SWEX Dataset Documentation

Gaviota Site Vaisala CT12K Ceilometer data

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1.0 Data Set Description

- The CT12K ceilometer reports aerosol backscatter intensity and cloud base, up to 12000 feet.
- Data version number and date ***1.0 September 11, 2024***
- Data Status (Preliminary or Final) ***Final***
- Time period covered by the data ***April 20, 2022 12UT to May 15, 2022, 12UT.***
- Physical location ***latitude: 34.476552; longitude: -120.214465; elevation: 73 m. On the Santa Barbara County Fire Station #38 front patio.***

Figure 1. The ceilometer was located at the **Red Circle** on the patio of the Santa Barbara Count Fire Station #38.

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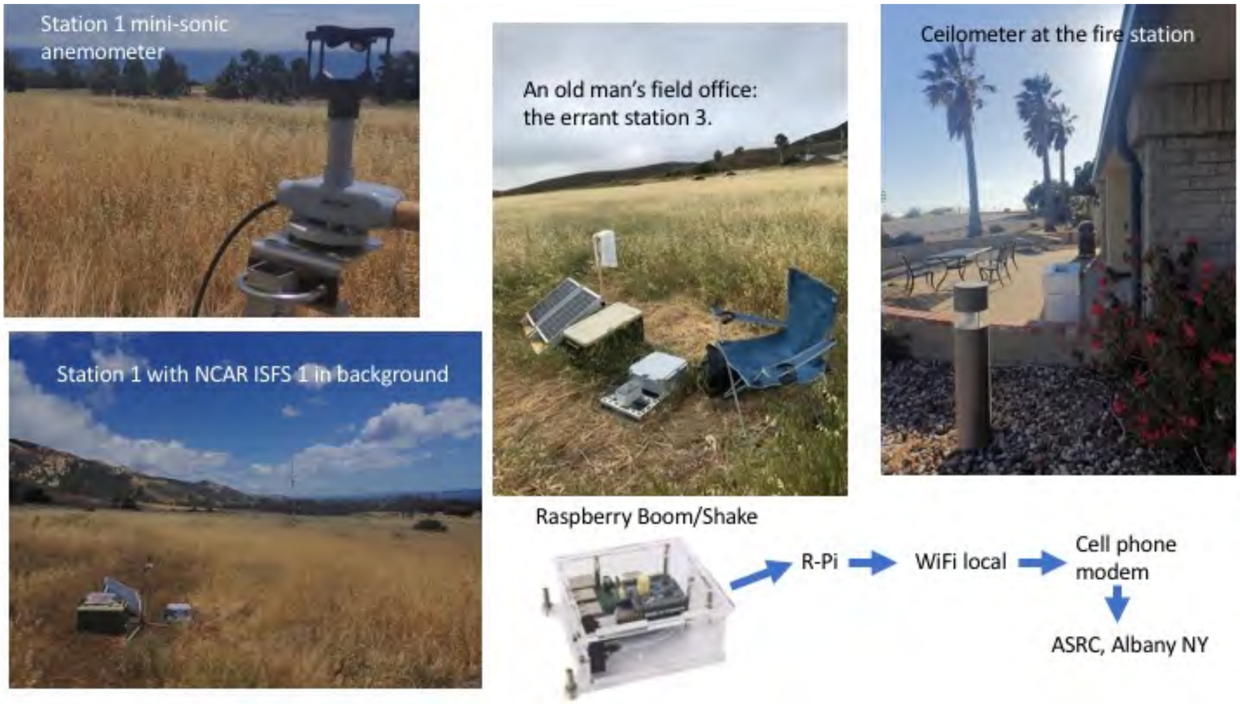


Figure 2 Location of the ceilometer, image at far right

- Data Frequency. ***There is a scan at approximately 30 s intervals. (Owing to the behavior*** **of the 'geriatric' clock on the instrument, the average time reported between scans is ≈ 29.96 seconds, but the report in the data records varies between 29 and 31 seconds.**
- Data set restrictions ***None.***

2.0 Instrument Description

- The **Vaisala CT12K manual** is at: *https://www.google.com/search?client=firefox-b-1-d&q=Vaisala+CT12K+ceilometer+manual*
- Figures (or links), if applicable
- Table of specifications (i.e., accuracy, precision, frequency, resolution, etc.) ***Profiles of backscatter are reported at 50 foot (≈ 15.24 meter) intervals; when present, cloud base is reported at the beginning of the record.***

3.0 Data Collection and Processing

- Description of data collection ***Serial stream captured by laptop on site. Downloaded manually daily.***
- Description of derived parameters and processing techniques used. ***Vaisala data acquisition code, CL-VIEW. (See output description below).***
- Description of quality assurance and control procedures ***Vaisala data flags.***
- Data intercomparisons: ***None***

4.0 Data Format (attached here in the Appendix)

- Data file structure and file naming conventions ***Standard Vaisala CT12K data output format is described in detail at:*** *https://www.inscc.utah.edu/~jyoung/ceilview/about/reading_raw.php* (copied below).
- The **Vaisala CT12K manual** is at: *https://www.google.com/search?client=firefox-b-1-d&q=Vaisala+CT12K+ceilometer+manual*

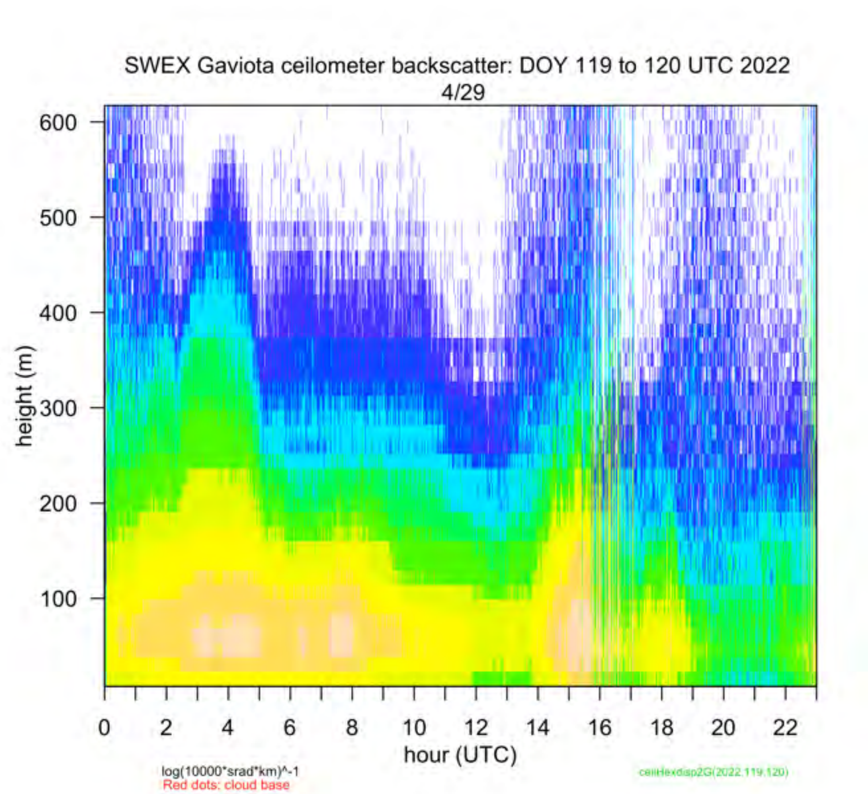
5.0 Data Remarks

- PI's assessment of the data (i.e., disclaimers, instrument problems, quality issues, etc.)

- Data files available: **C2042010.DAT** → Year **2022**; Month **04**; Day **20,** Hour file start: **10** UT.

C2042010.DAT	C2042306.DAT	C2042706.DAT	C2050106.DAT	C2050506.DAT	C2050918.DAT	C2051318.DAT
C2042011.DAT	C2042312.DAT	C2042712.DAT	C2050112.DAT	C2050512.DAT	C2051000.DAT	C2051400.DAT
C2042013.DAT	C2042318.DAT	C2042718.DAT	C2050118.DAT	C2050518.DAT	C2051006.DAT	C2051406.DAT
C2042023.DAT	C2042400.DAT	C2042800.DAT	C2050200.DAT	C2050600.DAT	C2051012.DAT	C2051412.DAT
C2042100.DAT	C2042406.DAT	C2042806.DAT	C2050206.DAT	C2050606.DAT	C2051018.DAT	C2051418.DAT
C2042106.DAT	C2042412.DAT	C2042812.DAT	C2050212.DAT	C2050612.DAT	C2051100.DAT	C2051500.DAT
C2042108.DAT	C2042418.DAT	C2042818.DAT	C2050218.DAT	C2050618.DAT	C2051106.DAT	C2051506.DAT
C2042109.DAT	C2042500.DAT	C2042900.DAT	C2050300.DAT	C2050700.DAT	C2051112.DAT	C2051512.DAT
C2042110.DAT	C2042506.DAT	C2042906.DAT	C2050306.DAT	C2050706.DAT	C2051118.DAT	C2051518.DAT
C2042112.DAT	C2042512.DAT	C2042912.DAT	C2050312.DAT	C2050712.DAT	C2051200.DAT	C2051600.DAT
C2042118.DAT	C2042518.DAT	C2042918.DAT	C2050318.DAT	C2050718.DAT	C2051206.DAT	C2051606.DAT
C2042200.DAT	C2042600.DAT	C2043000.DAT	C2050400.DAT	C2050800.DAT	C2051212.DAT	C2051612.DAT
C2042206.DAT	C2042606.DAT	C2043006.DAT	C2050406.DAT	C2050806.DAT	C2051218.DAT	
C2042212.DAT	C2042612.DAT	C2043012.DAT	C2050412.DAT	C2050812.DAT	C2051300.DAT	
C2042218.DAT	C2042618.DAT	C2043018.DAT	C2050418.DAT	C2050818.DAT	C2051306.DAT	
C2042300.DAT	C2042700.DAT	C2050100.DAT	C2050500.DAT	C2050912.DAT	C2051312.DAT	

- Example backscatter plot: File **Backscatter_4_29_0.png**



Backscatter_4_20_11.png	Backscatter_4_25_0.png	Backscatter_4_29_6.png
Backscatter_4_21_0.png	Backscatter_4_25_18.png	Backscatter_4_30_0.png
Backscatter_4_21_12.png	Backscatter_4_25_6.png	Backscatter_4_30_12.png
Backscatter_4_21_18.png	Backscatter_4_26_0.png	Backscatter_4_30_18.png
Backscatter_4_21_6.png	Backscatter_4_26_12.png	Backscatter_5_10_0.png
Backscatter_4_22_0.png	Backscatter_4_26_18.png	Backscatter_5_10_12.png
Backscatter_4_22_12.png	Backscatter_4_27_0.png	Backscatter_5_10_18.png
Backscatter_4_22_6.png	Backscatter_4_27_12.png	Backscatter_5_10_6.png
Backscatter_4_23_0.png	Backscatter_4_27_18.png	Backscatter_5_1_0.png
Backscatter_4_23_12.png	Backscatter_4_27_6.png	Backscatter_5_11_0.png
Backscatter_4_23_6.png	Backscatter_4_28_0.png	Backscatter_5_11_12.png
Backscatter_4_24_0.png	Backscatter_4_28_18.png	Backscatter_5_1_12.png
Backscatter_4_24_12.png	Backscatter_4_28_6.png	Backscatter_5_11_6.png
Backscatter_4_24_18.png	Backscatter_4_29_0.png	Backscatter_5_1_18.png
Backscatter_4_24_6.png	Backscatter_4_29_18.png	Backscatter_5_1_6.png

6.0 References

Carvalho, L.M., Duine, G.J., Clements, C., De Wekker, S.F., Fernando, H.J., Fitzjarrald, D.R., Fovell, R.G., Jones, C., Wang, Z., White, L. and Bucholtz, A., 2024. The Sundowner Winds Experiment (SWEX) in Santa Barbara, California: Advancing Understanding and Predictability of Downslope Windstorms in Coastal Environments. *Bulletin of the American Meteorological Society*, *105*(3), pp.E532-E558.

Carvalho, L.V., Duine, G.J., Jones, C., De Wekker, S., DeOrla-Barille, M., Fernando, H.J., Clements, C., Fitzjarrald, D.R., Fovell, R.G., Melarkey, K. and Wang, Z., 2022, December. Downslope Windstorms in Coastal Environments and Interactions with the Continental and Marine Boundary Layers: Lessons Learn from the Sundowner Winds Experiment (SWEX-2022), Santa Barbara, CA. In *AGU Fall Meeting Abstracts* (Vol. 2022, pp. A45E-07)

Fitzjarrald, D. R., 2022, New York State Mesonet Forum, May 13, 2022. "*Report from the field on the SWEX campaign near Santa Barbara CA*".

Fitzjarrald, D. R., 2022, Keynote address, XII Brazilian Micrometeorology Workshop, Santarém PA, Brazil, November 16, 2022: "*Sensing downslope winds using infrasound measurements in the SWEX Project, Santa Barbara California, 2022*.

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7.0 Appendix **Vaisala CT12K Ceilometer: Reading Data Messages**

https://www.inscc.utah.edu/~jyoung/ceilview/about/reading_raw.php

Joe Young -- University of Utah Department of Atmospheric Sciences Salt Lake City, Utah

Last Updated 6 February 2012 *This document is not absolute, if you find something to be contrary to what is written here, please let us know (joe.young@utah.edu)*

First, I will begin with an example of a good CT12K backscatter profile/data message:

```
♥
00  ///// ///// ///// ///// 0000000010
2 4 0.01   1  42 130  8.4  1.05 20 01
 0 4 E 6 91220242623221D1B1815141211 F FD
 1 C A 9 8 9 7 7 7 6 5 6 5 3 4 4 4 3 3 3 3
 2 3 3 3 2 2 2 3 2 2 1 3 2 1 1 1 2 2 1 0 1
 3 2 1 1 2 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0
 4 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1
 5 0 0 0 0 1 1 0 0 1 0 0 0 1 0 1 0 0 0 0 0
 6 1 0 1 1 1 1 1 1 1 1 1 1 2 0 1 1 1 1 1 1
 7 1 0 1 1 0 0 1 1 0 0 1 0 1 1 1 1 1 0 0 1
 8 1 0 1 0 1 0 0 0 1 0 1 1 1 0 1 1 1 1 1 0
 9 1 0 1 1 0 0 1 0 1 0 1 1 2 0 0 1 1 0 1 0
10 1 0 1 1 1 0 0 1 0 0 2 0 1 2 1 1 2 1 0 0
11 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1
12 1 0 1 1 1 0 1 0 1 1
♠
```

This is a standard message #2 from the CT12, as received by setting it to automatically report ("PMOD OFF" that part I am hazy on right now). It needs to be translated. If your message does not look like this (and you are sure you have a CT12, then you should consult the manual regarding settings, since this is the only message format which contains backscatter information. However, if you are interested only in cloud reports, then message #3 will provide you with a shorter message which includes the same cloud status line as is included here. With those messages, the cloud status line analysis can be the same.

Characteristics:

The message is about 630 characters long (that is not an exact number!), and contains no time stamp. There are 17 lines, including two non-printing message control characters. These are defined as:

♥ = BOM = \x002 - Unicode character #2 indicates beginning of message transmission

♠ = EOM = \x003 - Unicode character #3 indicates the end of message transmission

The first two lines are cloud and status lines. The next 13 lines are data profile.

Status Lines

All this information is explained in slightly more detail within the Vaisala manual on pages 45-46

```
             00  ///// ///// ///// ///// 0000000010
characters:   12345678901234567890123456789012345678
```

Char. #	Meaning
1:	Number of clouds, or type of clouds reported
2:	1 if there is an alert
3:	Unicode character if 2 == 0
5-9:	Height of first layer OR vertical visibility if 1==3
11-15:	Backscatter range of first layer OR highest received b/s if 1 == 3
17-21:	height of second cloud layer
23-27:	Backscatter range of second cloud layer

The next 10 values are status messages, indicating TRUE or ALERT if value == 1, unless otherwise noted.

Char. #	Meaning
29:	Hardware Alarm
30:	supply voltage alarm
31:	laser power low
32:	temperature alarm (can indicate improperly connected hood)
33:	solar shutter on
34:	blower on
35:	heater on
36:	cloud report unit: 0 == feet, 1 == meters
37:	Normalization: 0 == range and instrument normalized, 1 == extinction normalized (inverted) [I can't explain this one]
38:	Fast Heater Off is active

The second status lines contain operating information, such as the current gain, transmitter temperature, laser status, and more information. Much of this is not useful to the basic user; I have explained all the pieces to the best of my knowledge anyway:

```
            2 4 0.01   1  42 130  8.4  1.05 20 01
characters: 12345678901234567890123456789012345678
```

Char. #	Meaning
1:	GAIN: 0 = gain of **250**, 2 = gain of **930**
3:	laser pulse frequency: 0 = 620Hz to 7 = 1120 Hz - a diagnostic tool, NWS techs tell us 7 is very bad. Ours is highly variable between 2 and 5. If this is equal to the pulse repetition frequency (PRF) then I can see that a super high PRF means the unit is not working right.
5-8:	Noise RMS voltage in ADC unit increments. Seems to be constant, and low, and not particularly useful.
10-12:	Sum of total backscattered power per unit solid angle
14-16:	Algorithm related value
18-20:	Laser power in ADC increments
22-25:	Transmitter temperature in °C
27-31:	Offset of zero signal negative (?)
33-34:	Algorithm related value
36-37:	Representation of 500ft extinction coefficient - used to determine if obscuration is ground based.

All of this was almost copied from the manual, so that is where you should go if you want more explanation of these things. The only advice I can give you is that these values are largely produced for Vaisala's own purposes, so be wary if you think you can use some status information for something more complicated (like the extinction variable)

The Backscatter Data Profile

Ok, so here is a data line, like above I will break it down, but first, it is 13 lines, the first value is the height of the bottom of the row in thousand feet. The data is then 2-digit hexadecimal encoded values.

There are 20 values per row, except the last, which has 10.

Each value is 50 feet apart, meaning 50-foot range gates. (yes, everything with this Finnish instrument is defined with imperial units). 50 feet is approximately 15.2 meters, and, knowing how these instruments are developed, it is certainly possible the measurement length is *actually* 15 m, however they round to 50' because aviation works in imperial units

```
0 4 E 6 91220242623221D1B1815141211  F F D
1 C A 9 8 9 7 7 7 6 5 6 5 3 4 4 4 3 3 3 3
2 3 3 3 2 2 2 3 2 2 1 3 2 1 1 1 2 2 1 0 1
3 2 1 1 2 0 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0
4 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1
```

```
 5 0 0 0 0 1 1 0 0 1 0 0 0 1 0 1 0 0 0 0 0
 6 1 0 1 1 1 1 1 1 1 1 1 1 2 0 1 1 1 1 1 1
 7 1 0 1 1 0 0 1 1 0 0 1 0 1 1 1 1 1 0 0 1
 8 1 0 1 0 1 0 0 0 1 0 1 1 1 0 1 1 1 1 1 0
 9 1 0 1 1 0 0 1 0 1 0 1 1 2 0 0 1 1 0 1 0
10 1 0 1 1 1 0 0 1 0 0 2 0 1 2 1 1 2 1 0 0
11 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1
12 1 0 1 1 1 0 1 0 1 1
```

An example data line, using the same character numbering as before:

```
 0 4 E 6 91220242623221D1B1815141211 F FD
 12345678901234567890123456789012345678901 2
```

1-2: height index - defines the 'starting' height for the row *1000 ft (*Questionable, since the format can assure the height, so this information never changes.*)
3-4: first range gate, whose height is 1-2's value * 1000
5-6: the pattern continues, every 2 characters is a new data value, 1000ft per row

Note: there appears to be a ~75 meter (first 5 gates) 'dead zone' where this unit does not seem to get proper returns. I suspect this is due to the focusing length/distance until the beams converge from the unit. Whatever the reason, you will probably see it quickly when you start plotting. There are also other issues we have, and we are curious to see if you have the same, contact me (joe.young@utah.edu) if you see something odd.

So, now you have the data bits all separated out, so what do you do with them, well, this is when it all gets a bit hairy. Your hex value == DD

The values are in Hex, so translate them to whatever numeric format your favorite language works best in, (usually integer). Ie '1F' = 1×16 + 15 = 31. Data can range from: '00' = 0, to 'FF' = 15×16 + 15 = 255. Spaces should be interpreted as 0.

So says the manual:

```
DD = 50 × ln(RAWDATA − MINV) + 1
```

We accept this equation as accurate (we had to pick one) so:

```
(RAWDATA−MINV) = exp([DD−1]/50) = S + noise
```

You will notice, this is different from the version in the manual. We have made the bet that they just messed up their algebra in this step, but have been correct up to this time.

As well, the term noise is used, as:

```
S = RAWDATA−MINV − Noise
```

Well, that is theoretical, you cannot just remove noise, so they tell you it is there, so you know that it is influencing your measurements. You receive noise, to remove it, you need to make a lot of potentially risky assumptions. We have noticed that the diurnal noise cycle is very strong, solar noise is quite noticeable

As for a unit for S, the 'name' would indicate it is a form of backscatter. BUT, we honestly have no verification of that, AND the values of this (around .01 - 100) really do not see how this is related to backscatter, which is normally in the 10^{-3} to 10^{-6} range for ceilometer-type lidars. So, we have left this value as an unknown type S.

Thus, we take the other equation in the manual, which derives what they call 'power' (we are still suspicious) with units of ***μ*W**

So, as it is shown in the manual

```
Power = (S * 0.188) / GAIN
```

Where gain is the value derived in the first key on status line 2. The gain varies by some logic completely controlled by the ceilometer

```
Power = S * 0.188 / 930 (GAIN == 2) OR S * 0.188 / 250 (GAIN ==0)
```

This gives us reasonable values, like 10^{-4} to 10^{-3} W. For this reason, this is the data we are plotting/using.

Here is wolfram Alpha's graph of the expected power outputs in watts for the data value from 0 to 255. Low gain is on the left and high gain on the right. It is important to notice that the powers are different for each power return. This is expected since the divisor term is so vastly different for high and low gains. However, it is observed that DD values do not remotely offset these differences, therefore, when plotting power, the scales will have to be normalized to allow them to actually be plotted.

This is also a concern for any time averaging you want to do

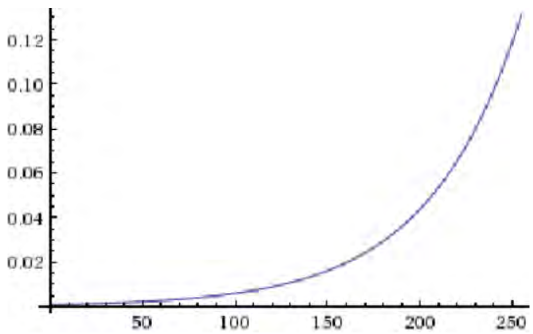

Fig 1. Power values per DD value for low gain.

