David Husband, M.Sc in IT, *Baremetal Engineer Extraordinaire*

What you see detailed on my CV are "merely" the things I have done to earn money...
In reality, my abilities, knowledge and capabilities range far beyond my CV..

I am a ***BAREMETAL ENGINEER*** and what is in this document showcases a small part of my ***baremetal engineering***...
I have an embryonic "personal passion" website on the subject here: http://baremetal.engineer/

The purpose of that web site is to expose and document some of what I have spent many years doing so that hopefully, young engineers can & will learn from it !!

In http://baremetal.engineer/baremetal.software.engineer.pdf I showed my proven abilities, including researching, analysing, extracting and applying freshly acquired knowledge from within the TCP/IP subject domain

In http://baremetal.engineer/baremetal.blockchain.engineer.pdf I showed my recently acquired blockchain knowledge, including my analysis of how Blockchain can be applied to embedded IoT systems.

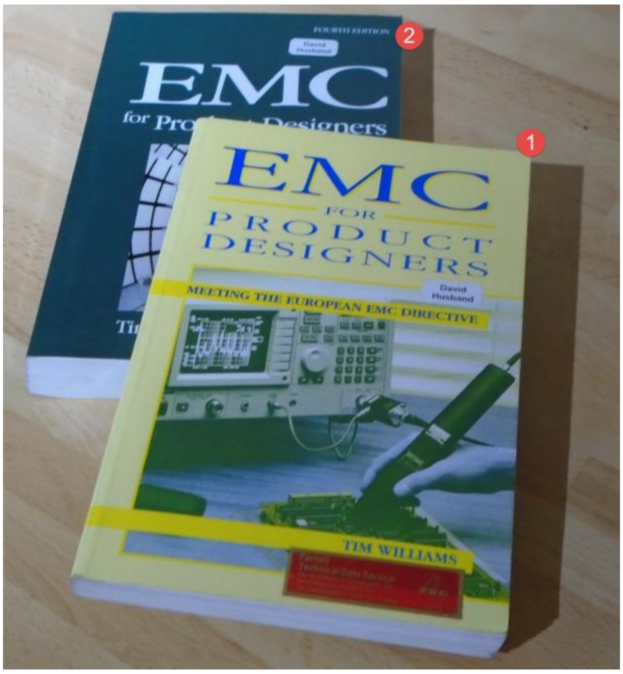
In http://baremetal.engineer/baremetal.hardware.engineer.pdf I showed how electronic hardware has not changed in essence over the last 60 years or so, due to being based upon the principles of physics established hundreds of years ago. I showed how, counter-intuitively, electronics hardware was actually ***easier now*** due to ever increasing integration and increasing functionality...

I also have extensive radio-communications knowledge and ability[1] (having been a licensed radio amateur since 1973); having successfully designed, manufactured, and sold worldwide, a range of products to decode various kinds of data transmitted over radio... And I know what an SDR is! https://en.wikipedia.org/wiki/Software-defined_radio

What is described here is **my <u>EMC design and implementation experiences</u> around 1995 & 1996** producing a prototype "Scanmaster 3" ("SM3") communications computer

The purpose of that product was to remote control[2] one of a selected range of commercially available wide-range radio receivers ("scanning radios") such as the Icom IC-R7000 and to be able to decode/resolve a number of different data formats used over radio transmissions such as MPT1327 and analogue cellular ("TACS")

It involved processing and decoding a variety of "microphone-level" audio signals via microprocessor-controlled audio circuitry in close proximity to high-speed microprocessor circuitry, so an excellent EMC design was paramount[3]



Image# 1: Tim William's EMC book

I came across Edition 1 of Tim William's book and was very impressed by the vast amount of practical detail it contained

(1) in Image#1 is the edition I used...
(2) shows the 4th edition which is about 50% larger in size !

Note: The various technical standards and documents referenced reminds me very much of a similar situation in the Aircraft industry where these documents HAVE to be complied with and TRACEABILITY to them (and the testing) proved...

I found chapter 5 ("Circuits, layout and grounding") of particular interest, and realised that this topic was of fundamental importance to "get right" from the very beginning - the design stages...

