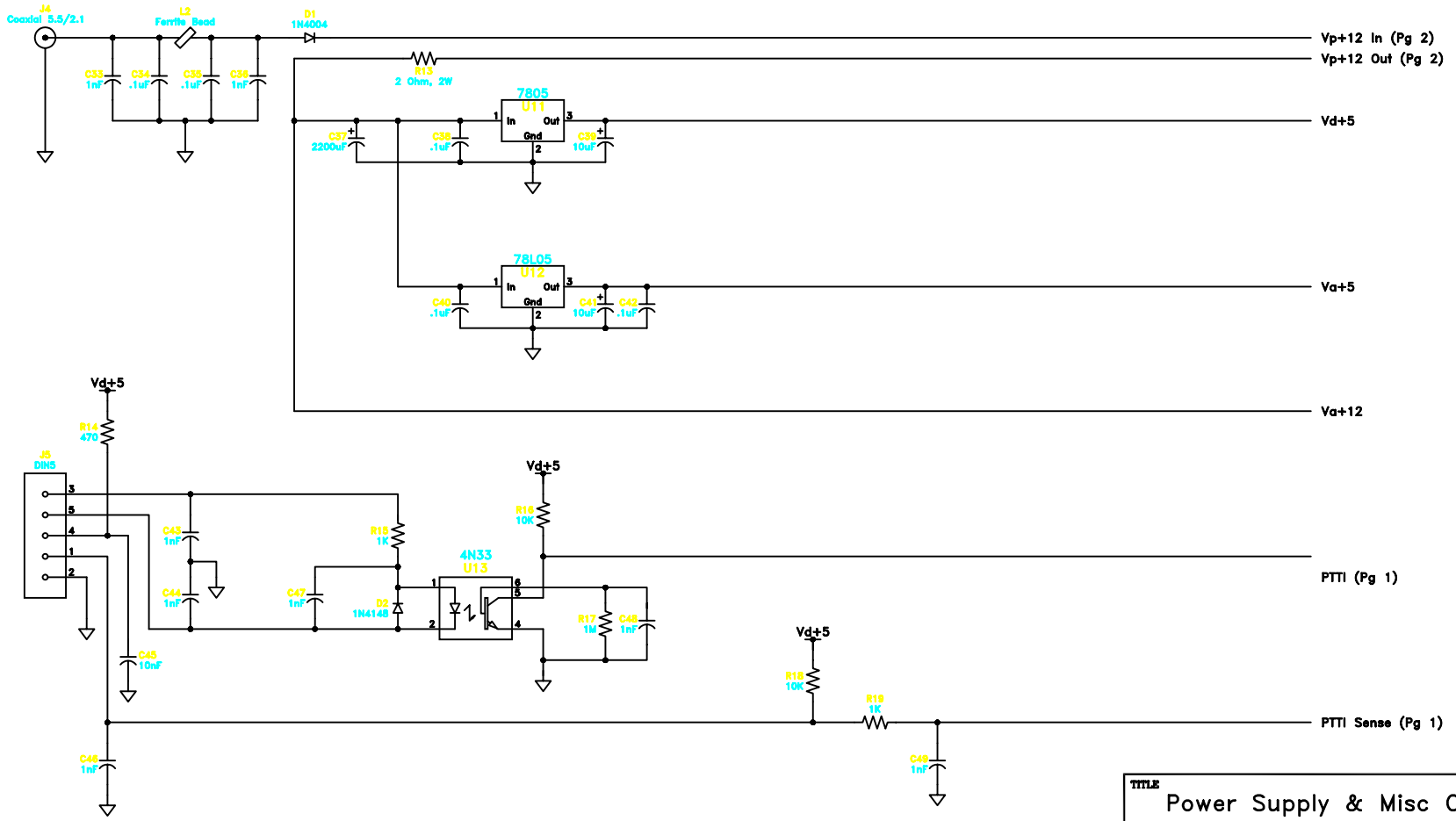

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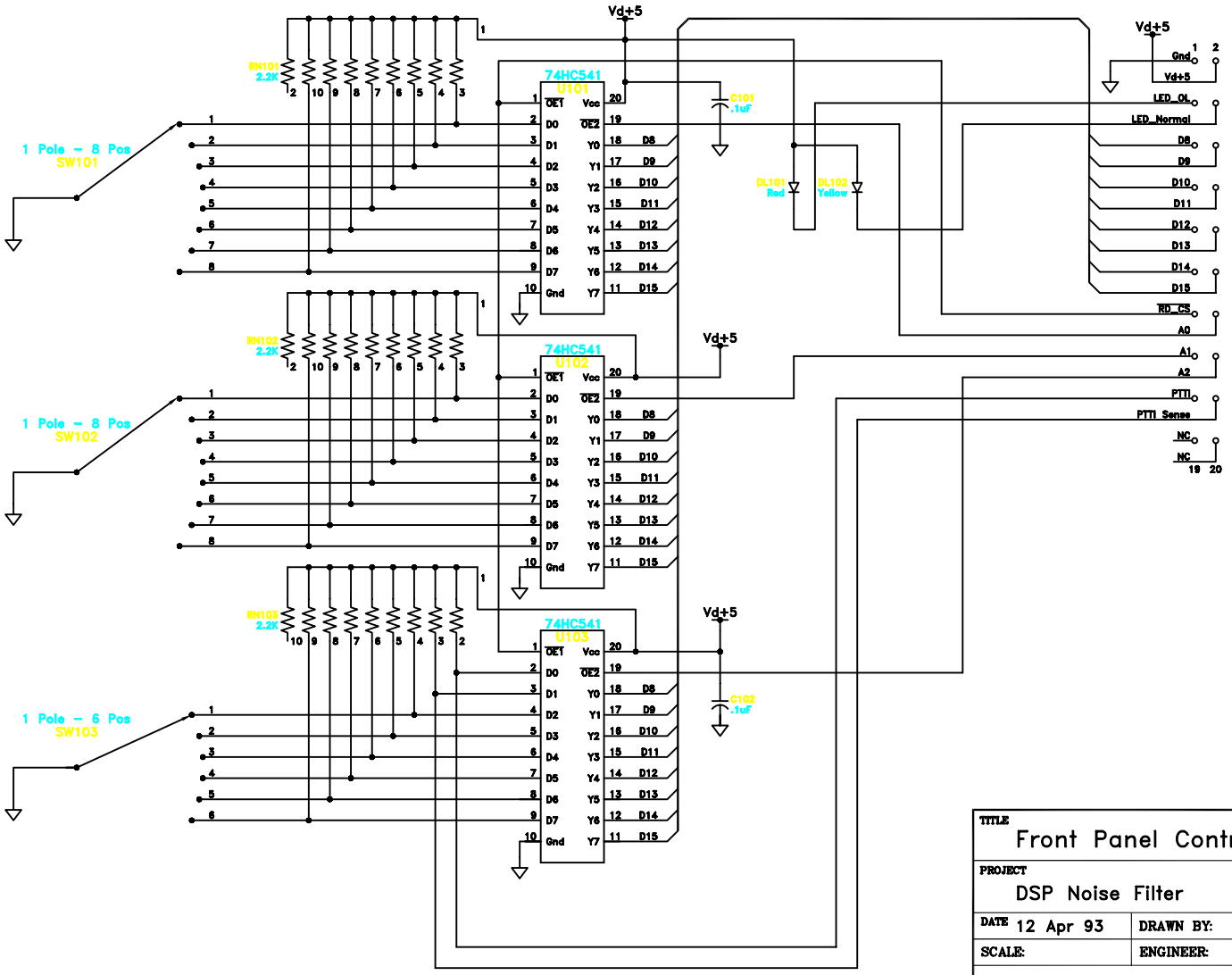

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DATE: 12 Apr 93	DRAWN BY:	A. Clark	SHEET 1 OF 1
SCALE:	ENGINEER:	A. Clark	

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