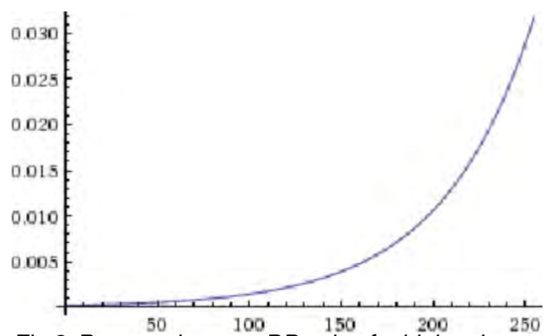

Fig 2. Power values per DD value for high gain.

Using the lidar equation, you can back out backscatter information (ie backscatter coefficient Beta) (which I am working on) however; the lidar equation relies on some calibration information, like antenna area, efficiency and pulse energy, (Emeis, 2011) which are not immediately obvious (though that information is hidden within the status lines – emphasis on hidden). This is often referred to the calibration information, and there have actually been a few studies into the determination of the calibration information, as it applies to the derivation of backscatter information. It is a difficult task, to generally summarize.

So, that is most of what I can tell you on that topic.

Reference:

Emeis, Stephan, 2011: Surface Based Remote Sensing of the Atmospheric Boundary Layer. Springer. Ed Mysak and Hamilton.

And the Vaisala CT12 User's Manual

TECHNICAL MANUAL

OPERATION AND MAINTENANCE INSTRUCTIONS

LASER CEILOMETER CT12K

VAISALA
100 COMMERCE WAY
WOBURN, MA 01801

PART NO. 66-2292

The contents of instruction manuals are subject to change without a prior notice.

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions, or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. VAISALA assumes no liability for the customer's failure to comply with these requirements:

NEVER LOOK INTO LASER TRANSMITTER WITH MAGNIFYING OPTICS: The instrument is intended for operation in an area restricted from public access, and pointing vertically up. Whenever this is not the case, care must be observed so as to prevent exposure to the laser beam through focusing optics. Work area access by unauthorized persons during service operations must be prevented.

GROUND 'THE INSTRUMENT: To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor AC power connector. The power cable must either be plugged into an approved tlhree-contact electrical outlet or the instrument must be carefully earthed to a low-resistance safety ground.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE: Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS: Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE: Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT: Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a VAISALA office or authorized Depot for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS: Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed:

WARNING! Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

AMENDMENTS TO
CEILOMETER CT-12K TECHNICAL MANUAL (REVISION E - SEPT. 1989)

AMENDMENT NUMBER	NEW REVISION	AMENDMENT DESCRIPTION OR PARAGRAPHS AFFECTED	NEW SOFTWARE	DATE EFFECTIVE

Please note that the following pages without text or diagrams were intentionally left blank:

ii, x, 2, 12, 13, 14, 16, 28, 29, 30, 34, 91, 92, 116, 118, 212, 222, 224, 256, 257, 258, 260, 263, 264, 266, 302, 303, 304

TECHNICAL MANUAL
LASER CEILOMETER CT12K

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CHAPTER 1. GENERAL INFORMATION

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1.1 SAFETY AND HANDLING

1.1.1 SAFETY PRECAUTIONS

1.1.1.1 Laser Safety

The CT-12K laser ceilometer is classified as a Class 1 laser device when used within its normal operational conditions. This means that a CT-12K Laser Ceilometer installed in a field environment with instrument covers on poses no established biological hazard to humans. However, the following precautions are to be noted and followed during service and maintenance of the instrument:

- The CT-12K uses invisible laser radiation which may harm human eyes.
- Never look directly into the transmitter with magnifying glasses, binoculars, telescopes, etc.
- When operating, avoid looking at the unit from the beam direction.
- Only trained personnel should perform maintenance functions.
- Follow all ***WARNING!***-labels.

WARNING!-label used with CT-12K:

DANGER- INVISIBLE LASER RADIATION WHEN OPEN. AVOID DIRECT EXPOSURE TO BEAM.	NON-INTERLOCKED PROTECTIVE HOUSING WARNING LABEL.

1.1.1.2 High Voltage

High voltage will be readily accessible when the transmitter (A7) or receiver (A6) covers are removed and the unit is powered. High voltage is present in the High Voltage Power Supply (PS1) and Window Conditioner (Bl).

WARNING!-labels used with CT-12K:

DANGER- HIGH VOLTAGE INSIDE THIS COVER	RECEIVER (A6) AND TRANSMITTER (A7) COVER WARNING LABELS
DANGER- HIGH VOLTAGE INSIDE THIS ENCLOSURE	HIGH VOLTAGE POWER SUPPLY (PSl) WARNING LABELS

1.1.2 HANDLING

1.1.2.1 Handling of the Optics Assembly

The VAISALA cloud ceilometer CT-12K uses laser radiation, produced by a GaAs semiconductor diode, for detecting cloud levels.

The laser radiation is accurately collimated by internal optics and provides a beam of 904 nm invisible laser light. During the factory alignment procedure, the optical adjustments are carefully carried out to fulfil1 the requirements and specifications of the device. Optical adjustments occur at factory or depot only. There is no need to readjust any of these settings at the field site before installation. If mishandling occurs during transit or installation, the instrument should be returned to a VAISALA office or authorized Depot for inspection.

Do not touch the lens surfaces. Maintain dust covers on the lenses during adjustments and during long periods of storage.

The optics and windows should always be kept clean of any dirt or particles, especially during operation.

1.1.2.2 Lifting and Carrying

Do not attempt to carry the unit alone. Do not lift the unit from Window Conditioner or Equipment Cover; lift from Equipment Base only. Use proper gloves for protection against sharp edges, etc. Disconnect Window Conditioner Cable from Equipment Base before placing unit on flat, hard surface. Remove cable from underneath Equipment Base edge.

1.1.2.3 Exposed Connectors

Maintain dust caps on all external connectors if stored unpacked for extended times in an unconditioned area. When installed, always maintain the integral protective caps on the unused interface connector (J3 or J4) and the Maintenance Terminal CTH12 connector.

1.2 SPECIFICATIONS

1.2.1 MECHANICAL

Height: Total . . . . . 52.8 in. (1340 mm)
Excluding Pedestal . . 29.1 in. (740 mm)
Width . . . . 22.8 in. (580 mm)
Depth . . . . 16.5 in. (420 mm)
Weight: Total . . . 156 Lbs. (71 kg)
Excluding
Pedestal 135 Lbs. (61 kg)

1.2.2 POWER

115 V ± 10% 45 Hz to 65 Hz 800 W (7 A) max.
220 / 240 V (optional)
Power connector (Jl): MIL-C-26482 type MS 3110E12-3P (male)

Mating connector type: MS 3116F12-3S or equivalent

1.2.3 OUTPUT INTERFACES

1.2.3.1 Output Interface Connector (J3)

MIL-C-26482 type MS 3112E12-8P (male)

Mating connector type: MS 3116F12-8S or equivalent

Circuit A-B: FSK Interface
Circuit C-D: Recorder Trigger Break
Circuit E-F: Recorder Inscription (Cloud) Signal
Circuit G: Equipment Ground

All signal circuits are non-polar, symmetrical; electrically floating to overvoltage protection rating (300V-500V).

Overvoltage Protection in each circuit:

Primary. . . . ..Noble Gas Surge Arrester
Secondary....Wirewound Resistors and Transient Zeners or Diodes

1.2.3.1.1 Bell 103 FSK Interface

Bell 103 standard Frequency Shift Keyed (FSK)
Full Duplex Modem Interface for
Serial Asynchronous Data Interchange

Baud Rate: 300

Answer Mode Standard Frequencies: Mark (1) 2225 Hz
Space (0) 2025 Hz
Originate Mode Optional

Signal Level: (Jumper-Selectable)	-6 dBm (0.3 V) into 600 Ohm standard 0, -3, -6, -9, -21 dBm optional
Distance to Operate:	0...10 miles (0...16 km) with AWG 22 (0.35 mm2), unshielded twisted pair
Standard Character Frame:	1 start bit 8 data bits No Parity 1 stop bit
Standard Character Code:	USASCII 8th (unused) data bit MARK (1)

1.2.3.1.2 Gifft RBC Recorder Interface

Trigger Break Relay Contact; N/C

Ratings: 150 VDC max
2 A max

107 cycles at 24 VDC, 1A Resistive

Break Duration: 80 ms normally
200 ms for Fault Indication

Inscription (Cloud) Signal:

Transformer Coupled, 600 ohms standard
Signal level ON: +2 dBm standard
Jumper selectable: -2, 0, +2, +5 dBm

Frequency: 2 x Line Frequency
(normally 2 x 60 Hz = 120 Hz)

Signals Interrelationship:

End of Trigger Break starts timing of delay to Cloud Signal;
3 seconds (= max) delay equals 12,000 ft;
linear delay-to-height relationship,

Distance to Operate::

0...10 miles (16 km) with AWG 22 (0.35 mm^2)
unshielded twisted pair terminated by recorder
Field Junction Box

1.2.3.2 Output Interface for Local Equipment (J4)

RS-232C standard serial asynchronous full duplex input/output interface, internally parallelled with FSK interface.

Used also with Ceilometer Maintenance Terminal.

Ceilometer configured as Data Terminal Equipment (DTE).

Baud Rate: 300 Baud standard and default
1200 Baud available on command

Note! FSK interface operates at 300 Baud only

Distance to Operate: 1000 ft (300 m) at 300 Baud
300 ft (100 m) at 1200 Baud
(typical values with standard
communication cables)

Overvoltage Protection: Series resistors and Transient Zeners

Connector (54): MILC-26482 type MS3110E12-8S (female)
Mating connector: MS 3116F12-8P or equivalent

Circuits: B TXD Transmitted Data (from Ceilometer)
C RXD Received Data (from external equipment)
F Signal Ground
A Equipment Ground
H + 12 V DC supply (for Maintenance Terminal CTH 12)
G Flag (from Maintenance Terminal CTH 12)

1.2.4 LASER TRANSMITTER

Laser Source:	Gallium Arsenide (GaAs) Semiconductor Diode
Wavelength:	904 nm nominal
Operating Mode:	Pulsed
Initial Transmitted Pulse Energy:	6.6 µWs ± 5% (factory adjustment)
Peak Pulse Power:	40 W typical
Pulse Width, 50%:	135 ns typical
Repetition Rate:	620 Hz-1120 Hz, processor controlled for constant average power
Average Power:	5 mW
Max b-radiance:	50 µW/cm² measured with Dia. 7 mm aperture
Laser Classification:	Class 1 in compliance with FDA CFR 1040.10 (Subsection e,3)
Laser Source Dimensions:	50 mil square (1.3 mm x 1.3 mm)
Transmitter Optics System Focal Length:	14.45 inches (367 mm)
Transmitter Effective Lens Diameter:	4.65 inches (118 mm)
Transmitter Beam Divergence:	±2.5 mrad maximum
Lens Transmittance:	90% typical
Window Transmittance:	97% typical, clean

1.2.5 RECEIVER

Detector:	Silicon Avalanche Photodiode Responsivity at 904 nm:40 A/W (factory adjustment)
Surface Diameter:	0.0314 inches (0.8 mm)
Interference Filter:	904 nm
50% Pass Band:	880-940 nm typical
Transmissivity at 904 nm:	85% typical 60% minimum
Focal Length:	5.91 inches (150 mm)
Receiver Lens Effective Diameter:	4.65 inches (118 mm)
Field-of-View Divergence:	±2.7 mrad
Lens Transmittance:	90% typical
Window Transmittance:	97% typical, clean

1.2.6 OPTICAL SYSTEM

Lens Distance Transmitter-Receiver: Laser Beam Entering Receiver	12.20 inches (310 mm)
Field-of-View:	l00 feet (30 m)
Laser Beam 90% Within Receiver Field-of-View:	1000 feet (300 m)

1.2.7 PERFORMANCE

Measurement Range:	0 - 12,650 feet
Resolution:	50 feet
12,000 ft Acquisition Time:	30 s maximum
System Bandwidth:	10 MHz at Low Gain (-3db) 3 MHz at High Gain (-3db)
Tolerance to Precipitation:	to 0.3 inches per hour (7.5 mm per hour) range limited

1.2.8 ENVIRONMENTAL CONDITIONS

Ambient Temperature:	-60°F... +120°F (-51°C... + 49°C)
Humidity:	100% RH
Salt Spray:	MIL-STD-810C Method 509.1
Wind:	100 kt (50 m/s)
Shock:	4-inch drop (10 cm)

1.3 RBC ANGLE / HEIGHT TABLE

The table below converts the RBC angle in degrees on the Gifft RBC Recorder to a cloud height determined by the VAISALA CT-12K. The scale is linear, 1 degree equals 133.3 feet, with 0 to 90 degrees representing 0 to 12,000 feet.

GIFFT RBC RECORDER/CEILOMETER VAISALA CT-12K

ANGLE (degrees)	HEIGHT (feet)	ANGLE (degrees)	HEIGHT (feet)	ANGLE (degrees)	HEIGHT (feet)
0	0				
1	130	31	4130	61	8130
2	270	32	4270	62	8270
3	400	33	4400	63	8400
4	530	34	4530	64	8530
5	670	35	4670	65	8670
6	800	36	4800	66	8800
7	930	37	4930	67	8930
8	1070	38	5070	68	9070
9	1200	39	5200	69	9200
10	1330	40	5330	70	9330
11	1470	41	5470	71	9470
12	1600	42	5600	72	9600
13	1730	43	5730	73	9730
14	1870	44	5870	74	9870
15	2000	45	6000	75	10000
16	2130	46	6130	76	10130
17	2270	47	6270	77	10270
18	2400	48	6400	78	10400
19	2530	29	6530	79	10530
20	2670	50	6670	80	10670
21	2800	51	6800	81	10800
22	2930	52	6930	82	10930
23	3070	53	7070	83	11070
24	3200	54	7200	84	11200
25	3330	55	7330	85	11330
26	3470	56	7470	86	11470
27	3600	57	7600	87	11600
28	3730	58	7730	88	11730
29	3870	59	7870	89	11870
30	4000	60	8000	90	12000

CHAPTER 2. INSTALLATION

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2.1 GENERAL

2.1.1 PREFACE

The installation of laser cloud ceilometer CT 12K requires a concrete foundation and a set of cables to establish the operation.

Some basic information is needed to guarantee the proper start-up of the instrument. It is important to carefully follow the installation instructions.

2.1.2 TRANSPORTATION CONTAINERS

The CT 12K is shipped in two containers, the larger one containing the Ceilometer without Pedestal, and the smaller one containing Pedestal, Maintenance Terminal CTH 12, Field Site Spares Kit, and installation accessories.

The main container is provided with unpacking and re-packing instructions which are to be observed.

Containers are suggested to be saved for eventual later transport use. Repacking instructions must be carefully observed in that case since the heavy Main Equipment Assembly may otherwise be damaged during transport.

2.1.3 ORIENTATION

The receiver side of CT 12K should preferrably be oriented away from sun (e.g., in the northern hemisphere towards the north and towards the south in the southern hemisphere). This will reduce noise of sunlight.

2.1.4 REQUIREMENTS

For mechanical installation requirements, refer to Installation Drawing U.CT 3282.

For electrical connections, refer to Connection Diagram C.CT 3105.

Suggested Cable Dimensions

Line AC Supply Cable:	Standard 3-pronged power cord 3 x min 0.75 mm^2 (AWG 18)
RS-232C Interface: (subset of Maintenance Terminal Interface)	22 Gage Stranded conductors twisted pair with foil shield and drain wire.

Output Interface Cable (Twisted Pairs Preferred)	22 Gage stranded conductors 3 twisted pairs with foil shield and drain wire. Minimum working voltage 200 volts.
Window Conditioner Cable: (Part of Window Conditioner, supplied)	6 x min 0.75 mm^2 (AWG 18)
Maintenance Terminal Cable: (Part of Maintenance Terminal, supplied)	8 x 0.75 mm^2 (AWG 18)

2.2 SITE PREPARATION

2.2.1 FOUNDATION

The suggested minimum dimensions for the foundation are found in Installation Drawing U.CT 3282.

Mounting hardware is included with the Pedestal.

If a new foundation is laid, the Wedge Bolts and Foundation Screws (4 each), are suggested to be cast into the concrete so that 1 to 2 inches (25 to 50 mm) of the threads stand above the surface.

If an existing foundation is used, four holes of Diameter 0.5 inches x 6.5 inches (12 mm x 165 mm) are drilled into the concrete. The Wedge Bolt and Foundation Screw combinations are placed in the holes, with Wedge Bolts down; the protruding threads are alternately hammered and tightened a few times so that the Wedge Bolts attach to the hole walls.

2.2.2 CABLING

All the cable connectors are located under the equipment base and are referred to as Jl, J2, J3, and J4.

The location of the connectors are found in Bottom View Drawing ACT 3406.

The connector signals and connector types are found in the Connection Diagram C.CT 3105.

Mating connectors for Jl (Power) and J3 (Output Interface) are supplied with the Ceilometer.

2.2.3 GROUNDING

The power supply connector Jl provides a standard protective ground for the instrument chassis.
Connection of an external earthing shall be made to the ground terminal of the equipment base (reference: A.CT 3406 for location).
CONNECTION TO A SOLID EARTH GROUND AT THE INSTALLATION SITE IS MANDATORY FOR ADEQUATE LIGHTNING AND TRANSIENT PROTECTION.

2.3 START OF OPERATION

2.3.1 LINE POWER "ON"

Before plugging in any connectors, check the field cables referred to in the Connection Diagram C.CT 3105.

Remove the unit covers of CT 12K and make a visual check of the internal connectors, subassemblies, etc.

Turn the main circuit breaker CBl to "OFF" position.

Plug in the line supply cable to connector Jl after checking the voltage and signals of the power supply cable connector.

The line voltage indicator DSl in PSl should be lit indicating the line voltage at the main circuit breaker CBl.

When turning the main circuit breaker CBl to the "ON" position, the following shall happen with the monitoring LEDs D4 and D5 on the processor board, Al:

D4 (red) "ON" for approximately 5 seconds (internal reset performed).

D5 (green) After D4 has turned "OFF", this will start blinking at a rate of once per second (software operates normally)

If LEDs D4 and D5 operate differently, the unit needs service or maintenance. Refer to Chapter 6, 'Troubleshooting".

2.3.2 INTERFACES

The CT 12K provides three (3) different interfaces for remote devices:

- RS-232C Maintenance Terminal Interface
- Bell 103 Modem Interface
- Gifft RBC Recorder Interface

Depending on the distance between the Ceilometer and the observer site, the data communication can be arranged either with the RS-232C level direct connection (up to 1000 feet) or with the Bell 103 modem connection (for distances exceeding 1000 feet).

The RS-232C (Maintenance Terminal) connection signals are available at CT 12K equipment base connector J4.

The Gifft RBC Recorder interface consists of two (2) signal pairs:

- Recorder sweep synchronization (trigger break)
- Cloud Data signal

The modem signals and Gifft RBC Recorder signals are available through connector J3. Reference Connection Diagram C.CT 3105.

The CTI 12 Interface Board (Reference A3) provides five LEDs for monitoring the communication:

- D10 (yellow) TXD (Transmitted Data) Indicates a presence of data being transmitted from the processor board Al, either via the modem circuitry or via the RS-232C
- Dll (yellow) RXD (Received Data) Data received via the modem line
- Dl2 (green) CD (Carrier Detect) Indicates the presence of a carrier in the receive channel of the modem communication
- D13 (yellow) RBCT (RBC-recorder Trigger Break) Gifft RBC Recorder pen sweep start and synchronization signal
- D14 (yellow) RBCE (RBC-recorder Enable Cloud Signal) Gifft RBC Recorder cloud data signal

These LEDs provide an easy means to check and monitor the operation of the communication.

After "POWER UP", the following sequence is performed automatically 'by the CT 12K software:

- Data transmission starts with the data memory and modem test messages, and "TXD" will blink according to the character stream.

- The modem circuitry and communication lines, if used, are tested and the communication is established. "CD" will be turned on for 2 - 3 seconds while the testing is performed, then remains "OFF" except when an active counter-modem with carrier "ON" is connected to J3.

- Modem test, program memory tests and internal status messages are transmitted and "TXD" will indicate the presence of transmission.

In the normal operation mode (Automatic mode) the cloud data collection and the calculations take maximum of 30 seconds to provide the first message table. When the message is sent, "TXD" will indicate the character stream of transmission for serial communications (RS-232C or Modem).

The Gifft RBC Recorder output LEDs D13, and D14 shall start operating according to the interface specifications in 12 seconds.

However, the automatic measurements of the Ceilometer may be terminated for maintenance purposes by using the AUTO OFF command. Refer to Chapter 3, "Operation." In the maintenance mode, most of the functions can be individually activated and, therefore, easily tested.

After monitoring the operation with the LEDs on Al and A3, the cables can be connected to the connectors J3 and J4.

The operation should continue as described earlier. If not, then the cables, operators' terminals, etc., should be checked and possible mistakes corrected.

2.3.3 MAINTENANCE TERMINAL CTH 12

While operating at the installation site, the Maintenance Terminal CTH 12 provides an easy way to monitor and control the operation of the Ceilometer. Refer to Chapter 3.

The Maintenance Terminal is connected to connector J4 of the equipment base.

2.4 PERFORMANCE VERIFICATION

2.4.1 MESSAGE ALARMS

Check that the Start-Up Message (Reference Paragraph 3.4.3) does not contain any messages of alarm, error or suspicion, and that none of the numerical values output in the message has an asterisk ("*") immediately after it.

After Start-Up, observe operation for a suitable time. Check that no alarms are generated.

If cause for suspicion exists, turn to Chapter 6.

2.4.2 OPERATIONAL CHECK WITH TOTAL COMMAND

The CT 12K Ceilometers are factory adjusted and aligned for optimum performance.

After installation, the operation can be checked with a constant and solid cloud base within the height range of 1000 - 5000 ft with no fog, haze or precipitation. The TOTAL command of the CT 12K software is used for this purpose.