Seeing Fig 5.16 was like a revelation, as it was almost exactly what the layout of the SM3 would entail, apart from the analogue POTS telephone interface...
See Image 5 below where the design detail was developed, inspired by Fig 5.16 and Chapter 5

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[1] I am currently setting up my own satellite transmitting/receiving terminal to use the new Geostationary QO-100 Amateur Radio Transponder ***https://amsat-uk.org/satellites/geo/eshail-2/*** Web-SDR for QO-100 at Goonhilly: ***https://eshail.batc.org.uk/nb/*** ***https://eshail.batc.org.uk/wb/***

[2] In this case, via a remote telephone line interface...

[3] In addition, sales were envisaged as being worldwide, including the EU, so compliance with CE requirements was important

"5.1.7 Configuring I/0 grounds

Decoupling and shielding techniques to reduce common-mode currents appearing on cables both require a 'clean' ground point, not contaminated by internally generated noise. Filtering at high frequencies is next to useless without such a ground. Unless you consider this as part of the layout specification early in the design phase, such a ground will not be available

Provide a clean ground by grouping all 1/0 leads in one area and connecting their shields and decoupling capacitors to a separate ground plane in this area. The clean ground can be a separate area of the pcb [65], or it can be a metal plate on which the connectors are mounted. The external ground (which may be only the mains safety earth) and the metal or metallised case, if one is used, are connected here as well, via a low-inductance link

Figure 5.16 shows a typical arrangement for a product with digital, analogue and interface sections

This clean ground must only connect to the internal logic ground at one point. This prevents logic currents flowing through the clean ground plane and "contaminating" it

No other connections to the clean ground are allowed. As well as preventing common mode emissions, this layout also shunts incoming interference currents (transient or RF) to the clean ground and prevents them flowing through susceptible circuitry"