To use the TOTAL command, proceed as follows:

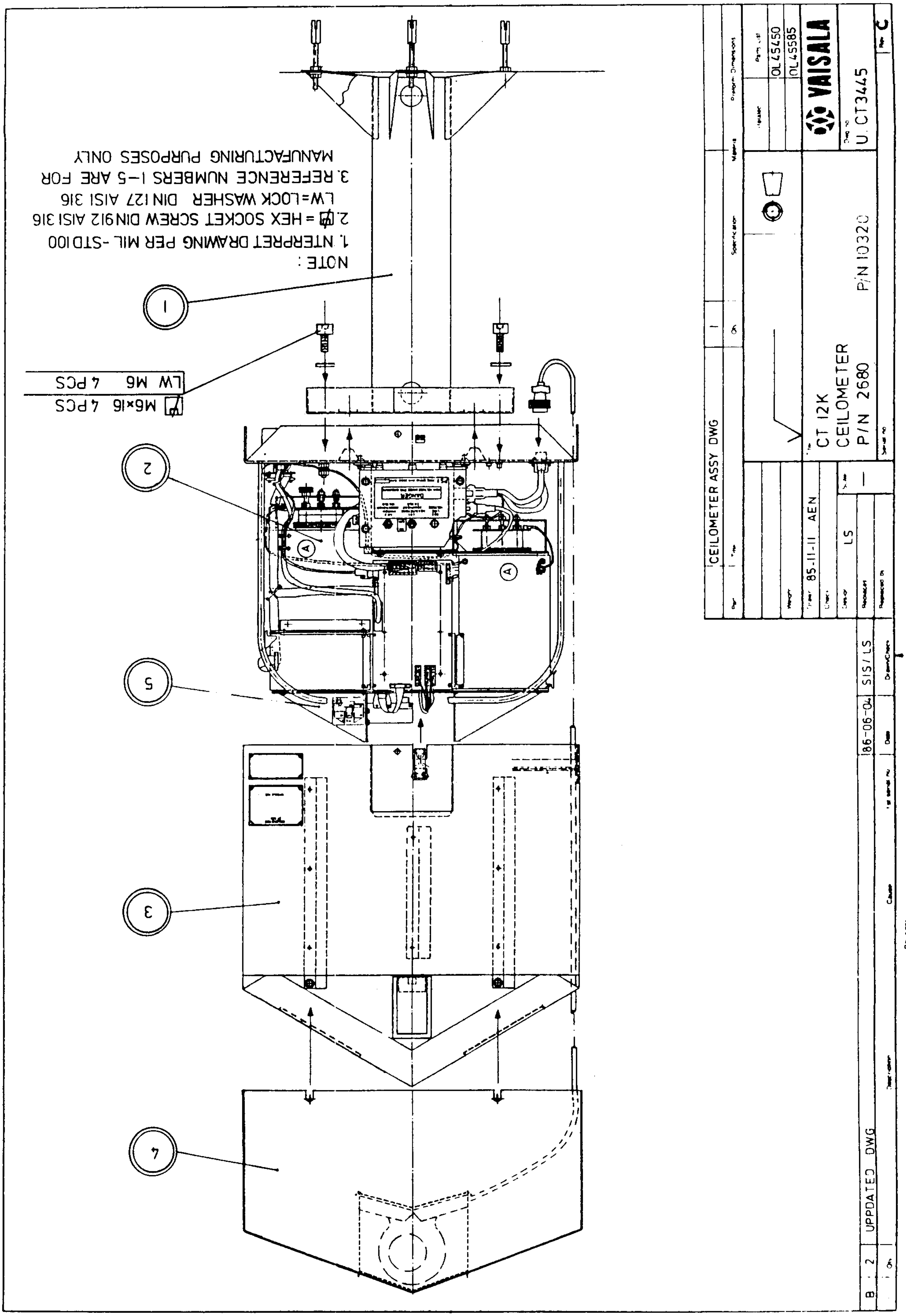
- Open the communication line giving a “CR” symbol (CR = Carriage Return from the Operator’s Terminal)

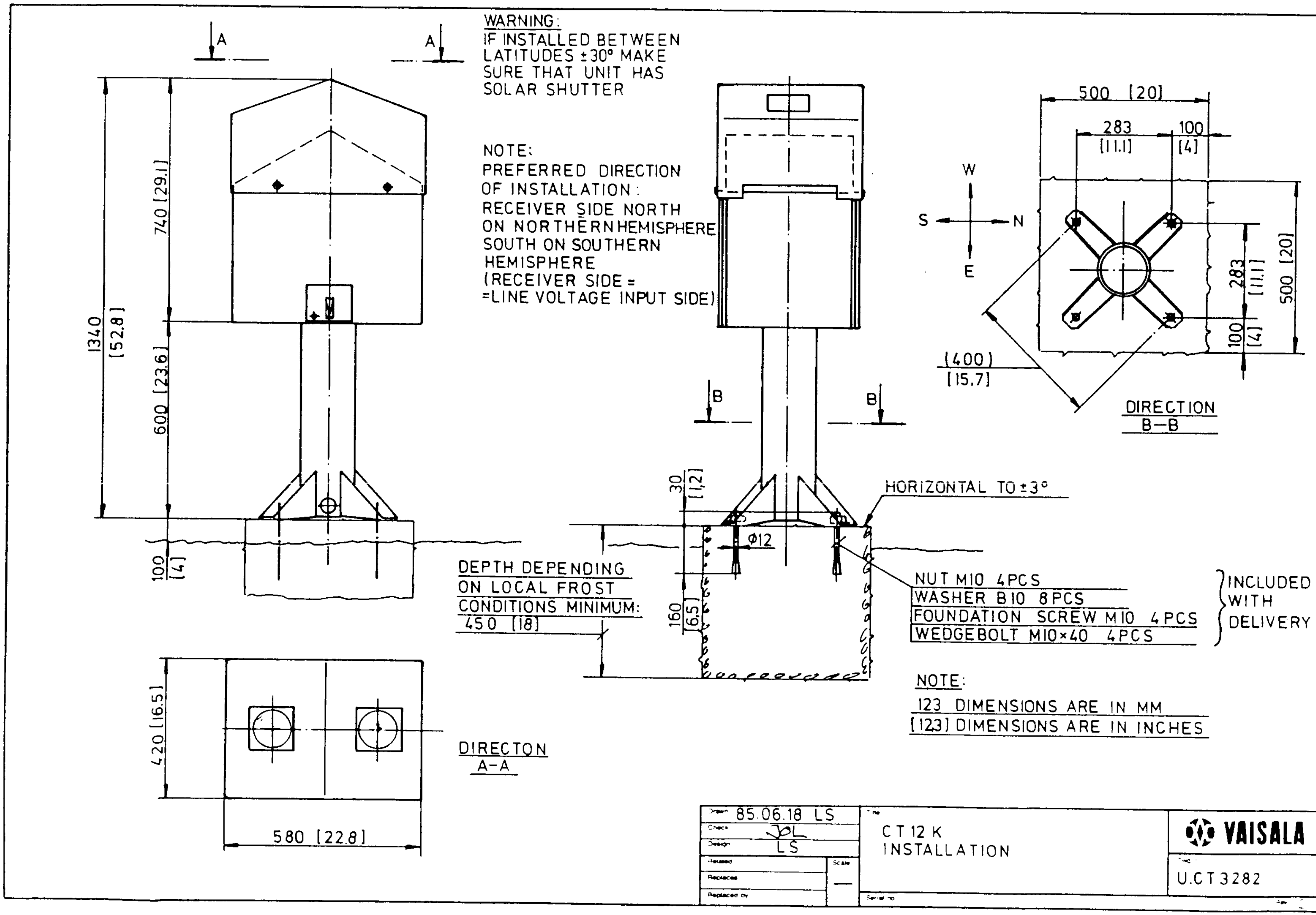
- Give “TOTAL” command and “CR”

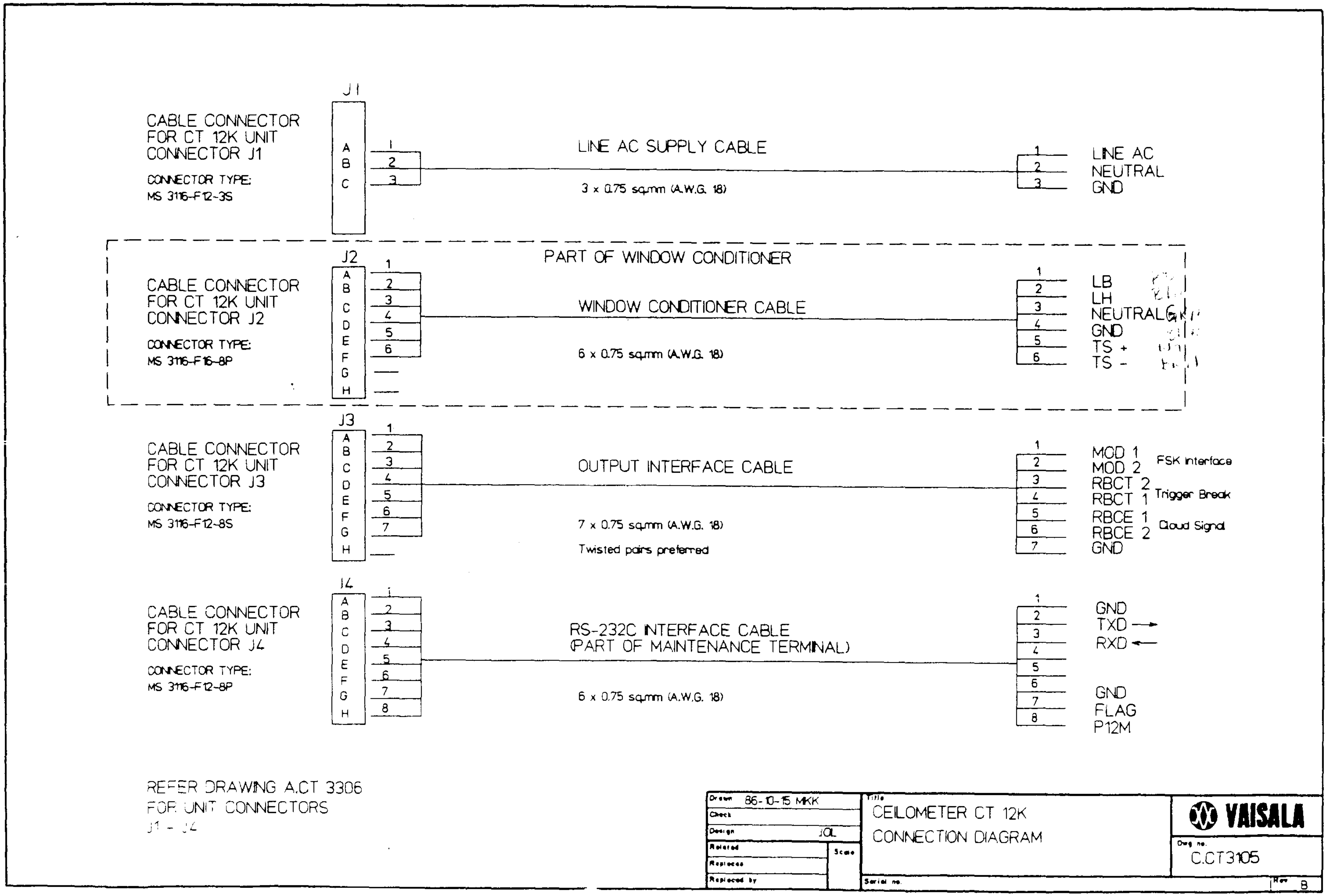
The CT 12K software responds to this by giving the parameter value (TOTAL SIGNAL LIMIT) and the measured total value (CURRENT SIGNAL SUM).

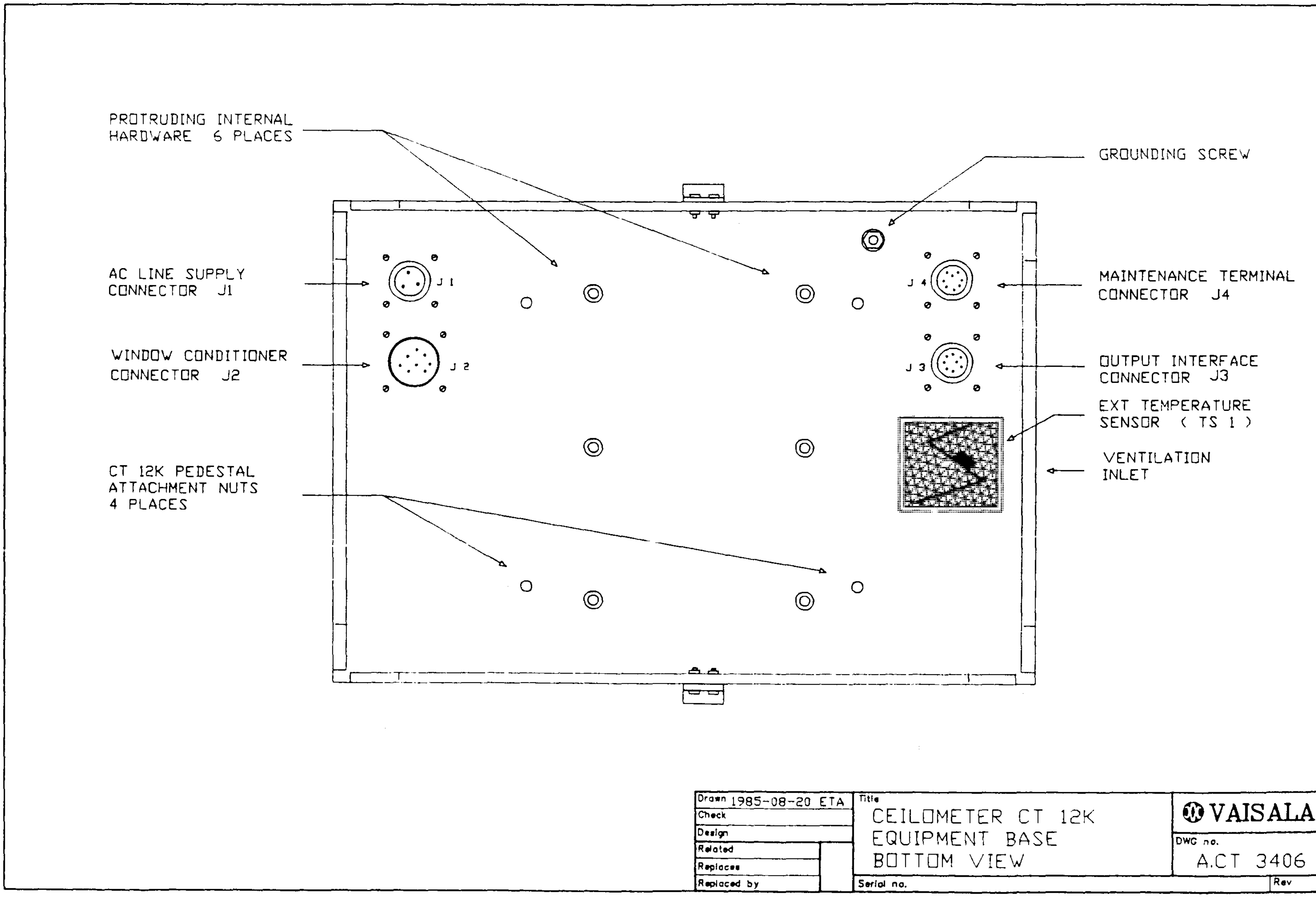
The “SUM” values reported in above conditions should be in range 20...40. If out of limits, then turn to Chapter 6.

For exact command syntaxes and additional information, see Section 3.4.


NOTE :
1. NTERPRET DRAWING PER MIL -STD100
2. = HEX SOCKET SCREW DIN912 AISI 316
LW=LOCK WASHER DIN127 AISI 316
3. REFERENCE NUMBERS 1-5 ARE FOR
MANUFACTURING PURPOSES ONLY
M6x16 4PCS
LW M6 4PCS
1
2
3
4
5
A
A
CEILOMETER ASSY DWG
1
0L45450
0L45585
VAISALA
85-11-11 AEN
LS
CT 12K
CEILOMETER
P/N 2680
P/N 10320
U. CT3445
C
B 2 UPPDATED DWG
86-06-04 SIS/LS


WARNING:
IF INSTALLED BETWEEN LATITUDES ±30° MAKE SURE THAT UNIT HAS SOLAR SHUTTER
NOTE:
PREFERRED DIRECTION OF INSTALLATION:
RECEIVER SIDE NORTH ON NORTHERN HEMISPHERE SOUTH ON SOUTHERN HEMISPHERE
(RECEIVER SIDE = =LINE VOLTAGE INPUT SIDE)
A
A
B
B
1340 [52.8]
740 [29.1]
600 [23.6]
100 [4]
500 [20]
283 [11.1]
100 [4]
W
S
N
E
(400) [15.7]
DIRECTION B–B
30 [1.2]
HORIZONTAL TO ±3°
Φ12
160 [6.5]
DEPTH DEPENDING ON LOCAL FROST CONDITIONS MINIMUM: 450 [18]
NUT M10 4PCS
WASHER B10 8PCS
FOUNDATION SCREW M10 4PCS
WEDGEBOLT M10×40 4PCS
INCLUDED WITH DELIVERY
NOTE:
123 DIMENSIONS ARE IN MM
[123] DIMENSIONS ARE IN INCHES
420 [16.5]
580 [22.8]
DIRECTON A–A
85.06.18 LS
LS
CT 12 K INSTALLATION
VAISALA
U.CT 3282


J1
CABLE CONNECTOR FOR CT 12K UNIT CONNECTOR J1
CONNECTOR TYPE: MS 3116-F12-3S
LINE AC SUPPLY CABLE
3 x 0.75 sq.mm (A.W.G. 18)
LINE AC
NEUTRAL
GND
PART OF WINDOW CONDITIONER
J2
CABLE CONNECTOR FOR CT 12K UNIT CONNECTOR J2
CONNECTOR TYPE: MS 3116-F16-8P
WINDOW CONDITIONER CABLE
6 x 0.75 sq.mm (A.W.G. 18)
LB
LH
NEUTRAL
GND
TS +
TS -
J3
CABLE CONNECTOR FOR CT 12K UNIT CONNECTOR J3
CONNECTOR TYPE: MS 3116-F12-8S
OUTPUT INTERFACE CABLE
7 x 0.75 sq.mm (A.W.G. 18)
Twisted pairs preferred
MOD 1
MOD 2
RBCT 2
RBCT 1
RBCE 1
RBCE 2
GND
FSK interface
Trigger Break
Cloud Signal
J4
CABLE CONNECTOR FOR CT 12K UNIT CONNECTOR J4
CONNECTOR TYPE: MS 3116-F12-8P
RS-232C INTERFACE CABLE (PART OF MAINTENANCE TERMINAL)
6 x 0.75 sq.mm (A.W.G. 18)
GND
TXD
RXD
GND
FLAG
P12M
REFER DRAWING A.CT 3306 FOR UNIT CONNECTORS J1 - J4
Drawn 86-10-15 MKK
Check
Design JOL
Related
Replaces
Replaced by
Scale
Title
CEILOMETER CT 12K CONNECTION DIAGRAM
VAISALA
Dwg no. C.CT3105
Serial no.
Rev B


PROTRUDING INTERNAL HARDWARE 6 PLACES
GROUNDING SCREW
AC LINE SUPPLY CONNECTOR J1
MAINTENANCE TERMINAL CONNECTOR J4
WINDOW CONDITIONER CONNECTOR J2
OUTPUT INTERFACE CONNECTOR J3
EXT TEMPERATURE SENSOR (TS 1)
VENTILATION INLET
CT 12K PEDESTAL ATTACHMENT NUTS 4 PLACES
J 1
J 2
J 3
J 4
Drawn 1985-08-20 ETA
Check
Design
Related
Replaces
Replaced by
Title
CEILOMETER CT 12K
EQUIPMENT BASE
BOTTOM VIEW
VAISALA
DWG no.
A.CT 3406
Serial no.
Rev

CHAPTER 3. OPERATION

TABLE OF CONTENTS

3.5 OPERATION WITH MAINTENANCE TERMINAL CTH 12

3.1 GENERAL

3.1.1 INTRODUCTION: NORMAL OPERATION

The normal operation of Ceilometer CT 12K is fully automatic and no intervention is needed.

A digital data message is sent at predetermined intervals, without any polling action, over both the FSK Interface and the RS-232C Interface. Framing, content and timing are identical. See paragraph 3.2 for use and interpretation of Digital Messages.

The Gifft RBC Recorder signals are operated at 12 second intervals. See paragraph 3.2.3 for use and interpretation of these.

The requirements for obtaining normal operation are, along with the corresponding paragraphs of description in brackets:

Power On and all switches in correct positions (3.1.2, 3.1.3)
Automatic Mode of Operation (3.1.5)
Line Closed (3.1.4)
Correct parameters inserted (3.3)
No alarms detected (3.4)

3.1.2 SWITCHES

The following are the switches of Ceilometer CT 12K, along with Reference Designation and normal operation position:

Ref.	Description	Position
PSl CBl	Power On/Off (doubles as Circuit Protecting Breaker)	on (up)
PSl CB2	Window Conditioner On/Off (doubles as Circuit Protecting Breaker)	on (up)
Al Sl	Reset/Normal /(spare)	Normal (middle)
A2 Sl	Internal Heating On(= automatic)/Off	On (right)
A2 S2	Interface Control Normal/Line	Normal (left)

3.1.3 INDICATORS

The following is a summary of all Ceilometer CT 12K indicators, with reference designations and indications in normal operation:

Ref.	Color	Description	Normal Operation
PS1 DS1	Red	Line Power	Always ON
A1 D4	Red	Processor Self-check Alarm	Always OFF
A1 D5	Green	Processor OK	Blinking once per second
A3 D10	Yel	Data Transmitted on FSK line	Blinking when Ceilometer transmits digital characters; ON in between
A3 D11	Yel	Data Received on FSK line	Blinking when Ceilometer receives digital characters; ON in between
A3 D12	Green	Carrier Detect on FSK line	ON when Ceilometer detects carrier received on digital FSK line
A3 D13	Yel	Trigger Break for Gifft RBC Recorder	ON when Ceilometer activates Break
A3 D14	Yel	Cloud Signal for Gifft RBC Recorder	ON when Ceilometer marks recording paper
A5 D4	Red	Laser Power	Always ON except if optional Solar Shutter is ON

3.1.4 USE OF SERIAL DIGITAL INTERFACE

3.1.4.1 General

The serial digital interface of Ceilometer CT 12K may be accessed remotely through the FSK line (connector J3) or locally - up to a few hundred yards or meters - through the RS-232C port (connector J4). These are functionally equivalent.

Maintenance Terminal CTH 12 connects to the RS-232C port. Its presence will convert ceilometer communication to the Maintenance Terminal mode when the line is opened.

3.1.4.2 Frame, Code and Speed

Communication is asynchronous, 300 Baud, using the following character frame:

Start Bit
8 Data Bits
No Parity
1 Stop Bit

Character code is USASCII and the unused eighth bit equals the stop bit in polarity ("MARK"), except for a few special characters which initialize Maintenance Terminal CTH 12 when it is plugged in.

3.1.4.3 Notations and Abbreviations

The following notations are used throughout Chapter 3 of this Manual: -

ST:	Standard Terminal or equivalent device communicating in USASCII
MT:	Maintenance Terminal CTH 12
(CR)	"Carriage Return" i.e. "Return" i.e. "Enter"; terminates a line; completes and actuates a command; opens a "closed" line for dialog. MT: Character F ("Feed").
ABC	Operator action i.e. input to Ceilometer is underlined in this description; output from ceilometer is not.
_	Space character. One or more spaces must separate different parts of a command. MT: Character B.
>	Command Prompt is output by Ceilometer every time a command has been carried out and a new one may be input. Maintenance Terminal (MT) will leave the last line of the previous command on display until the first character of the new command is input; this clears the display.
CAPITALS	Ceilometer does not distinguish between letter cases. Output will be in capitals only.
Y	Yes; equals "1" with MT
N	No; equals "0" with MT
Hex	Hexadecimal code i.e. 0...9 = 0...9 decimal; A...F = 10...15 decimal.