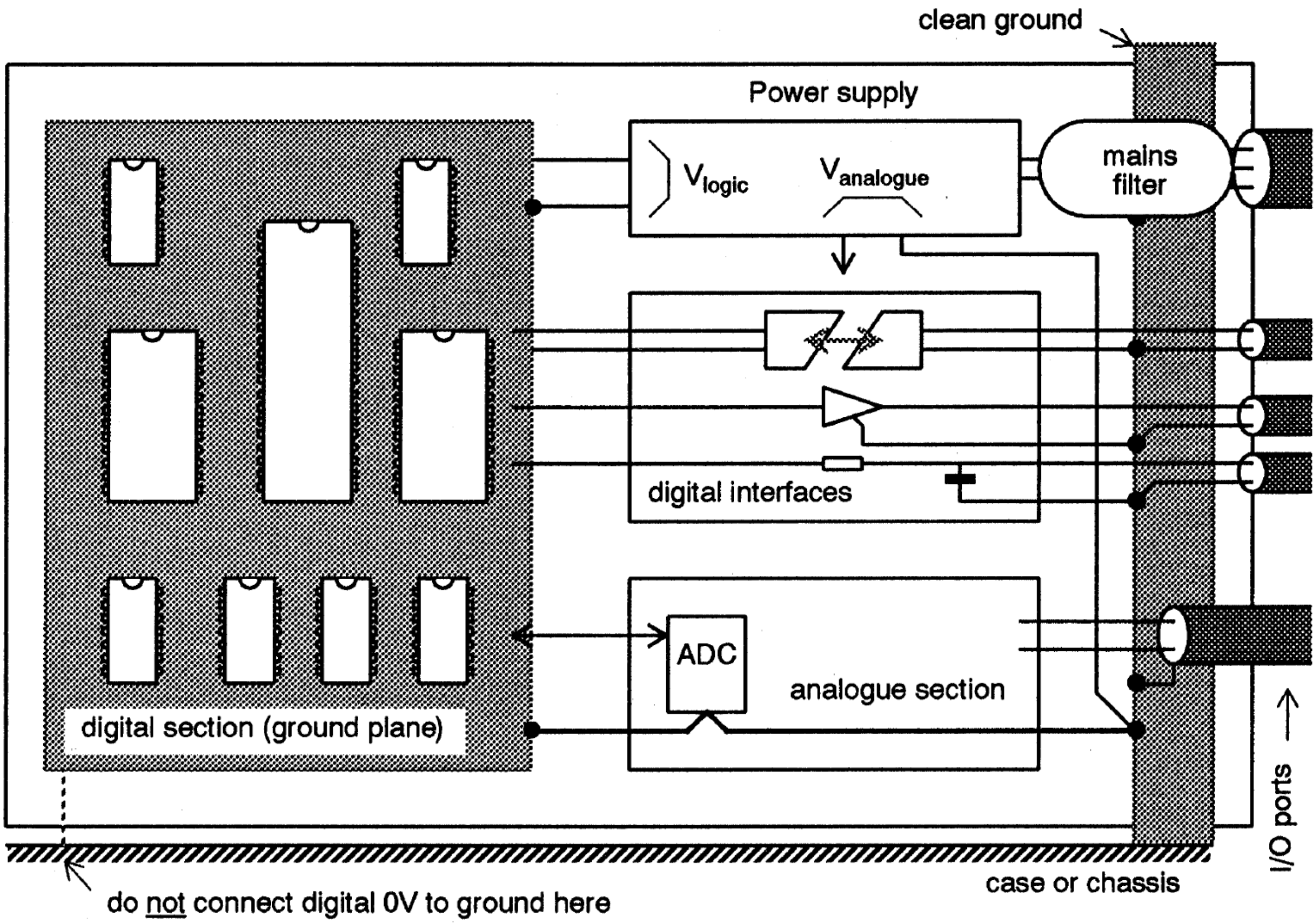


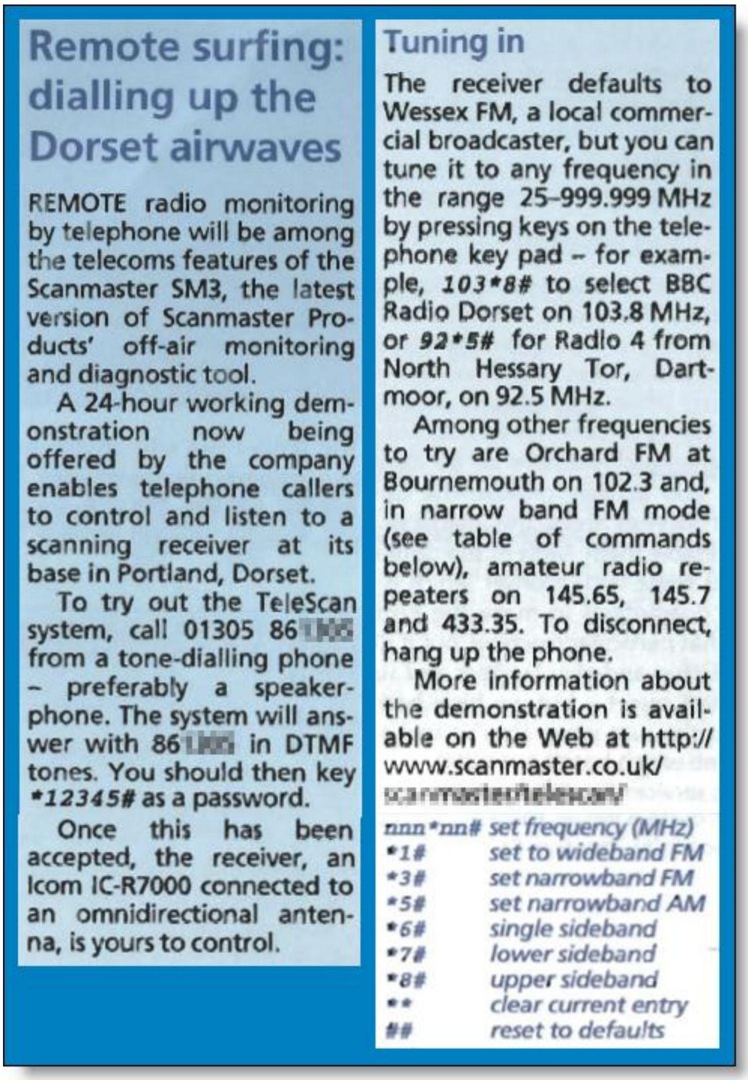
Figure 5.16 Grounding at the Interfaces, Page 137

A decision was made to use a 4-layer PCB, as it seemed to be the only way of implementing the advice given in Chapter 5, and special attention was paid to ensure that the power-plane and the ground-plane layers of the PCB were compliant[4]

As it turned out, the prototypes of the original design seemed to work very well and this enable the software to be written by me[5] and a working demonstration system was set-up in Portland and publicised by a press release story in a trade magazine called "Land Mobile" as shown in Image# 2 below

[4] Hopefully because we had no access to any laboratory and/or equipment to quantify anything !!

[5] ... to drive the hardware designed by me...



Remote surfing: dialling up the Dorset airwaves

REMOTE radio monitoring by telephone will be among the telecoms features of the Scanmaster SM3, the latest version of Scanmaster Products' off-air monitoring and diagnostic tool.

A 24-hour working demonstration now being offered by the company enables telephone callers to control and listen to a scanning receiver at its base in Portland, Dorset.

To try out the TeleScan system, call 01305 86[illegible] from a tone-dialling phone – preferably a speaker-phone. The system will answer with 86[illegible] in DTMF tones. You should then key ***12345#** as a password.

Once this has been accepted, the receiver, an Icom IC-R7000 connected to an omnidirectional antenna, is yours to control.

Tuning in

The receiver defaults to Wessex FM, a local commercial broadcaster, but you can tune it to any frequency in the range 25–999.999 MHz by pressing keys on the telephone key pad – for example, **103*8#** to select BBC Radio Dorset on 103.8 MHz, or **92*5#** for Radio 4 from North Hessary Tor, Dartmoor, on 92.5 MHz.

Among other frequencies to try are Orchard FM at Bournemouth on 102.3 and, in narrow band FM mode (see table of commands below), amateur radio repeaters on 145.65, 145.7 and 433.35. To disconnect, hang up the phone.

More information about the demonstration is available on the Web at http://www.scanmaster.co.uk/scanmaster/telescan/

nnn*nn#	set frequency (MHz)
*1#	set to wideband FM
*3#	set narrowband FM
*5#	set narrowband AM
*6#	single sideband
*7#	lower sideband
*8#	upper sideband
**	clear current entry
##	reset to defaults