3.1.4.4 Line Closed - Line Open

The serial digital interface serves both for transmitting measurement data and for communicating e.g. maintenance information. For separation, the interface has two distinct states:

LINE CLOSED: Normal operation. Measurement data messages are transmitted automatically if in AUTOMATIC MODE of operation (see 3.1.5). Commands are ignored except for OPEN and FAST HEATER OFF. This is also Restart and Power Up default state.

LINE OPEN: Dialog mode. Commands are accepted and responded to. Command Prompt arrowhead bracket (>) signifies readiness. State is not maintained through a Restart or Power Down.

The state of operation is changed by the OPEN and CLOSE commands. OPEN is accomplished with a Carriage Return (CR) only. Command syntaxes and Ceilometer responses are:

ST:	MT:
(CR)	F
LINE OPENED FOR OPERATOR COMMANDS	> LINE OPEN
> (ready for command input)	(ready for input)
> CLOS(CR)	> ClF
LINE CLOSED	LINE CLOSED
(message output continues)	(output continues)

The LINE OPEN state is automatically terminated in the Automatic Mode by a one minute time-out after the last character input.

The Line may be commanded OPEN in the middle of a message transmission. Message is not interrupted but response to command is delayed until the end of message transmission.

In the LINE OPEN mode the last Digital Message No. 2 can be requested with command MES; see Section 3.4.

3.1.4.5 Command Format and Editing Rules

The command consists of a command identifier (ID) and none, one, two, three or four groups of parameters (PARn). It is terminated by a Carriage Return (CR) which also actuates its execution. One or more spaces must separate identifier and parameters:

ID_PARl_PAR2(CR)

With input commands, new data values or states of operation are defined by the parameter (one only). If the parameter is omitted, *the current value or state will he output;* with certain output commands, a default set of parameters will be used.

With standard ASCII communication (ST:) the identifier part consists of 2 to 4 letters. Additional letters will be ignored. The pararneters are numbers or letter combinations. The DEL(RUBOUT) key can be used for editing the command.

With Maintenance Terminal Communication (MT:) the identifier part consists of letter C and a number code; these need not be separated by space. The parameters are numbers, ON and YES is “1”; OFF and NO is "0" No DEL(RUBOUT) equivalent is available.

Numeric parameters may be input as they are written i.e. zeroes and decimal point are used as in writing.

All input characters are echoed.

3.1.4.6 Advanced Information

Internally, Ceilometer CT 12K is equipped with one serial digital interface. This is used both for FSK and RS-232C electrical interface ports. Outputs are identical; inputs are ORed. Input devices may be simultaneously connected to RS-232C and FSK ports but may not input characters simultaneously.

No handshake signals are used.

The RS-232C port (J4) doubles as a port for Maintenance Terminal CTH 12. The presence of this special 16-key, 16-character terminal is sensed by an input signal ('FLAG"), whereupon an opening of the line will convert data interchange to be in the Maintenance Terminal mode.

Output from Ceilometer may be stopped by issuing an XOFF (=Control- S = 13 hexadecimal). Output will commence upon reception of any character except XOFF. The BEL character is output in addition to that shown in this chapter:

when Line is Opened or Closed
when a Syntax Error is encountered

All input parameters and operation modes are stored in non-volatile memory (EEPROM) except when specifically mentioned.

3.1.5 AUTOMATIC MODE - MAINTENANCE MODE

The Automatic Mode is the normal mode of operation; the Maintenance Mode is available for e.g. maintenance checking etc. The following is a summary of their operations:

AUTOMATIC MODE	Normal mode of operation. A measurement cycle is (completed every 12 seconds. Outputs according to 3.2 are active. The Digital message is withheld if the line is "opened" for operator dialog. Internal monitoring and controls are updated every 15 seconds.

MAINTENANCE MODE	Used temporarily for checking operation etc. Measurement cycle is halted but may be operated by command. Measurement calculations are not performed. Internal settings and controls may be operated by commands. No automatic time-out for closing an open communication line is applied. The Maintenance Mode doubles as a STANDBY MODE for minimizing wearout of laser and moving parts. The Window Conditioner is operated automatically only the first 5 minutes every hour of the internal clock.

The following are the commands for setting the mode of operation, along with Ceilometer response. Omitting the parameter part (OFF/ ON or 0/l) results in response according to the prevailing mode:

ST:	MT:
> AUTO OFF(CR)	> CllB0F
WAIT FOR SEQUENCE STOP	WAIT SEQ. STOP_
MAINTENANCE MODE	>MAINT. MODE
> (next input)	(next input)
> AUTO ON(CR)	> CllBlF
AUTOMATIC MODE	> AUTOMATIC MODE
> (next input)	(next input)

The current 12 second measurement sequence is completed before switching to Maintenance Mode.

The Mode selection will remain in effect over a Restart or Powerdown.

3.1.6 FAST HEATER OFF

The 600W Window Conditioner Heater can be forced OFF at any time, e.g. to decrease the loading of an Uninterruptible Power Supply System.

The OFF state is set via the FSK or KS-232C serial line, by sending two subsequent BELL characters (= Control-G = 07 Hex) to the Ceilometer. After reception of the last bit of the two incoming characters, the Heater will be disconnected within a maximum of 20 milliseconds.

The state is stored in EEPROM and will thus be preserved over a power outage or Reset. Status Bit Sl0 of the Digital Messages (see 3.2) is set to 1 to indicate the forced OFF state. No other acknowledgement will be output.

The forced OFF state is inhibited. via the FSK or RS-232C serial line by sending two subsequent ACK characters (= Control-F = 06 hex) to the Ceilometer. After this, the normal control will resume operation and the heater may be turned on within 15 seconds.

Syntaxes:

ST:	MT:
(BEL) (BEL) (= Cntr-G Cntr-G)	(no equivalent)
(Window Conditioner Heater shuts OFF within 20 ms.)	
(Next digital message status BIT Sl0=l)	
(ACK) (ACK) (= Cntr-F Cntr-F)	(no equivalent)
(Window Conditioner Heater is released to be turned ON if other conditions call for it)	
(Next digital message status BIT Sl0 = 0)	

3.2 STANDARD OUTPUTS

3.2.1 DIGITAL MESSAGE NO. 2

3.2.1.1 General

This message contains detailed range gate data, and internal monitoring data for the most important variables. Message is output automatically every 30 seconds in Automatic Mode when line is closed.

Activation is done with command SEND 2. This cancels any previous message activation; only one digital message may be active at a time. The following is the command, and Ceilometer response; omitting the parameter (2) will cause the current selected message to be announced:

ST:	MT:
> SEND 2(CR)	> C31B2F
AUTOMATIC MESSAGE: 2	AUTO MES 2
> (next input)	>_ (next input)

The Message number selection will remain in effect over a Restart or Power-down.

Message can be output with command MES; see Section 3.4.

3.2.1.2 Format

STXCRLF

<status data line l> CR LF
<status data line 2> CR LF
<data table . . . CR LF
.

... > CR LF
ETX CR LF

ON/OFF data is l/O accordingly.
Other data is decimal or hexadecimal numbers.

Coding is USASCII. STX, CR, LF, ETX are Start-of-Text, Carriage Return Line Feed and End-of-Text characters which format the message but are not visible in a printout.

Total length of message is 636 characters.

Printout is 15 lines, width is max 44 characters, whereof 42 are visible.

3.2.1.3 Status Line 1 (Identical in all messages)

$NSB_H_1H_1H_1H_1H_1_T_1T_1T_1T_1T_1_H_2H_2H_2H_2H_2_T_2T_2T_2T_2T_2_S_1S_2S_3S_4S_5S_6S_7S_8S_9S_{10}$CRLF

N = 0 no significant backscatter (clear air)
N = 1 one layer detected
N = 2 two layers detected
N = 3 sky is fully obscured but no cloud base can be detected from echo signal received (e.g. fog or precipitation)
N = 4 sky is partially obscured and no cloud base is detected

S = 0 no alarm status bits Sl...S4 ON for more than 5 mm.
S = 1 at least one alarm status Sl...S4 ON for more than 5 min.

B = space if S = 0

B = 'bel' character if S = 1. Because 'bel' is a nonprinting character the alarming line appears one character shorter in a printout than normally.

N = 0 or 4: $H_1 = H_2 = T_1 = T_2 =$ /////

N = 1 or 2: $H_1H_1H_1H_1H_1$ = the lowest detected cloud height in 5 digits. Leading zeroes not suppressed.

$T_1T_1T_1T_1T_1$ = range of backscatter of first layer; ///// if not defined

N = 2:	$H_2H_2H_2H_2H_2$ =	second cloud height; ///// if not defined
	$T_2T_2T_2T_2T_2$ =	range of backscatter of second layer; ///// if not defined
N = 3:	$H_1H_1H_1H_1H_1$ =	calculated vertical visibility
	$T_1T_1T_1T_1T_1$ =	signal range i.e. height of highest detected backscatter

STATUS INDICATORS:

S_1 = Hardware alarm
S_2 = Supply Voltage alarm
S_3 = Laser power low
S_4 = Temperature alarm
S_5 = Solar shutter On
S_6 = Blower On
S_7 = Heater On
S_8 = 0: Unit is feet
1: Unit is meters
S_9 = 0: Data in internal table 2 is range and instrument normalized
1: Data in internal table 2 is inverted i.e. extinction normalized
S_{10} = Fast Heater Off is active

3.2.1.4 Status Line 2

G_F_N.NN_SUM_IIN_LAS_TLx_OF.FS_XX_PP CR LF

G = 0 Gain used is 250
G = 2 Gain used is 930

F = 0 Laser pulse frequency used is 620 Hz (minimum)

F = 7 Laser pulse frequency is 1120 Hz (maximum)

N.NN = Noise RMS voltage in units of ADC increments, computed from the latest 12 s measurement period. One digit, two decimals.

SUM = Sum of total backscattered power per unit solid angle i.e. range and instrument normalization applied. Three digits, no decimals. Leading zeroes replaced by space characters.

IIN = Algorithm related internal processing information. 3 digits.

LASE = Measured Laser Power in units of ADC increments (LLAS). 3 digits.

TL.x = Internal variable indicating transmitter temperature. 2 digits, one decimal; preceded by minus sign if negative. Degrees Celsius.

OF.FS = Offset of zero signal relative to Data Table minimum (=0), in units of ADC increments. Two digits, two decimals.

X X = algorithm related internal processing information. 2 digits.

PP = A two digit number representing calculated extinction coefficient values of the ten lowest range gates (0...500ft.). This two digit number will determine if the obscuration is ground based.

3.2.1.5 Data Line Format

H H D_0 D_1 D_2 D_3 ....D_9 CR LF

Data scaled to hexadecimal number O...FE (decimal 0...254). Overflow indicated by FF. Leading zero replaced by space character.

Data values are presented for each 50 ft range gate.

Height of the first value in the line in thousands of feet. Two digits; leading zero replaced by space. Twenty 50 ft values per line starting with 0 (ft), next line 1000 (ft). 13 lines altogether. Last line (12000 ft) has 10 values.

Compression and Scaling

The data item is compressed and scaled according to the following formula:

DD = 50 x ln(RAWDATA - MINV) + 1

where

DD is the data item for a particular range gate,, in 2 digit hexadecimal format

ln symbolizes the natural logarithm

RAWDATA is the raw data value measured for the range gate in question

MINV is the smallest raw data value measured

The raw data value differential is retrieved with the following formula:

$$(RAWDATA\text{-}MINV) = \exp(\frac{DD}{50})\text{-}1$$

NOTE: The data values presented are those of the last complete 12 s scan. The cloud heights etc. presented in Status Line 1 (ref. paragraph 3.2.1.3) may have been determined from the two last 12 s scans and minor inconsistencies may therefore appear in rapidly changing situations.

(Key: First digit of field XX of Status Line 2, ref. paragraph 3.2.1.4, indicates number of scans used for Status Line 1 cloud information.)

Data Item to Backscatter Power Relationship

Let

S = (RAWDATA-MINV)-Noise

where Noise is the remaining noise-induced offset of the data table.

Then instantaneous received backscatter power P is:

$$P = (\frac{S*0.188}{GAIN})\ \mu W$$

where GAIN is 250 at No. 0 or 930 at No. 2.

3.2.1.6 Message Example

STXCRLF

10_04200_00150_/////_/////_0000011010 CR LF

2_3_0.08_36_12_168_23.9_4.56_20_10 CR LF

ODD........................... DD CR LF
-1 CR LF
-2 CR LF
-3 CR LF
-4 CR LF
-5 CR LF
_6 (DATA VALUES;) CR LF
_7 CR LF
8 CR LF
-9 CR LF
10 CR LF
11 CR LF
12DD.................DD CR LF

ETX CR LF

_ = Space Character

3.2.2 DIGITAL MESSAGE NO. 3

3.2.2.1 General

This message contains Status Line 1 identical to Message No. 2 (see 3.2.1.3) and one single range gate data line indicating the presence or absence of backscatter in each range gate.

Message is output automatically every 12 seconds, simultaneously with the Gifft RBC Recorder Output (3.3) in Automatic Mode when Line is Closed.

Activation is done with command SEND 3. This cancels any previous message activation; only one digital message may be active at a time. The following is the command and Ceilometer response; omitting the parameter (3) will cause the current selected message to be announced:

ST:	MT:
> SEND 3(CR)	> C31B3F
AUTOMATIC MESSAGE: 3	AUTO MES 3
> (next input)	>_ (next input)

The Message number selection will remain in effect over a Restart or Power-Down.
Message No. 3 is intended to be used with the EMOD control parameter set to EMOD ON (see 3.3).

3.2.2.2 Format

STX CR LF
<status data line l> CR LF
<backscatter data line . . . > CR LF

ETX CR LF

Status Data Line 1 is identical to that of Message No. 2.

ON/OFF data is l/O accordingly. Other data is decimal or hexadecimal numbers.

Coding is USASCII. STX, CR, LF, ETX are Start-of-Text, Carriage Return Line Feed and End-of-Text characters which format the message but are not visible in a printout.

Total length of message is 112 characters. Printout is 2 lines, width is max. 66 characters, whereof 64 are visible.

Time for message transmission at 300 baud is 3.73 s.

3.2.2.3 Status Line 1

Identical to that of Digital Message No. 2; see 3.2.1.3.

3.2.2.4 Backscatter Data Line

D_1 D_2 D_3 D_4 .... D_{64}CR LF

D_n where n= 1 to 64 is single ASCII coded hexadecimal character O...F where each bit of the 4-bit nibble of the hex character expressed in binary form represents one range gate.

With EMOD ON, range gate bit is 1 if Ceilometer determined extinction coefficient at that range gate exceeds a value corresponding to a horizontal visibility of approx. 10 km (6 miles) except for three lowest range gates which have higher thresholds.

D_1 represents the four lowest 50 ft range gates i.e. Oft, 50ft, l00ft, 150ft; D_2 represents the four next ones i.e. 200 ft, 250ft, 300ft, 350ft, etc.

0 indicates no detectable backscatter in four adjacent range gates
F indicates backscatter in all four range gates
8 indicates backscatter in the lowest range gate only
1 indicates backscatter in the highest range gate only

All other characters indicate a gate-by-gate combination of backscatter according to the binary nibble, converted to hexadecimal.

3.2.2.5 Message Example

STX CR LF

10_04200_00150_/////_/////_0000011010 CR LF
0001FFF80000000000007A000 . . . . ..000 CR LF

ETXCRLF

3.2.3 GIFFT RBC RECORDER OUTPUT

3.2.3.1 Introduction

The CT 12K Ceilometer provides two floating non-polar output signal circuits for producing graphical sky condition records on a Gifft RBC Recorder, operating according to the facsimile principle.

A new output is generated once every 12 seconds when the Ceilometer is in Automatic Mode, regardless of the state of the Digital Interface (Open or Closed). In normal operation (Line Closed), output coincides once per minute with Digital Message No. 2 transmission start, and every time with Digital Message No. 3 transmission start.

3.2.3.2 Signals

TRIGGER BREAK (Ref. RBCT)
Normally-Closed relay contact that opens for 80 milliseconds as an initiation for a new output.

Doubles as an Alarm Signal by extending the break duration to 200 ms when cause for Ceilorneter Fault Alarm exists. This state is logically identical to that of bits S and B of Status Line 1 of Digital Messages.'

CLOUD SIGNAL (Ref. RBCE)
Transformer Coupled 120 Hz, signal (twice Line Frequency), on/off controlled by Ceilometer for inscribing on Recorder paper.

OPERATION AND TIMING+
The Cloud Signal outputs cloud and obscuration heights as an analog delay with respect to the trailing edge of the Trigger Break. 0 to 12,000 ft is covered in 3 seconds, with a 20 ms resolution equalling 80 ft. If the Trigger Break is 200 ms (alarm) then the reference starting point is 80 ms after the leading edge of the Break.

3.2.3.3 Recording Modes and Set-Up Commands

Two on/off parameters RMOD and BMOD condition the Cloud Signal output:

RMOD (Recording MODe)

OFF: Only Cloud bases are recorded

ON: In addition to Cloud bases also non-cloud obscuration is recorded

BMOD (Base MODe)

OFF: Up to two cloud bases may be output during one sweep, each with a trace duration of mm. 80 ms.

ON: Only the lowest cloud base is output, and with a fixed 60 ms trace duration.

RECOMMENDED STANDARD SETTINGS ARE:

RMOD ON

BMOD OFF

Settings Matrix:

BMOD \ RMOD	OFF	ON
OFF	None, one, or two bases recorded with long traces	None, one or two bases recorded with long traces, non-cloud obscuration with short intermittent dots
ON	None or one base recorded with short trace	None or one base recorded with short trace, non-cloud obscuration with short intermittent dots

Syntaxes:

ST:	MT:
> <u>RMOD ON(CR)</u>	> <u>C13BlF</u>
MEASURED DATA RECORDING, RMOD ON	> RMOD ON
> <u>RMOD OFF (CR)</u>	> <u>C13B0F</u>
DETECTED CLOUDS RECORDING, RMOD OFF	> RMOD OFF
> (next input)	(next input)
> <u>BMOD ON(CR)</u>	> C29BlF
CLOUD BASE ONLY, BMOD ON	> BMOD ON

> BMOD OFF(CR)	> C29B0F
ALL CLOUD DATA, BMOD OFF	> BMOD OFF
> (next input)	(next input)

Settings are stored in non-volatile memory.

3.2.3.4 Examples and Interpretations

Scaling: The CT 12K 0 to 12000 ft range is linearly scaled for the Gifft RBC Recorder 0 to 90 degrees scale i.e.:

0 ft = 0 deg
1000 ft = 7.5 deg
12000 ft = 90 deg

Cloud Trace:

An instantaneous 12 sec. cloud hit is recorded as a solid thin line starting at the detected cloud height and extending upwards a minimum of 240 ft (60 ms) and a maximum equalling the penetration (typ. max. 400 ft). A time graph of cloud height is produced by several subsequent instantaneous traces.

In broken, scattered, or highly turbulent conditions instantaneous hit traces may be spread over a wide range, or group into several distinct cloud mass images. Visual grouping and averaging of a longer period of the record will then provide a better result for reporting purposes than instantaneous hits.

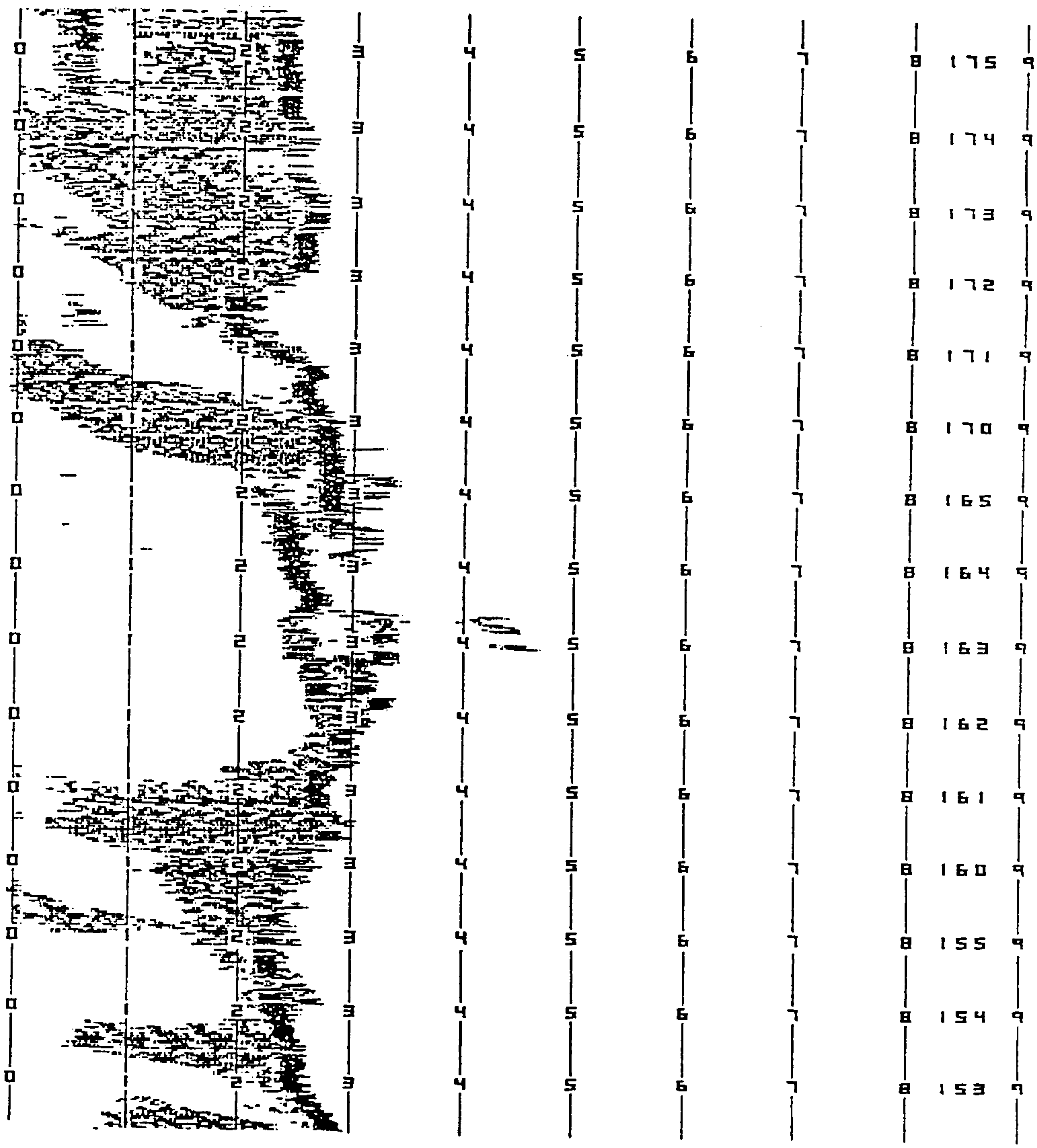
Non-Cloud Obscuration

Height ranges where backscatter has been detected and the obstruction calculated to have a point extinction coefficient exceeding a value corresponding to a horizontal visibility of approx. 6 miles (10 km) but not exceeding the cloud criteria, are marked with a greyish cloud signal in the RMOD ON recording mode.