Image# 2: Scanmaster SM3 "Remote Radio Surfing" Trial Promotion

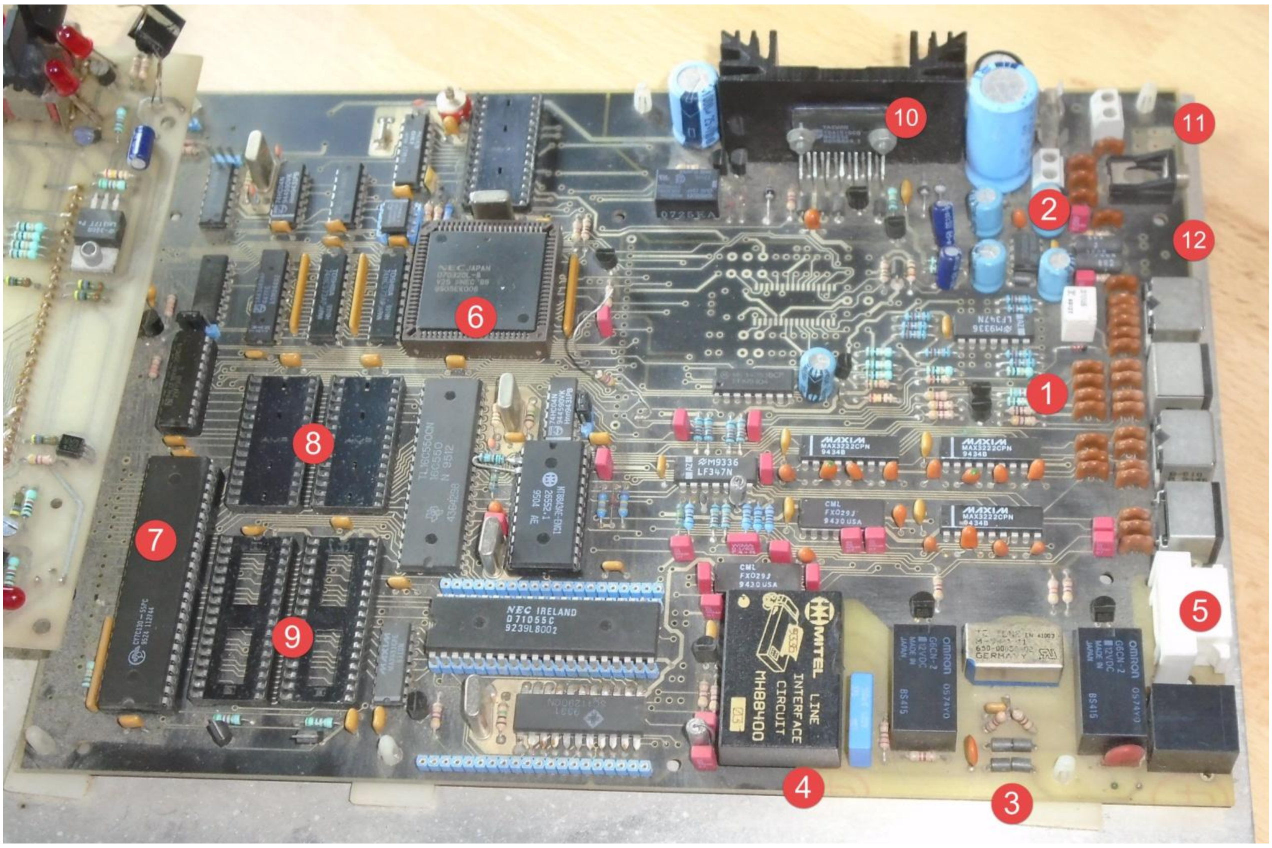
Land Mobile magazine, Aug 1996 p. 26

One of my engineering prototypes can be seen below in Image# 3:

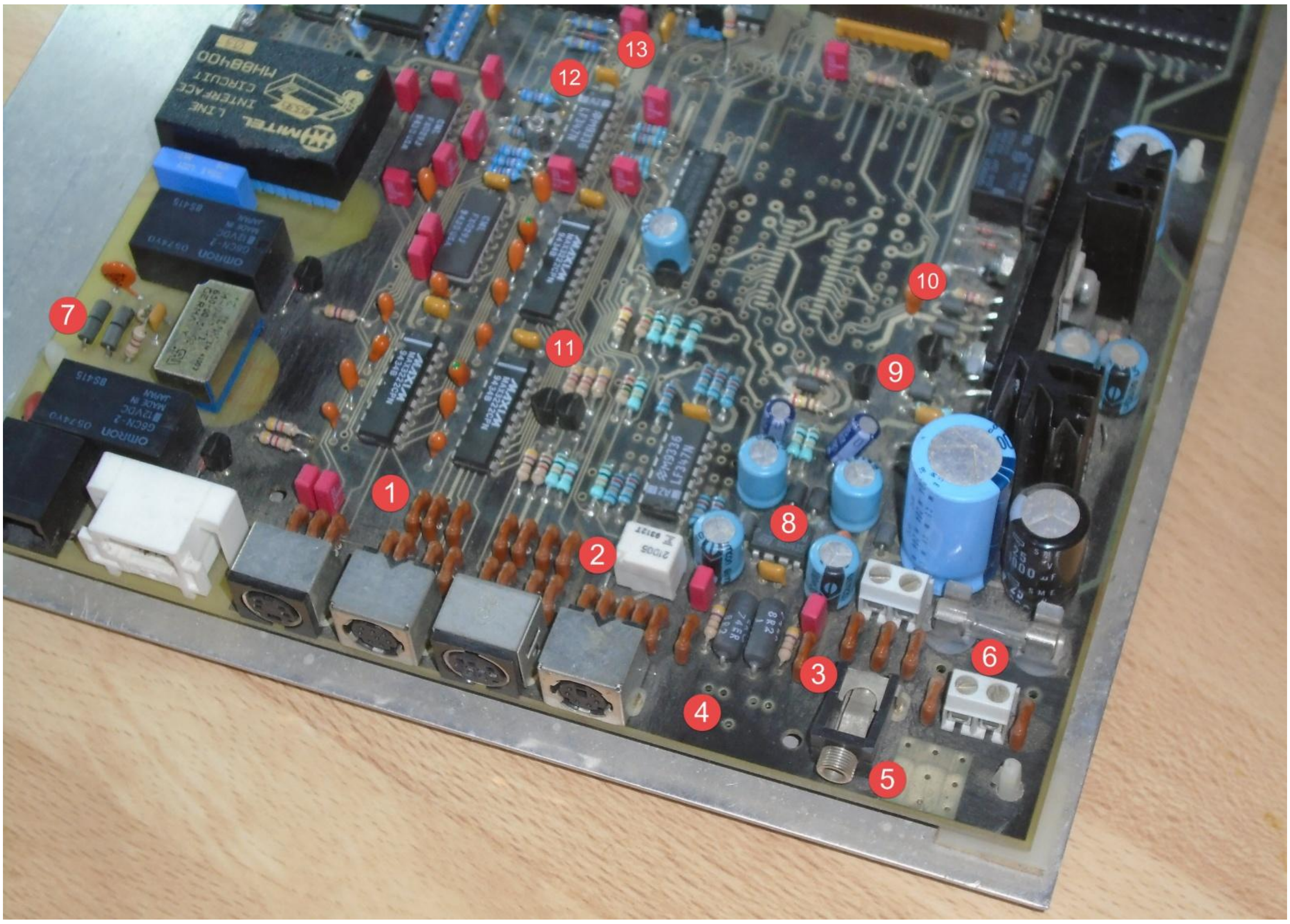
(1),(2) Shows the use of "*transorbs*" - high quality filters - a ceramic capacitor with a ferrite bead on each lead
(3) Some filtering to meet BABT requirements for the telephone line interface in **(4)**
(5) The connector in white is the Auxillary ("slave") phone line. Below it in black is the incoming phone line
(6) The NEC V25 Processor that offers an 8086 instruction set and a few other things...
(7) A Dual-port Ram for interfacing to the microprocessor of add-on data decoding boards
(8),(9) System EPROM & RAM
(10) Philips BTL 20W Audio amplifier to drive a monitoring loadspeaker (to render decoded digital audio)
(11),(12) Detail of through-hole connections on the "clean ground"