The greyish appearance is accomplished by semi-randomly on-off switching the cloud signal during the sweep, and disabling the non-cloud obscuration signal altogether every second sweep.

In totally obscured conditions where no cloud base is detected the non-cloud obscuration signal will be output up to the calculated Vertical Visibility (ceiling) height; this can then be seen in the record as the upper (higher) edge of the greyish area.

In cases of rapid changes in cloud heights and/or position, backscatter from a cloud base may be blurred over a wide range and momentarily fail to produce a reliable cloud backscatter signature. These instants will however at least provide a non-cloud obscuration detection to enhance the record image of the situation.



CT4569

Fig 1. (RMOD ON, BMOD OFF): (CT 4569)

Cloud mass at 3500 to 4000 ft.
Showers, some not reaching ground. New cloud deck forming at 600 ft starting at time 1730.

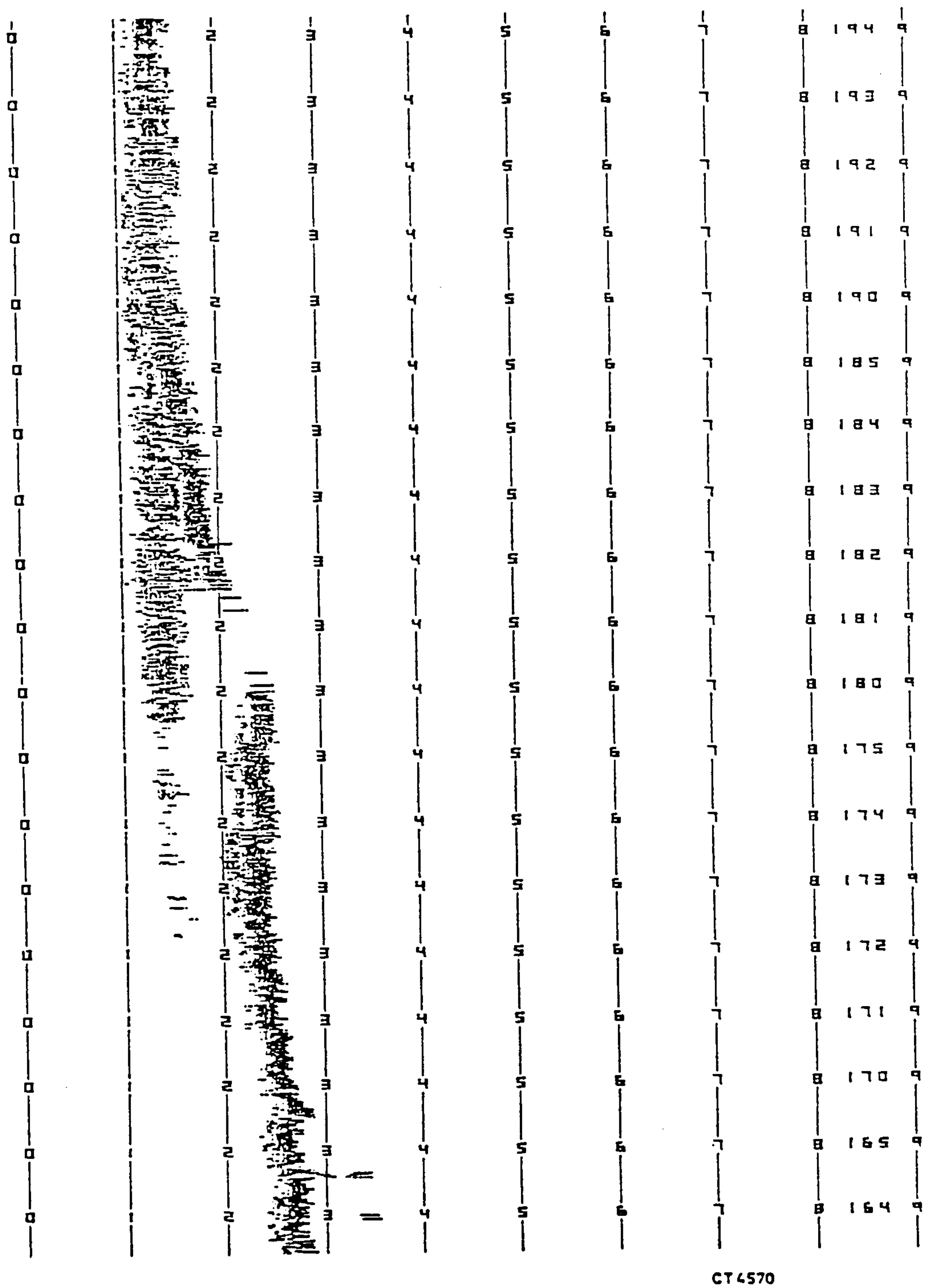


Fig 2. (RMOD ON, BMOD OFF): (CT 4570)

Cloud mass at 3500 ft gradually lowering to 1500 ft.
Gradual increase of density with height; distinct base indistinguishable at times, e.g. 1900.

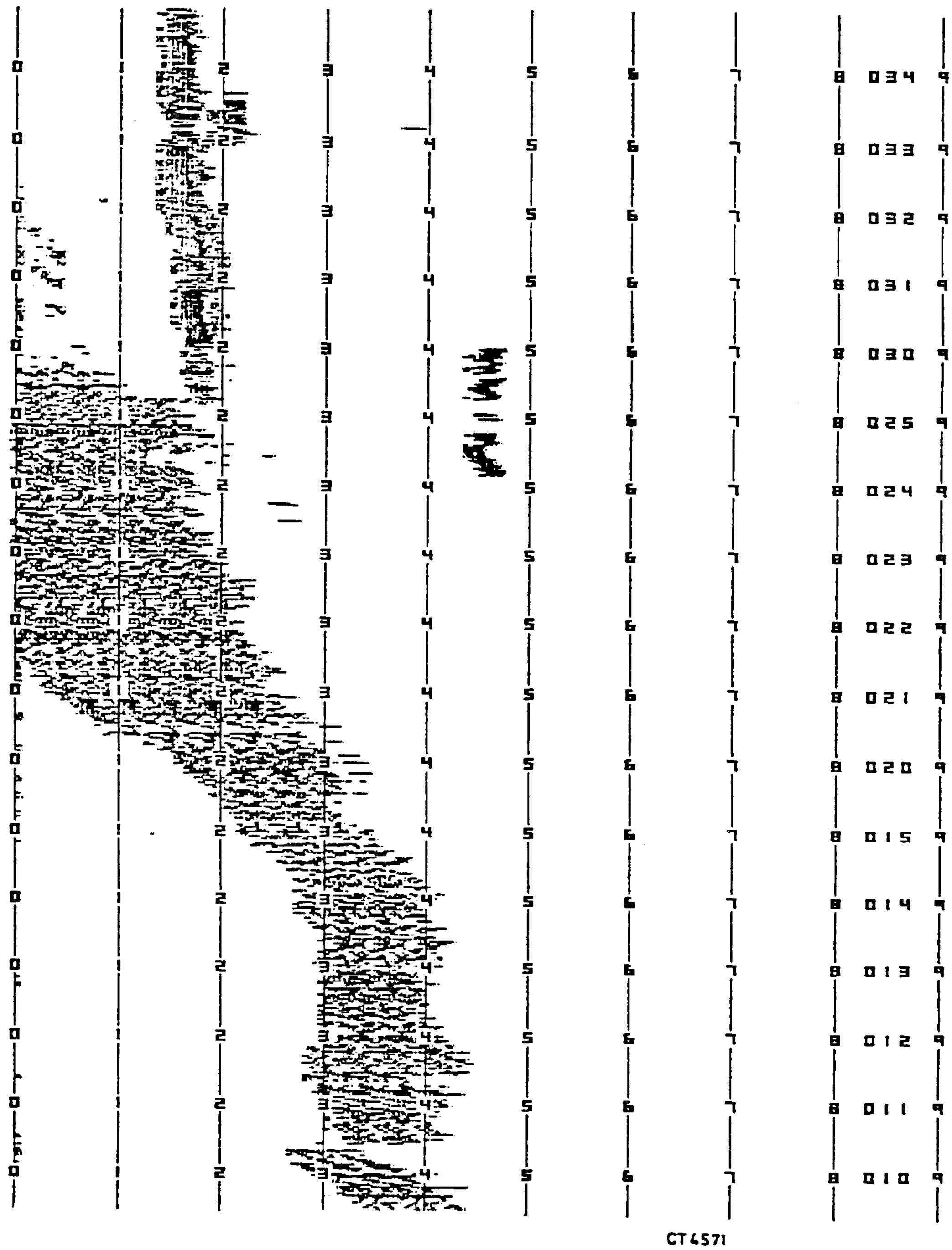


Fig 3. (RMOD ON, BMOD OFF): (CT 4571)

Blowing snow at 4000 to 5500 ft gradually lowering to ground during time 0140 to 0210.
Vertical Visibility (ceiling) at 5500 ft to time 0140, then lowering to 2200 ft.
Cloud deck forming at 2200 ft starting at time 0255.

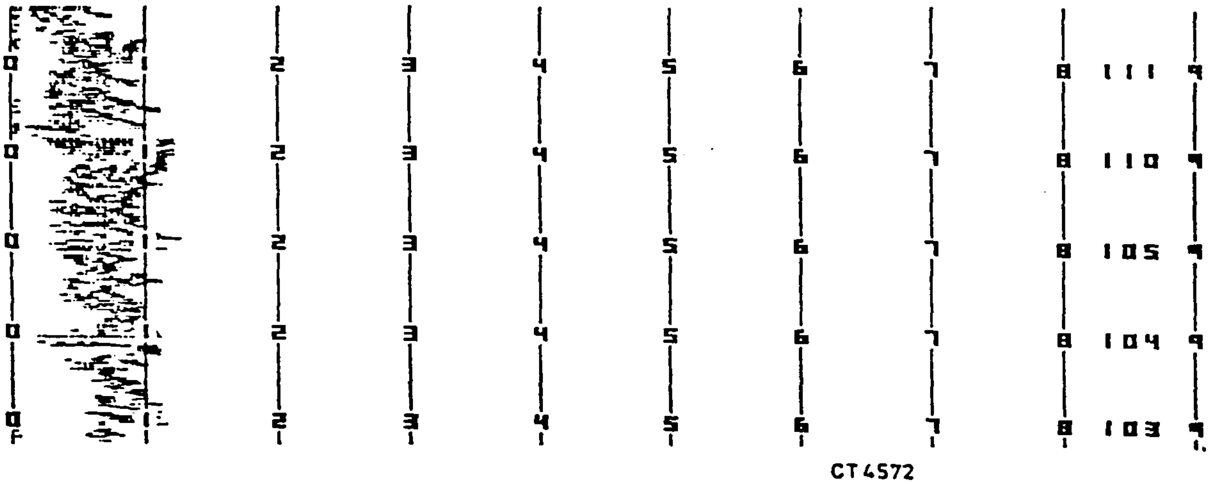


Fig. 4 Example of RMOD ON, BMOD ON recording (CT 4572)

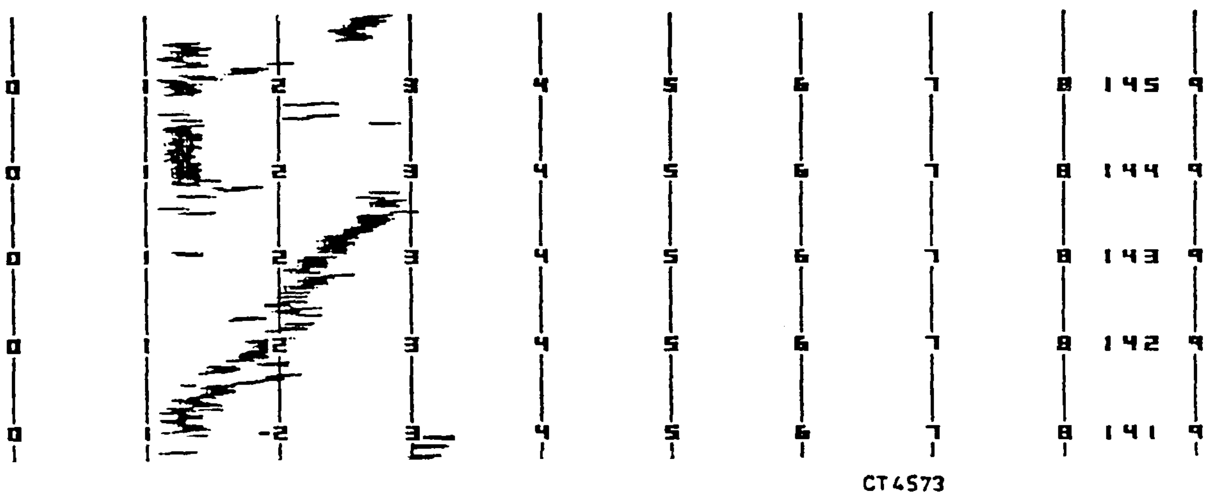


Fig. 5 Example of RMOD OFF, BMOD. OFF recording (CT 4573)

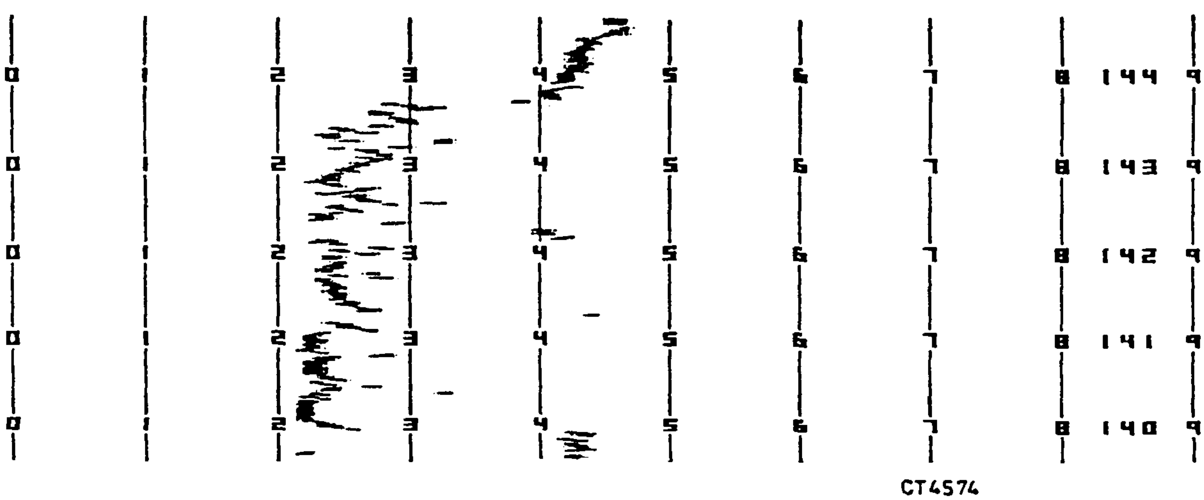


Fig. 6 Example of RMOD OFF, BMOD ON recording (CT 4574)

3.3 PARAMETERS AND OPERATION MODES

3.3.1 STANDARD PARAMETER SETTINGS

Existing parameter settings are checked with commands PAR, SHUT, SEND, AUTO, SERN. Below is a dialogue session showing the syntaxes and standard factory settings. If deviations exist, please check also instrument specific configuration documents.

Example Dialogue with standard settings:

ST:	MT:
>PAR(CR)	>C4F
SYSTEM PARAMETERS	SYSTEM PARAMETER F
CLOUD LIMIT CLIM 0.1000	CLIM 0.1000 F
SIGNAL LIMIT SLIM 0.2000	SLIM 0.2000 F
DEVICE SCALE DEV 1.2400	DEV 1.2400 F (5
NOISE SCALE NSCA 4.5000	NSCA 4.5000 F
OUTPUT SCALE SCAL 100 .0000	SCAL 100.0000 F
LASER NORM LNOR 164	LNOR 164 F (5
TOTAL SIGNAL TOTAL 10.0000	TOTA 10.0000 F
GAIN RATIO RAT 3.7012	RAT 3.7012 F
HEIGHT OFFSET HOFF 0	HOFF 0 F
HEIGHT SQUARE NORMALIZED MODE,	
EMOD OFF	EMOD OFF F
DATA UNIT FT	_DATA UNIT FT F (4
MEASURED DATA RECORDING,	_RMOD ON F
RMOD ON	
ALL CLOUD DATA, BMOD OFF	_BMOD OFF F
>SHUT(CR)	>C22F (3
NO SHUTTER	>NO SHUTTER
>SEND(CR)	>C31F (2
AUTOMATIC MESSAGE: 2	_AUTO MES 2
>AUTO(CR)	>C11F
AUTOMATIC MODE	>AUTOMATIC MODE
>SERN (CR)	>C33F
VAISALA CT 12K VERSION 2.42	
SN:87023	>V2.42 87023
(next input)	(next input)

NOTES:

1. All these parameters reside in non-volatile memory.
2. SEND may be 2 or 3; see Section 3.2.
3. Response to SHUT is SHUTTER IS OFF (or eventually ON) if one is installed. See also CONF.
4. If meters output is used DATA UNIT FT line will read DATA UNIT M. See also CONF.
5. LNOR and DEV values are instrument specific.
6. In addition to proper parameter settings, a proper Noise Offset Calibration must be in memory. See Section 6 in case of doubt.

3.3.2 Description of Parameters

CLIM (Cloud LIMit)
Sets the minimum increase in calculated extinction coefficient in Ceilometer specific units that must be present over a short range for cloud base condition. See SLIM for additional conditions.

SLIM (Signal LIMit)
Sets the minimum calculated extinction coefficient value in Ceilometer specific units that must be present in one range gate for cloud base condition.

DEV (DEVice scale)
Multiplying scaling factor applied to all range gate values after normalization and prior to application of Cloud detection algorithms and output. Does not affect heights. Does affect CURRENT SIGNAL SUM, see TOTA.

NSCA (Noise SCAle)
Multiplying scaling factor which when multiplied with the RMS noise calculated from the 12 sec. measurement scan sets the limit for discriminating between true signal and noise. Decreasing NSCA will increase sensitivity but cause more noise hits.

SCAL (SCALe)
Multiplying scaling factor to scale the value of PP.

LNOR (Laser NORmal power)
Device specific parameter for 100% nominal laser power, in units of Monitor A/D converter increments. Measured laser power (LLAS) is compared against this for laser power control and measurement normalization.

TOTA **(TOTAl** signal sum limit)

Limit for determining full, partial or no obscuration. For every 12 sec. scan all range and equipment normalized range gate backscatter values are added to provide value CURRENT SIGNAL SUM or SUM (see Digital Message No. 2). If SUM exceeds TOTA then full obscuration is concluded and first status bit N of Digital Message Status Line 1 is 1, 2 or 3. If SUM is less than TOTA but exceeds 0.4* TOTA then partial obscuration is concluded and N is 4. No height values are output in message. If SUM is less than 0.4* TOTA then no significant obscuration is detected. Parameter DEV multiplies SUM.

RAT (RATio)

Ratio of GAIN 2/GAIN 0. Multiplies results of measurement using GAIN 0 for normalization. Value must always be 3.7.

HOFF (Height OFFset)

Parameter for offsetting the heights reported in case the Ceilometer is installed considerably higher (positive value) or lower (negative value) than the level of interest, e.g. the runway.

The HOFF value will be added to the Cloud Height and Range Limit values. Cloud Penetration or Vertical Visibility values will not be affected except that Vertical Visibility will be set equal to Range Limit if the latter is lower. Negative values will be replaced by zeroes.

The Height Offset will offset the Range Gate output string of Digital Message No. 3 correspondingly. Digital Message No. 2 range gate data and Gifft RBC Outputs will not be affected.

The HOFF value must be expressed in the same units (feet or meters) as the output is.

WARNING 1: If output units are changed from feet to meters or vice versa, the HOFF value must be changed manually. No automatic recalculation is performed.

WARNING 2: If clouds or obscuration exists beween the Ceilometer installation height and the level of interest (e.g. runway), the Ceilometer output will not be representative of the sky condition situation at the level of interest.

RMOD (Recording MODe)
Controls the presentation. of non-cloud obstruction of the Gifft RBC Recorder; output included if ON. See also 3.2.3.

BMOD (Base MODe)
Controls the presentation of a second cloud height, and cloud penetration in all outputs;, maximum amount of output data available if OFF. See paragraph 3.2.

EMOD (Extinction MODe)
Controls the availability of extinction normalized ("inverted') range gate data with Digital Message No. 3; see Paragraph 3.2. Extinction normalized data available if ON. ON setting seen as Digital Message Status Line 1 bit S_9 = 1.

CONF (CONFiguration)
Determines if the output is feet (F) or meters (M), and tells the software whether a Solar Shutter is installed (Y) or not (N). The command is interactive, asking the operator above questions. No (CR) is needed for input of configuration parameters. Meters setting seen as Digital Message Status Line 1 bit S8= 1.

SEND (SEND)
Selects Digital Message No. 2 or 3 for output.

AUTO (AUTOmatic mode)
Sets the ceilometer in Automatic Mode which is the normal operating mode.

SERN (SERial Number)
Arbitrary serial number 'option. Range 0 . . . 999999. Only numericals allowed. Stored in the Processor Board EPROM. Will thus require reprogramming if Board or EEPROM is replaced. Has no effect on operation. Changing of number once input requires string (space) (space) NEW with standard terminal, or string (space) (space) 123 with Maintenance Terminal to be added after the new number before entering line with (CR).