Another view is shown above in Image#4:

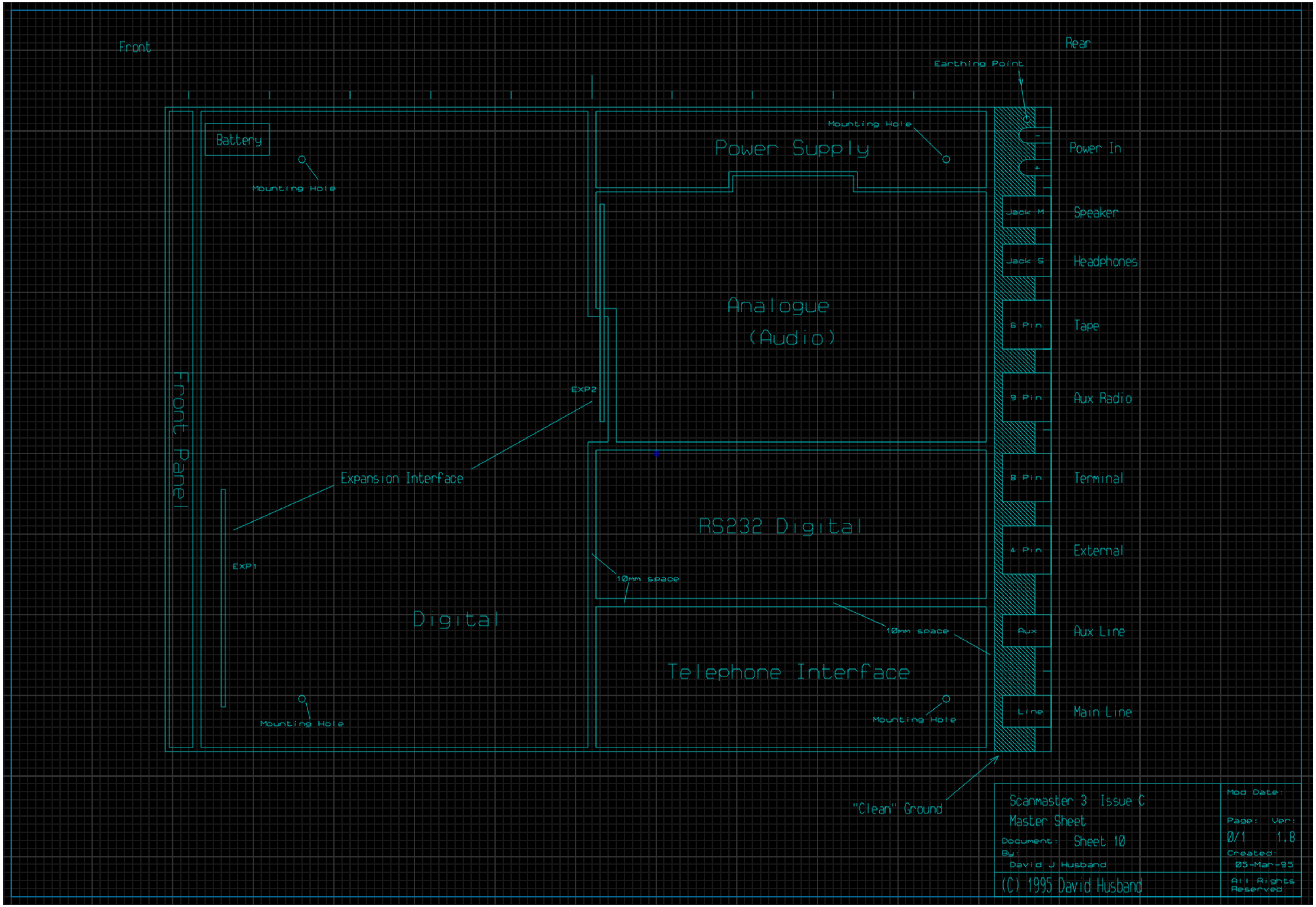
(1),(2),(3) Shows the use of "*transorbs*" - high quality filters - a ceramic capacitor with a ferrite bead on each lead
(4),(5) Detail of through-hole connections to connect the PCB planes appropriately on the "clean ground"
(6) The incoming 13.8v DC power connector
(7) Some filtering to meet BABT requirements for the telephone line interface
(8) The ferrite beads associated with the Headphone Driver I.C.
(9),(10) The ferrite beads associated with the use of Philips BTL 20W Audio amplifier
(11),(12),(13) Showing the use of high-quality ceramic decoupling capacitors in the various I.C. power supply lines