Example session showing syntaxes of above commands:

ST:			MT:
>CLIM(CR)			>C6K
CLOUD LIMIT	CLIM	0.1600	>CLIM 0.1600
>CLIM .15(CR)			>C6BD15F
CLOUD LIMIT	CLIM	0.1000	>CLIM 0.1500

```
>SLIMICR)                                      >C1OF
SIGNAL  LIMIT        SLIM    0.2600            >SLIM  0.2600

>SLIM  .25(CR)                                 >Cl0BD26F
SIGNAL  LIMIT        SLIM    0.2500            >SLIM  0.2500

>DEV(CR)                                       >C9F
DEVICE  SCALE        DEV     1.2000            >DEV  1.2000

>DEV  l(CR)                                    >C9B1F
DEVICE  SCALE        DEV     1.000             >DEV  1.0000

>NSCA (CR)                                     >C8F
NOISE  SCALE         NSCA    2.5000            >NSCA  2.5000

>NSCA  3(CR)                                   >C8B3F
NOISE  SCALE         NSCA    3.0000            >NSCA  3.0000

>SCAL (CR)                                     >C7F
OUTPUT  SCALE        SCAL   20.0000            >SCAL  20.0000

>SCAL  l0(CR)                                  >C7B1OF
OUTPUT  SCALE        SCAL   10.000             >SCAL  10.0000

>LNOR (CR)                                     >C28F
LASER  NORM          LNOR  162                 >LNOR  162

>LNOR  164(CR)                                 >C28B164F
LASER  NORM          LNOH  164                 >LNOR  164,

>TOTA(CR)                                      >C3OF
TOTAL  SIGNAL  LIMIT          6.00             >TOT  6.0  25.6
CURRENT  SIGNAL  SUM         25.63

>TOTA  5(CR)                                   >30B5F
TOTAL  SIGNAL  LIMIT          5.00             >zOT  5.0  25.6
CURRENT  SIGNAL SUM          25.63

>RAT(CR)                                       >C32F
GAIN  RATIO          RAT     3.7012            >RATIO  3.7012

>HOFF(CR)                                      >C34F
HEIGHT  OFFSET       HOFF    0                 >HOFF  0

>EMOD (CR)                                     >C12F
EXTINCTION  NORMALIZED  MODE,                  >EMOD ON
EMOD  ON

>EMOD  OFF (CR)                                >ClZB0F
HEIGHT  SQUARE  NORMALIZED                     >EMOD OFF
MODE,  EMOD OFF
```

>RMOD(CR) DETECTED CLOUDS RECORDING, RMOD OFF	>C13F >RMOD OFF
>RMOD ON(CR) MEASURED DATA RECORDING, RMOD ON	>Cl3BlF >RMOD ON
>BMOD(CR) CLOUD BASE ONLY, BMOD ON	>C29F >BMOD ON
>BMOD OFF(CR) ALL CLOUD DATA, BMOD OFF	>C29BOF >BMOD OFF
>CONF(CR) SELECT UNIT M/F ?F SHUTTER OPTION Y/N ?N	>C5F UNIT M/F (1/0)?0 SHUTTER Y/N (l/0) ?0
END OF CONFIGURATION	>END OF CONF.
>SEND(CR) AUTOMATIC MESSAGE: 3	>C31F >AUTO MES 3
>SEND 2(CR) AUTOMATIC MESSAGE: 2	>C31B2F >AUTO MES 2
>AUTO(CR) MAINTENANCE MODE	>C11F >MAINT. MODE
>AUTO ON(CR) AUTOMATIC MODE	>ClIBlF >AUTOMATIC MODE
>SERN (CR) VAISALA CT 12K VERSION 2.42 SN:O	>C33F >V2.42
>SERN 87023 NEW(CR) VAISALA CT 12K VERSION 2.42 SN:87023	>C33F87023BB123F >V2.42 87023
>CLOS(CR) LINE CLOSED	>C1F LINE CLOSED

3.4 PERFORMANCE MONITORING AND ALARMS

3.4.1 GENERAL

The primary indicator of performance failure is the second bit "S" of Digital Message Status Line 1 which operates concurrent with the third character, "B" which equals ASCII "BEL" when S = 1, this sounding the beeper of a std. terminal.

Concurrent with this the Trigger Break of the Gifft RBC Recorder Output extends from 80 ms to 200 ms.

The "S" indicator is an ORed sum of bits Sl, S2, S3, S4 of Status Line 1. The "S" setting is delayed 5 minutes;- Sl...S4 have no delay.

The optical path of the Ceilometer can be monitored by observing the "SUM" value of Digital Message No. 2 Status Line 2, or the "CURRENT SIGNAL SUM" output when requesting the TOTA parameter. In conditions of no precipitation nor fog, with a solid and stable cloud base at 1000...5000 ft, DEV= l and no temperature extremes SUM should be in range 20...40.

Detailed performance data is obtained with commands described below.

3.4.2 STATUS MESSAGE

Internal status is requested and reported as in the example that follows. Alarms are reported as plain language messages added to this message; or in case of numerical data as asterisks (*) immediately after the numerical value. In case of alarms, Section 6 is to be consulted.

ST:	MT:
>STA(CR) CTl2K STATUS 00 ///// ///// ///// ///// 0000000000 POWER STATUS Pl0D 8.5 P20I 21.5 M20I -20.7 P25V 27.9 M20A -20.9 P20A 19.3 P12M 13.1 Pl0X 9.9 PXHV 140 Pl0R 10.2 MRHV -382 SIGNAL STATUS LLAS 155 LSKY 1 GND 0 TEMPERATURE STATUS TL 30 TE 20 TI 34 TB 22	>C3F CTl2K STATUS F OO ///// ///// F ///// ///// F 0000000000 F (output of one data item at a time)

```
HEATER OFF
BLOWER OFF                                          .
AUTOMATIC MODE                                      .
GAIN 2                                              .
LASER FREQUENCY 3                                   -LASER FREQ. 3
>(next input)                                       A
                                                    >LASER FREQ. 3
                                                    (next input)
```

3.4.3 START-UP

At start-up, a series of self-checks are made and reported through the Digital Interface, followed by a Status Message. The format should be as follows:

```
ST:                                                      MT:
------------------------------------------------------------------------
VAISALA CTl2K VERSION 2.42 SN:97023                      V2.42 87023
DATA MEMORY OK                                           DATA MEMORY OK
SEQUENCE OK                                              SEQUENCE OK
?MODEM OK                                                ?MODEM OK
EEPROM OK                                                EEPROM OK

CTl2K STATUS                                             CTl2K STATUS
00 ///// ///// ///// ///// 0000000000                    (forwarding with
POWER STATUS                                             F or C; output
Pl0D  8.5  P20I  21.1  M201 -20.4  P25V 27.3             one data item
M20A -20.6 P20A  19.3  P12M  12.9  Pl0X  9.8             at a time)

PXHV  140  Pl0R  10.1  MRHV  -380
SIGNAL STATUS
LLAS  209  LSKY    0  GND    0
TEMPERATURE STATUS
TL   30  TE    18  TI    32  TB    20
HEATER OFF
BLOWER OFF                                               .
AUTOMATIC MODE                                           .
GAIN 0                                                   .
LASER FREQUENCY 0                                        -LASER FREQ.0
                                                         A
```

NOTES:

1. With MT: message will not exit automatically. Use Key A to Abort.

2. Last digit of software revision identification ("2.42") may change as a result of minor improvements not in conflict with the content of this manual.

3.4.4 ALARM LIMITS

The internal voltages, temperatures and light power levels reported in the Status Message are monitored against Alarm Limits. Alarms are reported as asterisks (*) immediately after the alarming value of the Status Message.

Voltages are in volts, they produce alarms if they are less than the corresponding Alarm Limit (signs disregarded).

Temperatures are in degrees centigrade (Celsius). They produce alarms if they exceed the corresponding Alarm Limit.

Laser Power is in units of Monitor AD Converter increments. It produces an alarm if it is less than the Alarm Limit, See also Note 2.

Sky Light Power Alarm Limit is of no practical significance in normal conditions since the numerical range is O-255.

Ground is monitored for self-test purposes, and produces an alarm if it exceeds the Alarm Limit.

In addition the Monitor A-to-D Converter internal reference is monitored to be 125...131, producing an "AN MONITOR ERROR" message if out of limits.

An Alarm Limit Message is obtained by commanding ALIM. Specific parameters are changed by adding the corresponding reference designation with standard terminal use or the number code of Appendix 1: "CTM 12 Monitored Parameters" with Maintenance Terminal CTH 12, and the new limit value. Interrogation of individual values is not provided.

NOTES:

1. Alarm Limit changes will not be maintained over a power outage or Reset but a return to default values will take place in these instances.

2. The LLAS default alarm limit is 0.7* LNOR and will thus be individual, as is LNOR.
   Below are the syntaxes for the ALIM message with default values, and a specific example:

ST:	MT:
>ALIM(CR)	>C26F
ALARM LIMITS	
POWER LIMITS	(Output one data item at a time.
P20I 15.0 Pl0X 7.5 M20A 15.0 Pl0R 7.0	
MRHV -150 P12M 8.0 Pl0D 6.0 P25V 20.0	Channel numbers
PXHV 52 P20A 15.0 M20I -15.0	instead of
SIGNAL LIMITS	alphanumeric references.)
LLAS 155 LSKY 256 GND 4	
TEMPERATURE LIMITS	
TI 100 TE 100 TL 70 TB 80	
>ALIM PXHV 54(CR)	>C26B7B54F
NEW LIMIT 54.0	>NEW LIMIT 54.0
>(next input)	(next input)

3.4.5 COMMANDS FOR DETAILED CHECKING

The following commands are intended for use in conjunction with troubleshooting (Section 6) or other special situations.

Some of the commands can be used in Maintenance Mode only. Misuse will produce comment: “AUTOMATIC MODE”.

3.4.5.1 AN (channel)

Continuous output of ANalog monitoring channel in units of Monitor A-to-D converter increments; range 0...255. Output is aborted with ESC character. “Channel” is specified either with the reference designations or code numbers of Appendix 1: “CTM 12 Monitored Parameters”; with the Maintenance Terminal only numbers work.

If no channel is specified, the AD Converter internal self-test channel value will be output; value 125...131.

Syntax example:

ST:	MT:
>AN 8(CR) or AN LLAS(CR)	>C14B8F
195	195
195	195
195	195
.	.
.	.
.	.
(ESC)	A
>(next input)	>_(next input)

3.4.5.2 LASE (on/off)

Control of Laser Enable. Interrogation (without ON/OFF) produces no response. Control possible only in Maintenance Mode. Requires SEQ setting for Laser trigger pukes output. The setting is automatically cleared after each measurement scan, either in Automatic Mode or a commanded one in Maintenance Mode (MEAS, CAL).

Syntax example:

ST:	MT:
>LASE ON(CR)	>C15BlF
LASER IS ENABLED	>LASER ENABLED
>(next input)	(next input)

3.4.5.3 SEQ (on/off)

Control of Measurement Sequence Enable. Interrogation (without ON/ OFF) produces no response. Control possible only in Maintenance Mode. Requires LASE setting for Laser trigger pulses output. The setting is automatically cleared after each measurement scan, either :iin Automatic Mode or a commanded one in Maintenance Mode (MEAS, CAL).

Syntax example:

ST:	MT:
>SEQ ON(CR)	>C16BlF
SEQ ON	>SEQ ON
>(next input)	(next input)

3.4.5.4 NOIS

Continuous output of Highest, Average and Lowest Receiver data measurement sample recorded after last laser pulse of last 12 seconds scan completed. Aborted with ESC character input. Output in units of Flash-AD Converter increments. Updating is instantaneous in Maintenance Mode; once every 12 seconds in Automatic Mode.

Syntax example:

ST:	MT:
>NOIS (CR)	>C17F
NOISE MEASUREMENT	NOISE
19 16 13	19 16 13
19 16 13	19 16 13
19 16 13	19 16 13
.	.
.	.
(ESC)	A
>(next input)	> 19 16 13
	(next input)

3.4.5.5 FREQ (number)

Interrogation and setting of Laser Pulse Frequency number. Setting is possible only in Maintenance Mode.

Nominal Frequencies are:

Number	Frequency (in Hz)
0	620
1	660
2	710
3	770
4	830
5	910
6	l000
7	1120

Minor deviations may be measured due to breaks between scans in Automatic Mode.

Syntax example:

ST:	MT:
>FREQ (CR)	>C18F
LASER FREQ COUNT 2	>LASER FREQ 2
>FREQ 5 (CR)	>C18B5F
LASER FREQ COUNT 5	>LASER FREQ 5
>(next input)	(next input)

3.4.5.6 GAIN (0 or 2)

Interrogation and setting of Receiver Measurement Amplifier Gain. Setting is possible in. Maintenance Mode only. Gain 0 is 250, Gain 2 is 930 (nominal values).

Syntax example:

ST:	MT:
>GAIN(CR)	>C19F
GAIN SELECT	>GAIN 0
0	
>GAIN 2(CR)	>C19B2F
GAIN SELECT	>GAIN 2
2	
>(next input)	(next input)

3.4.5.7 HEAT (on/off)

Interrogation and control of Window Conditioner Heater status. In Automatic Mode a control command will be cancelled within 15 seconds by the automatic operation algorithm. An ON control will not be responded to unless the Blower is ON (see BLOW).

Syntax example:

ST:	MT:
>HEAT(CR) HEATER OFF	>C20F >HEATER OFF
>HEAT ON(CR) HEATER ON	>C20BlF >HEATER ON
>(next input)	(next input)

3.4.5.8 BLOW (on/off)

Interrogation and control of Window Conditioner Blower status. In Automatic Mode an OFF command will cancel the automatic operation algorithm; an ON command has a 5 minute timeout whereupon automatic control commences. An OFF control will also shut the Heater OFF (see HEAT).

Syntax example:

ST:	MT:
>BLOW(CR) BLOWER OFF	>C21F >BLOWER OFF
>BLOW ON(CR). BLOWER ON	>C2lBlF >BLOWER ON
>(next input)	(next input)

3.4.5.9 SHUT (on/off)

Interrogation and control of Solar Shutter status, provided one is installed and configured (see CONF). In Automatic Mode a control command will be cancelled within 15 seconds by the automatic operation algorithm.

An OFF command cannot cancel an ON state controlled by the Light Monitor Board A5.

Syntax example:

ST:	MT:
>SHUT(CR)	>C22F
SHUTTER IS OFF	>SHUTTER IS OFF
>SHUT ON(CR)	>C22B1F
SHUTTER IS ON	>SHUTTER IS ON
>(next input)	(next input)

3.4510 RECT

Gifft RBC Recorder Output test; continuous until aborted with ESC character. Operates only in Maintenance Mode. Outputs a pattern of alternating on/off cloud signals, each half period 160 milliseconds (4.8 degrees) long, starting with on at 0 degrees. Trigger Break interval is 12 seconds.

Syntax example:

ST:	MT:
>RECT(CR)	>C23F
TEST RECORDING UNTIL ESC	RECTEST ON (A)
(ESC)	A
>(next input)	(next input)

3.4.5.11 TIME (HH MM SS)

Interrogation and setting of the internal clock in format:

hours (HH): 0...23; one or two digits
minutes (MM): 0...59, one or two digits
seconds (SS): 0...59, none, one, or two digits

Spaces shall separate number groups. Seconds may be omitted.

Time counting restarts from zero after each power down or Reset.

Syntax example:

ST:	MT:
>TIME(CR)	>C24F
00:08:19	>C24 00:08:19
>TIME 12 34(CR)	>C24B12B34F
TIME IS SET	>C24 12 34 TIME
>(next input)	(next input)

3.4.5.12 DATE (YYYY MM DD)

Interrogation and setting of the internal calendar in format:

Year (YYYY): Four Digits
Month (MM): 1...12; one or two digits
Day (DD): 1...31; one or two digits

Spaces shall separate number groups.
Leap years are observed.

Date counting restarts from zero after each power down or Reset.

Syntax example:

ST:	MT:
>DATE(CR)	>C25F
0000-00-01	>C25 0000-00-01
>DATE 1987 8 18 (CR)	>C25B1987138B18
DATE IS SET	>C25 1987 8 18
>(next input)	(next input)

3.4.5.13 RESE

The command inhibits all operation, including Watchdog Refresh, leading to a Reset and restart within approx. 5 seconds. See also START-UP, paragraph 3.4.3.

Syntax example:

ST:	MT:
>RESET(CR)	>C27F
	X27
(no-activity-delay)	(delay)
(start-up messages)	(start-up messages)

3.4.5.14 CAL (time)

Offset calibration command. Suggested time is 120...240 seconds; omitting it will prevent command execution.

Operates only in Maintenance Mode.

WARNING! ***COMMAND MAY CAUSE UNDETECTED ERRONEOUS OPERATION IF MISUSED! USE ONLY AS INSTRUCTED IN SECTION 6.***

Syntax example:

ST:	MT:
>CAL 120(CR)	>C40B12F
OFFSET BASE UPDATE	OFFSET BASE UPDATE
(120 sec. terminal inactivity)	(120 sec. inactivity)
OFFSET TO EEPROM	OFFSET TO EEPROM INPUT DATA AVE
INPUT DATA AVE 15.9500	- 0 16.0140
	(one data item at a time with C or F)

```
0     16.0140  15.9650  16.0890  15.9470  15.9720
250   16.0180  16.0880  16.0940  15.9810  15.9930
500   16.0270  16.0238  16.0205  16.0173  16.0140
750   16.0108  16.0075  16.0043  16.0010  15.9978
1000  15.9945  15.9913  15.9880  15.9848  15.9815
```

(ESC) (aborts output of table)	A
>(next input)	>_(next input)

3.4.5.15 HELP

The command outputs the Standard Terminal command set with short descriptions. No Maintenance Terminal equivalent is available. ESC will abort output.

Syntax example:

ST:	MT:

```
>HELP(CR)                                        (no  equivalent)
VAISALA CT 12K VERSION 2.42 SN: 87023

TIME        (HH MM(SS))
DATE        (YYYY MM DD)
MES         AUTOMATIC DATA MESSAGE
PAR         DISPLAY PARAMETERS
STA         STATUS MESSAGE
CONF        SYSTEM CONFIGURATION
CLIM        <LIMIT> CLOUD LIMIT
SLIM        <LIMIT> SIGNAL LIMIT
DEV         SET/DISPLAY DEVICE SCALE
TOTAL       <SIGNAL SUM> SET /DISPLAY THE NORMALIZED SIGNAL
            SUM LIMIT
NSCA        SET/DISPLAY NOISE SCALE
SCAL        SET/DISPLAY OUTPUT SCALE
LNOR        SET/DISPLAY THE LASER POWER NORM
EMOD        ON/OFF EXTINCTION NORMALIZATION
RMOD        ON/OFF DATA RECORDING MODE
BMOD        ON/OFF BASE OUTPUT ONLY ON/OFF
AUTO        ON/OFF AUTOMATIC MODE
RESET
LASE        ON/OFF LASER ENABLE DISABLE
SEQ         ON/OFF SEQUENCE START STOP
RAT         <HIGH/LOWGAIN> SET /DISPLAY THE GAIN RATIO FOR
            NORMALIZATION
MEAS        <TIME S> LASER MEASUREMENT
HOFF        <HEIGHT> SET/DISPLAY OFFSET VALUE FOR THE
            MEASURED HEIGHTS
FREQ        0...7 SET/DISPLAY LASER PULSE FREQUENCY
NOIS        SAMPLE NOISE DISPLAY
AN          0. ..17 ANALOG TEST
GAIN        SELECT GAIN 0/2
HEAT        ON/OFF BLOWER HEATER CONTROL
BLOW        ON/OFF BLOWER CONTROL
SHUT        ON/OFF SOLAR SHUTTER MANUAL CONTROL
ALIM        <ID><VALUE> SET/DISPLAY ALARM LIMITS
RECT        RECORDER TEST OUTPUT UNTIL ESC
```

3.4.5.16 MEAS (time)

Performs a measurement using the specified time for sampling. If no time is specified, 1 second is used.

The command can only be used in Maintenance Mode.

After measurement completion, the raw range gate data values are available in Table 0 (see TAB). No further processing is performed.

Syntax example:

ST:	MT:
>MEAS 12 BACK SCATTERED POWER (12 sec. terminal inactivity) INPUT DATA AVE 15.9488 >(next input)	(no equivalent)

3.4.5.17 TAB n (si ci)

Output of internal data tables, where:

n is table number as follows:

0 is raw receiver data in Flash AD converter units

1 is intermediate calculation table

2 is final range and instrument normalized data values if EMOD is OFF
or
final extinction normalized (inverted) data values if EMOD is ON

3 is static offset data table

4 is instrument-only normalized data table

si is Start Index, 0...253, equalling the 50 ft range gate number, from which output starts. If not specified, 0 is used (= 0 ft).

ci is Cycling Index, 1...254, equalling the number of range gates desired for cyclic, continuous output. If not specified, output will be once only, from Start Index to end of table. If specified then Start Index. must also be specified, and output cycles continuously until aborted with ESC.

Output and recycle of table starts with latest cloud heights and penetration in the form in Digital Message Status Line 1. Non-cloud obstruction heights are not indicated.

Output line contains height of first sample in line, followed by five samples.

Syntax example:

ST:	MT:
>TAB 3 17 13(CR)	**(no equivalent)**

```
LASER PULSE COUNT     10907
///// ///// ///// /////
850 16.0043 16.0010 15.9978 15.9945 15.9913
1100 15.9880 15.9848 15.9815 15.9783 15.9750
1350 15.9745 15.9740 15.9735

///// ///// ///// /////
850 16.0043 16.0010 15.9978 15.9945 15.9913
1100 15.9880 15.9848 15.9815 15.9783 15.9750
1350 15.9745 15.9740 15.9735

///// ///// ///// /////
850 16.0043 16.0010 15.9978 15.9945 15.9913

(ESC)
>(next input)
```

3.4.5.18 GRAP n (sc si ic)

Command for semigraphic output of internal measurement data, i.e. same as with TAB, where:

n is table number, see TAB

sc is Scaling Factor for specifying how many horizontal character positions shall equal a value of 1.0000 in the table in question. If not specified, 200 is used.

si is Start Index, 0...253 i.e. first range gate number of output. If not specified, then 10 is used (=500 feet).

ic is Index Count, 0...254 i.e. how many 50 foot range gates shall be output. If not specified then output will be to end of range.

Output is once only; no cycling is available. Comrnand parameters may be omitted from the end of the line, but not in between. Output may be aborted with an ESC character.

Range gate data is output one gate per line, starting from the Start Index; each line contains the height points, one per character position, and an asterisk (*) as a mark for the data value of that range gate.

Syntax example:

ST:	MT:

```
>GRAP 0 100 0 12(CR)                    (no equivalent)
  0 ....... *
 50 *
100 ..............*
150 *
200 ....*
250 .......*
300 ..............*
350 ..............*
400 ....*
450 ....*
500 .......*
550 .........*

>(next input)
```

3.4.5.19 MES

For output of Digital Message No. 2 in the Dialog Mode (LINE OPEN).

In AUTOMATIC MODE the message will be that of the last completed measurement; this operates continuously in the background in spite of automatic message transmission being inhibited.

In MAINTENANCE MODE a correctly formatted message will be output but only internal monitoring data will be updated. Additionally if a MEAS command (3.4516) is carried out, the raw range gate data table will be updated.

With Maintenance Terminal CTH 12 the output of Status Lines 1 and 2 will be in groups of max. 16 characters, and range gate contents will be output one gate at a time, preceded by the range height in feet or meters. Message viewing is controlled by Forward (F), Backward (B), Continuous (C; stepping) and Abort (A) keys.

Syntax example:

ST:	MT:
>MES(CR)	>C2F
10 04200 00150 ///// ///// ~3000011010	10 04200 00150 F
2 3 0.08 36 12 168 23.9 4.56 20	///// ///// F
	0000011010 F
-ODD.............................DD	2 3 0.08 3 6 F
-1	12 168 F
-2	23.9 4.56 20 F
-3	
-4	0 (Data Value) F
-5	50 (Data Value) F
-6 (DATA VALUES)	
-7	etc. to
-8	
-9	12450 (Data Value) A
10	
11	
l2DD.............DD	
>(next input)	> (next input)

3.5 OPERATION WITH MAINTENANCE TERMINAL CTH 12

3.5.1 GENERAL

The Maintenance Terminal CTH 12 is connected to the CT 12K Ceilometer through the Maintenance Terminal connector J4 at the Equipment base bottom.