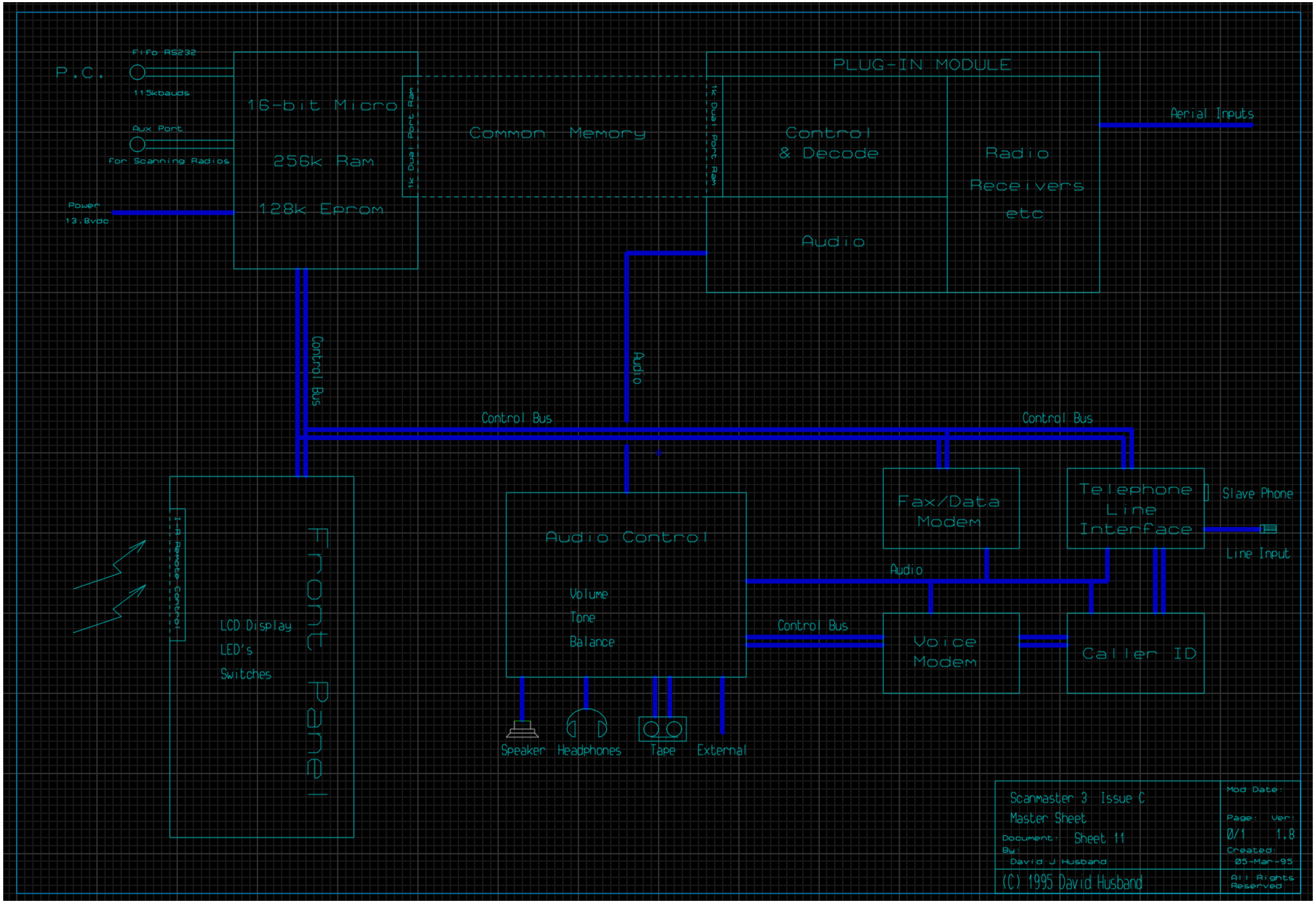
Image# 3: An early SM3 engineering prototype



Image# 4: The connector end


Front
Rear
Earthing Point
Battery
Mounting Hole
Power Supply
Mounting Hole
Power In
Jack M
Speaker
Jack S
Headphones
Analogue
(Audio)
6 Pin
Tape
9 Pin
Aux Radio
EXP2
Front Panel
Expansion Interface
8 Pin
Terminal
RS232 Digital
4 Pin
External
EXP1
10mm space
Digital
10mm space
Aux
Aux Line
Telephone Interface
Mounting Hole
Line
Main Line
Mounting Hole
"Clean" Ground
Scanmaster 3 Issue C
Master Sheet
Document: Sheet 10
By:
David J Husband
(C) 1995 David Husband
Mod Date:
Page: Ver:
0/1 1.8
Created:
05-Mar-95
All Rights Reserved

Image# 5



P.C.
Fifo RS232
115kbauds
Aux Port
for Scanning Radios
Power
13.8vdc
16-bit Micro
256k Ram
128k Eprom
1k Dual Port Ram
Common Memory
1k Dual Port Ram
PLUG-IN MODULE
Control
& Decode
Radio
Receivers
etc
Audio
Aerial Inputs
Control Bus
Audio
Control Bus
Control Bus
I-R Remote Control
Front Panel
LCD Display
LED's
Switches
Audio Control
Volume
Tone
Balance
Speaker
Headphones
Tape
External
Fax/Data
Modem
Telephone
Line
Interface
Slave Phone
Line Input
Audio
Control Bus
Voice
Modem
Caller ID
Scanmaster 3 Issue C
Master Sheet
Document: Sheet 11
By:
David J Husband
(C) 1995 David Husband
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05-Mar-95
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Image# 6