The Terminal is controlled with the hexadecimal keyboard incorporated in the terminal. The decimal number keyis (0...9) are used in entering number data; the alphabetic keys (A...F) have special functions:

A key	1. message viewing **ABORT DISPLAY** key
B key	1. blank character (= "space") **2.** message viewing BACK STEP key
C key	1. command header 2. message viewing CONTINUOUS DISPLAY key
D key	1. decimal point
E key	1. minus sign
F key	1. open line 2. line feed, command line terminator (= "return") 3. message viewing FORWARD STEP key

The operation of the CT 12K can be monitored/controlled by giving commands from the Maintenance Terminal CTI-I 12. The commands are identified by header key (C) and command numbers. The correspondence of the number and commands is found in table 3.5.3. **A** label inside the cover of the CTH **12** Terminal includes operating instructions and a command list.

The use of commands and the command format is described in Sections 3.3 and 3.4.

3.5.2 OPERATION

3.5.2.1 Opening and Closing the Line (F key, Cl command)

The system indicates being ready to accept commands by outputting a prompt (" > ") to the LCD display of the terminal.

After being connected to the CT 12K, the terminal display is clear. This indicates that the system is not ready for commands. The communication line is opened by pressing the F key. The system responds by displaying the prompt (" > ").

NOTE! If the system is outputting the automatic message when the CTH 12 is connected, some characters may appear in the display; and the line is not opened until the output is finished.

Similarly, the line should be closed when the command session is over so that the standard data message will be received.

The line is closed by the closing command (ClF).

As with a standard terminal, the line will close automatically 1 minute after the last keyboard entry.

3.5.2.2 Command format

After the system displays the prompt ("> "), commands may be given using the following command format:

```
C n B par1 B par2 F
```

where

C	is command header (C key)
n	is command number, 1...40 (see Sections 3.3 and 3.4 for the command descriptions)
B	is blank (B key), equals "space"
par1 par2	are optional command parameter values in the format:

```
E i D d
```

where

E	is minus sign (E key)
i	is integer portion of the parameter, decimal number
D	is decimal point (D Key)
d	is decimals, decimal number
NOTE!	E, D, d are omitted if not needed.
F	is command line terminator (F key)

When entering a command, the alphabetic key characters are displayed as follows:

A not used inside a command line
B blank (space) character
C C (command header)
D decimal point
E minus sign
F command line terminator

Examples: (The user-entered characters are underlined)

Standard data message display command

> C2F (entered)
> c 2 (displayed)

Cloud limit parameter setting

>C 6 B 0 D 1 5 6 7 F (entered)
>C6 0 . 1 5 6 7 (displayed)

Alarm limit setting

>C 2 6 B 1 1 B 1 6 0 F (entered)
>C 2 6 1 1 1 6 0 (displayed)

3.5.2.3 Viewing Messages

The LCD display of the Maintenance Terminal is capable of displaying only one line of 16 characters at a time. The commands MES (C2), STA (C3), PAR (C4), and ALIM (C26) generate responses of multiple lines. These outputs have to be viewed line by line on the CTH 12 terminal.

The command format is the same as other commands. After entering the command, the display is cleared and the first line of the output is displayed. In order to view the rest of the output lines, the view control keys (the alphabetic keys of the hexadecimal keyboard, see Paragraph 3.5.1) are used. The alphabetic keys have different functions in viewing messages than in entry of commands:

A key: ABORT DISPLAY key
B key: BACK STEP key
C key: CONTINUOUS DISPLAY key
D key: not used
E key: not used
F key: FORWARD STEP key

1. ABORT DISPLAY (A key) is used to stop the output and return to the ready state (prompt (" > ") is displayed when ready).

2. BACK STEP (B key) is used to display the previous line of the message (one line per key stroke).

3. FORWARD STEP (F key) is used to display the next line of the message (one line per key stroke).

4. CONTINUOUS DISPLAY (C key) is used to display the output continuously line by line.

BACK STEP or FORWARD STEP key determines the direction of the continuous display. If BACK STEP is pressed prior to CONTINUOUS DISPLAY, the output advances backward; if FORWARD STEP is pressed prior to CONTINUOUS DISPLAY, the output advances forward.

3.5.2.4 Operating Session

The use of the Maintenance Terminal CTH 12 can be divided into three phases:

1. Open the communication line for commands.

2. Use the commands for CT 12K operation monitoring or parameter setting.

3. Close the communication line to return to normal operation.

The CT 12K ignores operator inputs unless the communication line is opened for commands,,

The user should close the line after each session. The line is closed automatically after a l-minute time out period if no characters have been entered. Before closing the line, the system must be set to the proper operating mode (AUTO ON). If the system is left in Maintenance Mode (AUTO OFF), the automatic standard message output is inhibited.

Some of the commands can be used only in Maintenance Mode (Section 3.5).

3.53 COMMANDS TABLE

The commands available for the Maintenance Terminal are in the following table. Several commands that can be entered from a standard RS-232C data terminal have been omitted from the Maintenance Terminal command set. The TAB, GRAP, and MEAS, commands are not necessary for maintenance and troubleshooting.

The commands are identified with the command numlbers instead of command abbreviations that are used with a standard data terminal.

In the table are listed:
- o command number
- o parameter(s) - if needed
- o corresponding abbreviation used with standard data terminal (refer to Section 3.3)
- o description of the command
- o notes on use of the command

Command Table

NUMBER	PARAM1	PARAM2	ABBR.	DESCRIPTION
Cl	------	------	CLOS	Close line
C2	------	------	MES	Data message display
C3	------	------	STA	Status meesage display
C4	------	------	PAR	Parameter message display
C5	------	------	CONF	Configure unit (M/F) (l/O) shutter
C6	<value>	------	CLIM	Cloud limit parameter set / display
C7	<value>	------	SCAL	Output scale parameter set / display
C8	<value>	------	NSCA	Noise scale parameter Bet / display
C9	<value>	------	DEV	Device scale parameter set / display
Cl0	<value>	------	SLIM	Signal limit parameter set / display

Cl1	<l/0>	------	AUTO	Automatic mode ON/OFF	
Cl2	<l/0>	------	EMOD	Extinction normalization ON/OFF	
Cl3	<l/0>	------	RMOD	Record Data (1) Clouds (0)	
Cl4	<chan>	------	AN	Analog channel monitoring until aborted	(2
Cl5	<l/0>	------	LASE	Laser ON/OFF	(1
Cl6	<l/0>	------	SEQ	Sequence ON/OFF	(1
Cl7	------	------	NOIS	Noise value monitoring until aborted	(2
Cl8	<value>	------	FREQ	Laser frequency set / display	
Cl9	<0/2>	------	GAIN	Gain set / display	
C20	<l/0>	------	HEAT	Window conditioner heater ON/OFF	
C21	<l/0>	------	BLOW	Window conditioner blower ON/OFF	
c22	<l/0>	------	SHUT	Solar shutter ON/OFF	
C23	-----	------	RECT	Recorder ouput test until aborted	(l&2
C24	<time>	------	TIME	Time Set /Display HH MM (SS)	
C25	<date>	------	DATE	Date Set /Display YYYY MM DD	
C26	<chan>	<limit>	ALIM	Alarm limit set / display	
C27	------	------	RESET	CPU Reset	
C28	<value>	------	LNOR	Laser normal power parameter set /display	
C29	<l/0>	------	BMOD	Base only output ON/OFF	
C30	<value>	------	TOTA	Total parameter set / display current signal sum / display	

C31	<value>	------	SEND	Digital message no select / display
C32	<value>	------	RAT	Gain Ratio Set/Display
C33	<value>	------	SERN	Serial Number Set/Display
C34	<value>	------	HOF'F	Height Offset Set/Display
C40	<value>	------	CAL	Offset calibration, secl

Notes: (1 can be used only in maintenance mode

(2 abort display with A key

APPENDIX 1
CTM 12 Monitored parameters

Ch	Monitored parameters	Typical values (when loaded)	Temperature dependence	HW scaling	A/D bits respectively [5]	Official signal designations
0	+20VI I/F pos. supply, unreg.	+21.0 ± 3.5 V		0.18	193 ± 32	P20I
1	+20VA Analog pos. supply, unreg.	+19.5 ± 3.5 V		0.18	179 ± 32	P20A
2	+25V Shutter&heating supply, unreg.	+26.0 ± 4 V		0.13	172 ± 27	P25V
3	+10VD Logic supply, unreg.	+8.0 ± 2 V		0.32	131 ± 33	P10D
4	+10VR Receiver LOV supply, unreg.	+9.5 ± 2 V		0.32	155 ± 33	P10R
5	+10VX Xmitter LOV supply, unreg.	+9.5 ± 2 V		0.32	155 ± 33	P10X
6	+12VM Maint. term. supply, unreg.	+12.0 ± 2.5 V		0.32	196 ± 41	P12M
7	XHIV Xmitter HIV supply, unreg.	+160 ± 40 V [1] [2]	+0.3 %/°C [4]	0.01	82 ± 20 (+0.3%/°C)	PXHV
8	LLAS Laser peak power	+1.5 ...4.5 V		1.00	77...230	LLAS
9	LSKY Ambient light level	+0.0 ...5.0 V		1.00	0...255	LSKY
10	MTE External temperature	−2.98 ± 0.06 V [1]	−0.01V/°C	−1.00	152 ± 3 (+0.51/°C)	TE
11	MTB Blower temperature	−2.98 ± 0.06 V [1]	−0.01V/°C	−1.00	152 ± 3 (+0.51/°C)	TB
12	MTI Internal ambient temperature	−2.98 ± 0.06 V [1]	−0.01V/°C	−1.00	152 ± 3 (+0.51/°C)	TI
13	MTL Laser diode temperature	−2.98 ± 0.06 V [1]	−0.01V/°C	−1.00	152 ± 3 (+0.51/°C)	TL
14	−20VI I/F neg. supply, unreg.	−20.0 ± 3.5 V		−0.18	184 ± 32	M20I
15	−RHIV Receiver HIV supply, unreg.	−310 ± 80 V [illegible]	+1 %/°C [4]	−0.01	158 ± 41 (+1%/°C)	MRHV
16	−20VA Analog neg. supply, unreg.	−20.0 ± 3.5 V		−0.18	184 ± 32	M20A
17	GND Offset GND for Ch10...17	±0.00 ± 0.02 V		−1.00	0...1	GND

1) at 25 °C
2) adjusted depending on laser or photodiode parameters
3) may be higher value during the adjustment procedure (up to 425 V)
4) approximately
5) max. scale 255 refers to A/D ref. voltage V5 = +5.0V

CT3415

CHAPTER 4. FUNCTIONAL DESCRIPTION
TABLE OF CONTENTS

4.3 MODULE DESCRIPTIONS

4.3.1 PROCESSOR BOARD - CTM 12 REF. Al

REFERENCES:

1 MCS-5 1 Family of Single-Chip Microcomputers User’s Manual, Intel Corporation, 1981.

4.3.2 UNREGULATED POWER SUPPLY BOARD CTS 12 REF. A2

4.3.3 OUTPUT INTERFACE REF. A3

REFERENCES

Technical Note “MM 74HC942 300 Baud Modem”.

4.3.4 LIGHT MONITOR BOARD CTL 13 REF. AS

4.3.5 RECEIVER BOARD CTR 13 REF. A6

4.3.6 TRANSMITTER BOARD CTT 12 REF. A7

4.3.7 HIGH-VOLTAGE POWER SUPPLY CTP 12 REF. PSl

4.3.8 WINDOW CONDITIONER 2736 REF. Bl

4.3.9 MAINTENANCE TERMINAL CTH 12

4.1 OPERATION PRINCIPLES

Basic Principle of Oneration: The Speed of Light

The operating principle of the CT 12K. Ceilometer is based on measurement of the time needed for a short pulse of light to traverse the atmosphere from the Transmitter of the Ceilometer to a backscattering cloud base and back to the Receiver of the Ceilometer.

With the speed of light being:

$$c = 2.9929 \times 10 \text{ m/s} \quad (=9.8356 \times 10 \text{ ft/s})$$

a reflection from 12,000 ft will be seen by the receiver after

$$t = 24.4 \ \mu s$$

The general expression connecting time delay (t) and backscattering height (h) is

$$h = ct/2$$

where c is the speed of light.

Practical Measurement Signal

Generally, particles at all heights backscatter light, and so the actual return signal may look like that shown in Drawing 4413.

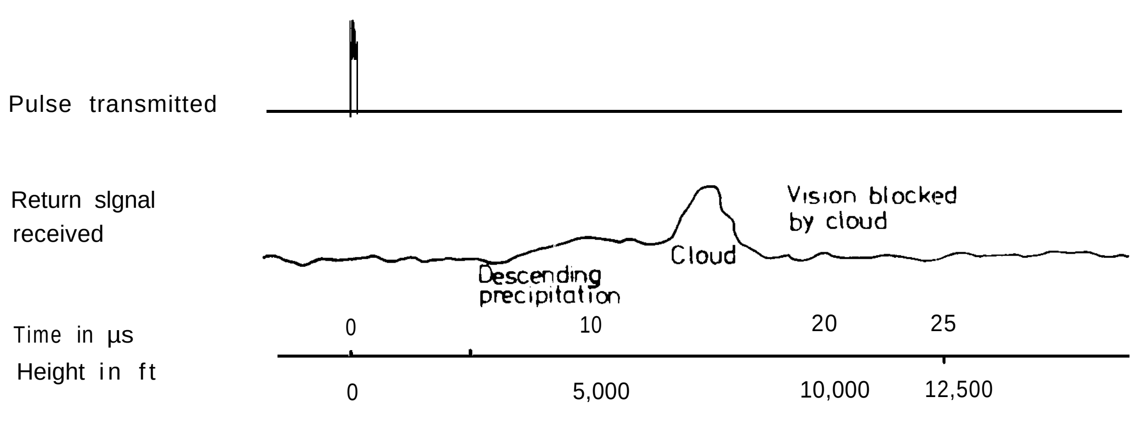


FIG 1. ACTUAL RETURN SIGNAL

CT 4413

The instantaneous magnitude of the return signal will provide information on the backscatter properties of the atmosphere at a certain height. From the return signal, information about fog and precipitation, as well as cloud, can be derived. Since fog and precipitation attenuate the light pulse, the cloud base signal will appear lower in magnitude in the return echo. However, the fog and precipitation information also provides data for estimating this attenuation and computing the necessary compensation, up to a limit.

The CT 12K ceilometer digitally samples the return signal every 100 ns from 0 to 25.4 us, providing a spatial resolution of 50 feet from ground to more than 12,500 feet above the surface. This resolution is adequate for measuring the atmosphere, since visibility in the densest clouds is in the order of 50 feet.

Noise Cancellation

For safety and economic reasons, the laser power used is so low that the noise of the ambient light exceeds the backscattered signal. To overcome this, a large number of laser pulses are used, and the return signals are summed. The desired signal will be multiplied by the number of pulses, whereas the noise, being random, will partially cancel itself. The degree of cancellation for white (Gaussian) noise equals the square root of the number of samples; thus, the resulting signal-to-noise ratio improvement will be equal to the square root of the number of samples. However, this processing gain cannot be extended ad infinitum since the environment changes. For example, clouds move.

Return Signal Strength

The instantaneous return signal strengtb is in general form (the Lidar Equation):

$$Pr(h) = E_0 \cdot \frac{c}{2} \cdot \frac{A}{h^2} \cdot \beta(h) e^{-2\int_0^h \sigma(z)dz}$$

where

Pr(h)	is the instantaneous power received from height (h)(Watts - W).
E_0	is the effective pulse energy (taking all optics attenuation into account) (Joules = J, 1J = 1 Watt - second).
c	is the speed of light (meters per second - ms).
A	is the receiver aperture (m^2).

h is the height in question (m).

ß(h) is the volume backscatter coefficient at height h(m^{-1} sr^{-1}, sr = steradian).

$e^{-2\int_0^h \sigma(z)dz}$ is the atmospheric transmittance and accounts for the transmitted and backscattered power by extinction (z) (m^{-1}) at various heights z between transceiver and height in question. The expression equals 1 in a clear atmosphere (i.e., no attenuation).

Height Normalization

Assuming a clear atmosphere, it can be seen that the power is inversely proportional to the square of the height i.e., the strength of a signal from 10,000 ft is generally one-hundredth of that from 1,000 ft.

The height-square dependence is eliminated by multiplying the value measured with the square of the height (height normalization). However, noise, being height independent from a measurement point of view, will then be correspondingly accentuated with increasing height.

The Backscatter Coefficient

The volume backscatter coefficient, ß(h), of the Lidar Equation represents the portion of light which is reflected back towards the Ceilometer (e.g., by water droplets). It is obvious that the denser a cloud is, the stronger the reflection will be. The relationship can be expressed as:

$$ß(h) = k\delta(h)$$

where

k is a "constant" of proportionality.

δ(h) is the extinction coefficient (i.e., the attenuation factor in a forward direction).

The extinction coefficient relates to *visibility* in a straightforward manner. If visibility is defined according to a 5% contrast threshold (World Meteorological Organization definition for *horizontal* visibility), then

$$\sigma = \frac{3}{V}$$

where

σ is the extinction coefficient

V is visibility (5% contrast)

The "constant" of proportionality, k, also called the Lidar Ratio, has been subjected to a lot of research. Although the Lidar Equation can be solved without knowing its value, it must remain constant with height if accurate estimates of the extinction (or visibility) profile are to be made.

It has been found that in many cases, k can be assumed to equal 0.03, tending to be lower in high humidities, to 0.024; and higher in low humidities, to 0.05. However, in precipitation of various kinds, k will have quite different values.

Assuming a value 0.03 ($srad^{-1}$) for k and visibility in clouds being in the range 15m...150m (50...500 ft) gives the range of value for B.

$$B = 0.0006...0.006 \quad m^{-1}sr^{-1}$$

$$= 0.6...6 \quad km^{-1}sr^{-1}$$

Extinction Normalization and Vertical Visibility

Any fog, precipitation, or similar obstruct.& to vision between ground and cloud base may attenuate the cloud base signal and produce backscatter peaks that far exceed that from the cloud. Virtually any backscatter height profile is possible, up to some physical limits. To distinguish a significant cloud return signal, the attenuation of fog, precipitation, etc., has to be taken into account by normalizing with regard to extinction. The profile thus obtained is proportional to the extinction coefficient at various heights, and enables the use of fairly straightforward threshold criteria to determine what is cloud and what is not.

By assuming a linear relationship between backscatter and extinction coefficient according to the previous formula and that the ratio, k, is constant over the range observed, it is possible to obtain an extinction coefficient profile through a mathematical computation. This is also called inverting the backscatter profile to obtain the extinction coefficient profile, and answers the question, “What kind of extinction coefficient profile would produce the backscatter profile measured?“.

No assumption as to the absolute value of the ratio, k, needs to be made if k is constant with height. The assumptions that have to be made are fairly truthful, and in any case accurate enough for the purpose of cloud detection.

Likewise, the inversion is also independent of several instrumental uncertainties including transmitted power and receiver sensitivity.

An estimate of *Vertical Visibility* can easily be calculated from the extinction coefficient profile because of the straightforward extinction coefficient-to-visibility relationship, provided that a constant contrast threshold is assumed. Visibility will simply be that height where the integral of the extinction coefficient profile, starting from ground, equals the natural logarithm of the contrast threshold, sign disregarded.

Tests and research have, however, shown that the 5% contrast threshold widely used for horizontal measurement is unsuitable for vertical measurement if values close to those estimated by a ground-based observer are to be obtained.

The CT 12K uses a contrast threshold value which, through many tests, has been found to give Vertical Visibility values closest to those reported by ground-based human observers. A wide safety margin is obtained with regard to pilots looking down in the same conditions since the contrast objects, especially runway lights, are much more distinct on the ground.

4.2 TECHNICAL DESCRIPTION

4.2.1 GENERAL OUTLINE

Refer to mechanical drawings A.CT 3400...A.CT 3406.

Drawing A.CT 3400 shows the Ceilometer in its normal operating configuration. It is mounted on the pedestal at a height which allows for convenient installation and maintenance, and raises it above snow and dust, etc.

The Main Equipment Assembly is protected by the Equipment Cover. This has windows on top of it for the Optics, and panels on its long sides to reflect sunshine.

The Window Conditioner mounts on top of the Equipment Cover, and connects to connector J2 underneath the Equipment Base, see Dwg ACT 3406. The main purpose of the Window Conditioner is to shelter the windows of the Equipment Cover from precipitation, and dry the windows of water droplets with warm air flow over the windows. In addition to this, the Window Conditioner also prevents excessive dust contamination, and curbs temperature extremes by warming the whole Ceilometer when external temperature is low, and circulating the air when it is warmed by sunshine.

The Main Equipment Assembly consists of two major subassemblies:

- The Optics Subassembly, which contains the Optics Housing as a frame; Transmitter Board; Receiver Board; associated optics adjustment hardware; the Light Monitor Board; Transmitter and Receiver lenses; Temperature Control Transformer; two Temperature Control Heaters; and, as an option, the Solar Shutter. The Optics Subassembly mounts on the Electronics Subassembly with six screws, and connects to it with seven separate cables and four attached connectors.

- The Electronics Subassembly, which contains the Equipment Base, High-Voltage Power Supply Housing and Board Frame as its mechanical body; High-Voltge Power Supply; Processor Board; Unregulated Power Supply Board; Output Interface Board (the last three mounted in the Board Frame). The External Temperature Sensor and four connectors are mounted to the Equipment Base and connect to various subassemblies with cables.

The four external connectors, placed underneath the Equipment Base for best protection, are (see drawing ACT 3406):

Jl	Line Input
J2	Window Conditioner (Control and Monitoring)
J3	Output Interface (FSK, Recorder)
J4	Maintenance Terminal

4.2.2 OPERATIONAL OUTLINE

The operation of the Ceilometer is described by way of the following separate functions; refer to Block Diagram CT 2295:

4.2.2.1	Measurement Circuit
4.2.2.2	Output Interfaces
4.2.2.3	Internal Temperature Control
4.2.2.4	Internal Monitoring
4.2.2.5	Power Supply Section
4.2.2.6	Solar Shutter Option
4.2.2.7	Window Conditioner

These will be described in conceptual terms. Where reference is made to modules or subassemblies with module descriptions of their own, or to the Software, detailed descriptions of the operation are found in the corresponding sections.

4.2.2. The Measurement Circuit

This is the main operational part of the instrument; that which measures the atmosphere. It is controlled by the processor and its software.

A measurement cycle is started by the processor by signaling the Laser Control Circuitry to issue Laser Trigger pulses at a selected frequency for a predetermined time.

A Laser Trigger pulse is sent from the Laser Control circuitry to the Transmitter board where it fires the thyristors of the Laser circuit. The ultrafast thyristors force a current pulse through the Laser diode which thus emits a short, high-intensity pulse of invisible infrared single-wavelength (904 nm) radiation.

The pulse is emitted over a 30° angle so a lens is needed to collimate the radiation into a parallel beam. The Laser Diode is thus located at the focal point of the lens.

The Laser Power Monitor senses the Laser pulses and outputs a voltage signal proportional to the average laser power.

The laser pulse then traverses the atmosphere and small amounts of radiation are backscattered from any non-gaseous particles in the atmosphere.

The optics are designed so that the Receiver field-of-view covers the transmitted beam completely at heights above approximately 1,000 ft. Between 100 ft and 1,000 ft, the coverage is partial ranging from 0% to 100% which aids in limiting the backscatter signal magnitude. Below 100 ft, no direct atmospheric coupling exists, but due to the multiple scattering phenomenon, signals can be measured. A cloud produces so much multiple scattering that detection is certain.

Some of the backscattered radiation hits the Receiver Lens, which focuses it onto a Silicon Avalanche photodiode operating as the radiation sensor.

Since only the wavelength of the Laser source (904 nm) is of interest, a Receiver Filter with a narrow bandwidth, 50 nm, is used for blocking most of the background radiation noise from interfering with the measurement.

The photodiode converts light signals into electrical current. The preamplifier of the Receiver Board converts current into a. voltage signal, which is then transferred to the actual data acquisition circuitry. Band pass is from 2kHz to l0MHz, so both DC and unwanted high frequency noise is blocked.

The Data Acquisition circuitry contains a processor-controlled Amplifier; a Flash Analog-to-Digital Converter; a Sample: Adder; a Sample Buffer Memory; and a Sample Summing Memory.

When the Laser Control circuitry issues a Laser Trigger pulse, the Data Acquisition circuitry get initiated at the same moment. The A-to-D converter takes a sample of the received and amplified backscatter signal, digitizes it, and inputs it into the first location of the Sample Buffer Memory. This all takes place within 100 ns. Exactly 100 ns after taking its first sample, the A-to-D converter takes the next sample. This will now represent backscatter from a height 50 ft above that of the first sample. After digitizing, this second sample is stored in the second location of the Sample Buffer memory.

In this way, samples are taken every 100 ns for 25.4 us, which provides 254 useful samples stored in consecutive locations in the Sample Buffer memory. These samples represent the backscatter signal of one laser pulse from 254 discrete heights at 50 ft intervals, resulting in a backscatter profile ranging from 0 to 12,650 ft. (For reasons of convenience, the speed. of light is assumed to be 1 ft/ns.)

Because the laser pulse transmitted is not infinitely short but of a duration of typically 150 ns, corresponding to an instantaneous ray length of 150 ft, the instantaneous backscatter signal will not represent the atmospheric conditions at the actual sampling height only, but will be an average value representing a height range. Based on the fact that both the laser ray and the backscatter signal propagate at the speed of light, it can be shown that this height range is half of the ray length (i.e., 75 ft with a 150 ns pulse). The digitized backscatter signal will thus represent averages over approximately 75 ft of height range, at 50 ft height intervals.

As was described in Operation Principles (Section 4.1), the amount of backscatter power within the field-of-view of the Receiver decreases by the square of the height, and is further attenuated by any backscattering matter. The signal received from more than about 1000 ft is completely buried in noise, both light noise and electrical noise. As described, the noise partially cancels itself relative to the number of samples summed or averaged from the same height.

Hence the laser is pulsed several times. Before the second pulse is transmitted, the data values of the first one have been transferred from the Sample Buffer Memory to consecutive locations in the Sample Summing Memory.

When the second laser pulse is transmitted, the backscatter signal from that is digitized exactly the same way as that of the first one. When done, the values in the Sample Buffer Memory are added by the Sample Adder to those of the first pulse, and the sums are stored in the Sample Summing Memory, in consecutive locations.

In this way, the operation proceeds until the end of the preset time. Now the 254 locations of the Sample Summing Memory contain the sums of thousands of samples, arranged by height. If the number of pulses has been, for instance, 10,000, a useful signal is 10,000 times stronger than that of one pulse, while normal random (“white”) noise is only 100 times stronger, according to the laws of probability. The improvement in signal-to-noise ratio is thus 10,000/100 = 100. For instance, a signal with an instantaneous amplitude one-tenth of the RMS value of the noise will now be ten times the RMS value of the noise.

Noise is not all bad, however. With the aid of noise, a signal that is a fraction of the A-to-D converter resolution in magnitude can be measured with an accuracy far exceeding this resolution.

After this sampling, digitizing and summing process, the Sample Summing Memory now contains a raw profile of the received backscatter power with 50 ft resolution from 0 to 12,650 ft. This data is now transferred by the processor to its Read/Write memory area for the actual processing, and the Sample Summing Memory is cleared for the next acquisition cycle.

Before the next acquisition cycle starts, the processor checks the average laser power measured by the Laser Power Monitor during the previous cycle. This is done with the Monitor A-to-D Converter by selecting the channel in question, by one of the processor tasks operating concurrently with the acquisition cycle storing the value in Read/Write memory. Based on the laser power value measured, a new value for the pulse frequency is calculated to keep average laser power as close as possible to the nominal value without exceeding it. Average laser power is thus controlled automatically by adjusting the pulse repetition rate.

Also, before the next acquisition cycle begins, the processor checks the measurement signal and noise levels and selects the gain to be used for the next cycle. High gain is desirable, but the active range of the A-to-D converter must not be exceeded.

The processor then starts a new measurement and data acquisition cycle and commences to process the data of the previous cycle concurrently with new data being gathered.

A diagram summarizing the different operational cycles is shown in Drawing 4411.

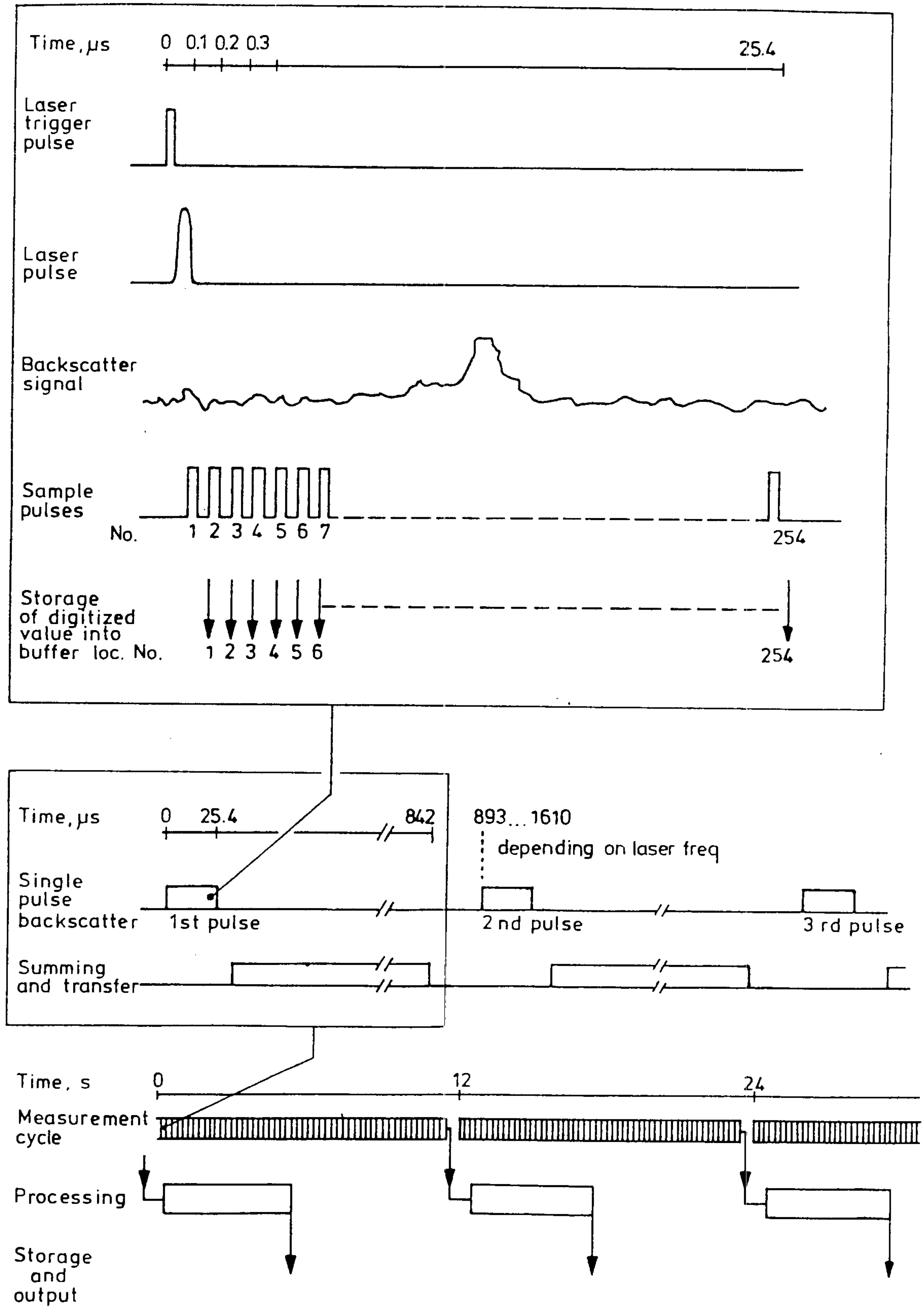


FIG.1. DIAGRAM OF INTERNAL CYCLES CT4411

The actual subassemblies and modules involved in the measurements are (see Dwgs A.CT 3401 through ACT 3405):

- Processor Board, Ref. Designation Al, contains the Amplifier, Flash A-to-D converter, Sample Adder and Memory, Processor, Program Memory and Read/Write memory, Laser Control circuitry and the Analog Monitoring section.

- Transmitter Board, Ref. Designation A7, contains the Laser Diode and associated pulse energy circuitry including its voltage regulator.

- Transmitter Optics

- Light Monitor Board, Ref. Designation A5, contains a downwardpointing photodiode for monitoring the laser power, and associated filtering and amplifying circuits. It also has a photodiode for monitoring sky radiation.

- Receiver Optics

- Receiver Board, Ref. Designation A6, contains the silicon Avalanche Photodiode Receiver, its Filter, and a current-to-voltage Converter Preamplifier.

- Subminiature coaxial cable W9 transfers the Laser Trigger pulse from Processor Board to Transmitter Board.

- Subminiature coaxial cable W8 transfers the preamplified backscatter signal from Receiver Board to Processor Board.

- Ribbon Cable W5 transfers the Laser Power Measurement signal from Light Monitor Board to Unregulated Power Supply Board A2.

- Unregulated Power Supply Board, Ref. Designation A2 tranfers the Laser Power Measurement signal to Processor Board Monitor A-to-D converter.

4.2.2.2 The Output Interfaces

The Output Interfaces of the Ceilometer are (Ref. Block Diagram CT 2295):

RS-232C Interface:	RS-232C interface of CTS 12 (A2) is mainly for maintenance and service purposes; routed to the Equipment base connector J4 with internal cablings.
FSK Bell 103 Interface:	Standard modem interface is provided by CTI 12; (A3), one line pair routed with internal cablings to the Equipment base connector J3.
Gifft RBC Recorder Output:	Interface for Gifft RBC Recorder is provided by CTI 12; (A3) two line pairs routed with internal cablfngs to the Equipment base connector J3.

The FSK and RS-232C interfaces are internally combined into one serial two-way processor interface, so that outputs from the Ceilometer are identical at both interfaces. Inputs from the two interfaces are "OR'ed" so that any one may serve as input. Simultaneous inputs are forbidden; the latter lead to erroneous input characters.

The RxD and TxD signals are connected at the 5V level to the microprocessor internal Universal Asynchronous Receiver Transmitter (UART). This is operated by software. Its Baud rate is determined by software through one of the microprocessor's internal counters. The Baud rate of the RS-232C interface of the CTS 12 board is 300 Baud as standard and default, but may be commanded to operate at 1,200 Baud.

The RS-232C interface is normally connected to the processor but may be manually switched to the FSK modem equipment side for FSK line troubleshooting purposes.

Beside RxD, TxD, and Grrd signals, the RS-232C connection of Unregulated Power Supply board A2 also contains a + 12V DC power supply and a Flag signal. These are used for the Ceilometer Maintenance Terminal CTH 12. This is powered from the Ceilometer, and since its keyboard is 16-key hexadecimal, the Flag is needed to signal the processor to interpret inputs from the terminal according to its special protocol.

CTH 12 Maintenance Terminal interfaces directly to the Equipment Base connector J4 to where Unregulated Power Supply RS-232C interface of Board A2 is routed by internal cablings.

Internally, the RS-232C interface of Board A2 is connected via a standard male 25-pin D-subminiature connector, which thus enables connections with standard cables for in-depth maintenance and service operations.

The standard asynchronous character frame is:

1 start bit

8 data bits (whereof: 7 used for std USASCII 1 "MSB" is normally TRUE but used for 8-bit special characters, when initiating the display of the Maintenance Terminal)

No Parity

1 Stop bit

Total character count is 10.

Due to the last data bit being TRUE in std ASCII communication, the character appears to have two stop bits.

The FSK Interface is Bell 103-compatible; transformer coupled and balanced. It is based on a monolithic single-chip modem with a jumper to operate either in Originate or Answer mode; the latter is standard. Its transmission rate is a fixed 300 Baud. The output signal level can be set with a jumper to five different levels.

Outputs for the Gifft RBC Recorder are:

1 Trigger break, which initiates the recorder sweep.

1 Inscription signal, which (when active) makes a mark on the recorder chart.

These outputs are controlled by the processor and its software via two output ports. The signals are routed via the Unregulated Power Supply board A2 to the Output Interface board A3 where the Trigger Break operates a normally closed relay contact and the Inscription Signal connects a 120 Hz signal, derived from the line frequency 60 Hz by full wave rectification via an isolation transformer, to the output line.

The inscription signal resolution is 20 ms corresponding to 80 ft; the full sweep is 3 s corresponding to 12,000 ft. The inscription signal timing starts at the end of the trigger break signal.

Refer to Drawing 4412.

If faults are detected, they are signalled by activating the trigger break for 200 ms, which causes the “projector” lamp on the Gifft RBC Recorder to blink.

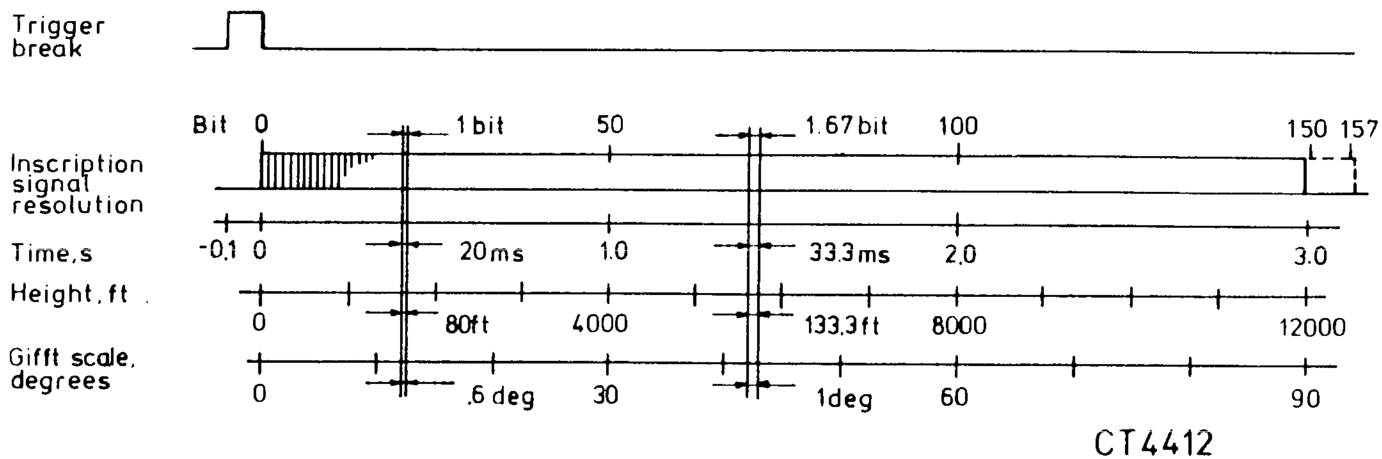


FIG. 2. DIAGRAM OF RECORDER OUTPUTS

The FSK and Recorder outputs are connected by Output Harness W3 to Output Interface Connector J3 at the Equipment Base. Primary surge protectors in the form of noble gas filled spark gaps are placed at the J3 connector. Secondary surge protectors in the form of series resistors and transient zener diodes are placed on the Output Interface Board.

The internal RS-232C interface is connected via male 25-pin D-subminiature connector J7 on the Unregulated Power Supply Board A2 with Maintenance Terminal Harness W4 to Maintenance Terminal Connector J4 at the Equipment Base. The signals are protected by series resistors and transient zeners.

4.2.2.3 Internal Temperature Control

Internal temperature is controlled by switching the two Temperature Control Heater resistors Rl and R2 “OFF,” in “series” or in “parallel.” The controller is situated on the processor board Al and uses a monolithic l0mV/°K temperature sensor. This is connected to two voltage comparators, which have reference set points at about 0°C (32°F) and 20°C (68°F). The comparators drive relays Kl and K2 on the Unregulated Power Supply Board A2 which connect power from Temperature Control Transformer Tl to Rl and R2. The processor has no control over the heating, but does monitor the temperature.

In indoor conditions and warmer, both relays are “OFF” and no heating power is connected.

Between 0°C (32°F) and 20°C (68°F) relay Kl is ON connecting the resistors to the transformer in series. Heating power will be approximately 20 W.

Below 0°C relay K2 in ON and relay Kl is forced OFF, connecting Rl, R2 in parallel to Tl. Heating power will be approximately 80 W.

Without heating, internal temperature will be 5°C...l0°C (l0°F...20°F) above ambient, after stabilizing.

With full heating, internal temperature will be 20°C...30°C above ambient, after stabilizing.

The time constant of the internal temperature is about 2 hours in calm conditions.

4.2.2.4 Internal Monitoring

The hardware for the internal monitoring consists mainly of the Scaling network, Selector and Monitor A-to-D Converter of the Processor Board Al. The actual alarm limits and algorithms are implemented in software, which also monitors and checks other functions.

The summary of the use of the Monitor A-to-D channels is presented in the Appendix of Chapter 3.

4.2.2.5 Power Supply Section

This consists of the High Voltge Power Supply PSl, the Unregulated Power Supply Board A2, and the Temperature Control Transformer Tl.

This section supplies unregulated power to all subassemblies, where the actual voltage regulators are located.

4.2.2.6 Solar Shutter Option

The option must be furnished if the geographical location is such that the sun may be right above the instrument (i.e., between the tropics of Capricorn and Cancer, plus some safety margin).

The solar shutter Kl consists of a solenoid and a flap placed above the transmitter lens. The receiver is adequately protected by its filter.

The sunlight sensor and solar shutter driver electronics are situated on the Light Monitor Board A5.

The shutter design is fail-safe (i.e., when no power is applied it is closed). The solenoid has to be energized to open. This is done by the electronics circuits without the need of processor control.

The processor is able to read the Sky Light sensor. The processor can also drive the shutter “ON” for testing purposes, but cannot force it to be “OFF’ when the shutter circuit detects excessive light.

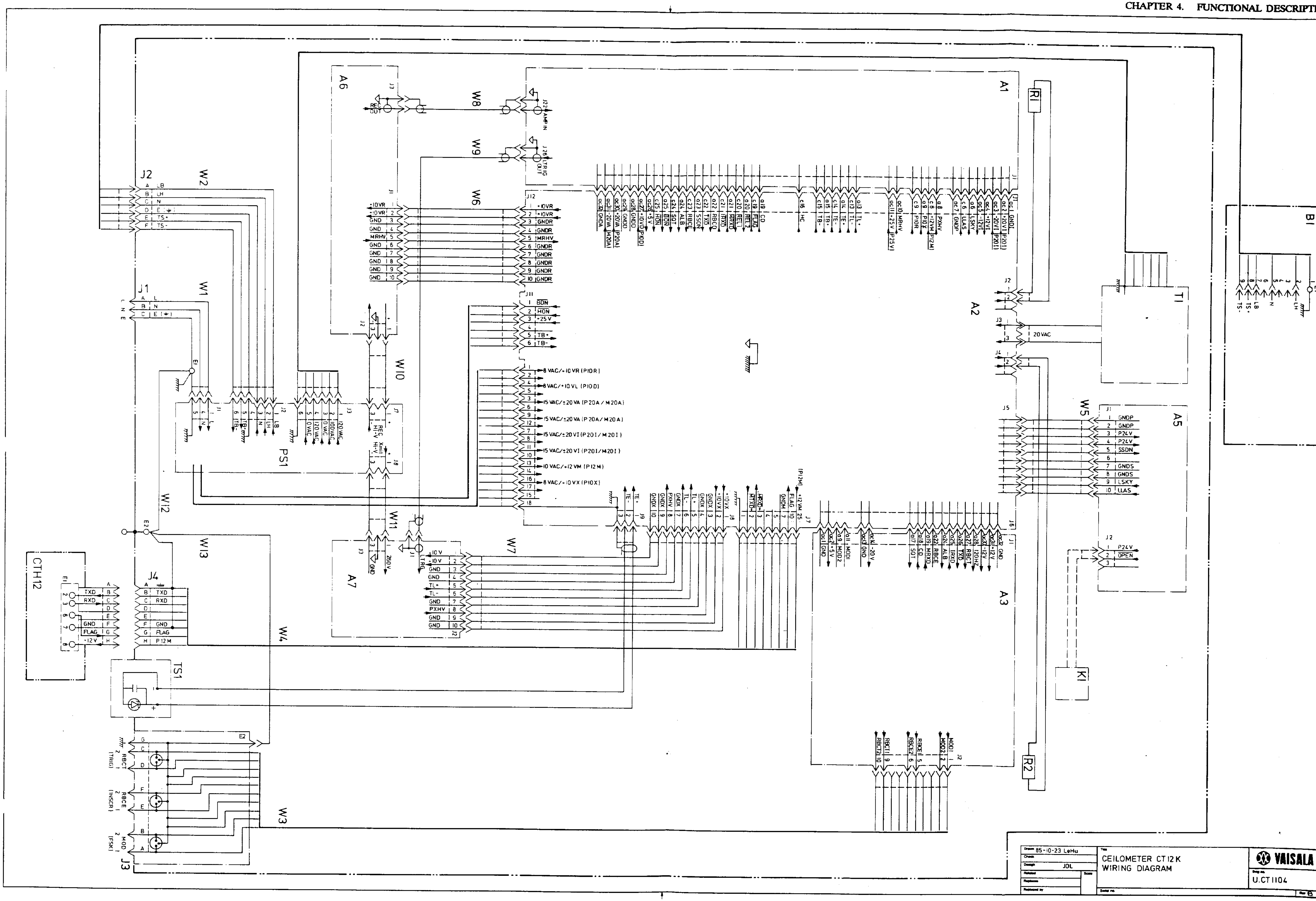
Note that in all documentation, Shutter “ON” corresponds to solenoid current being “OFF” and vice versa, due to the fail-safe design.

4.2.2.7 Window Conditioner

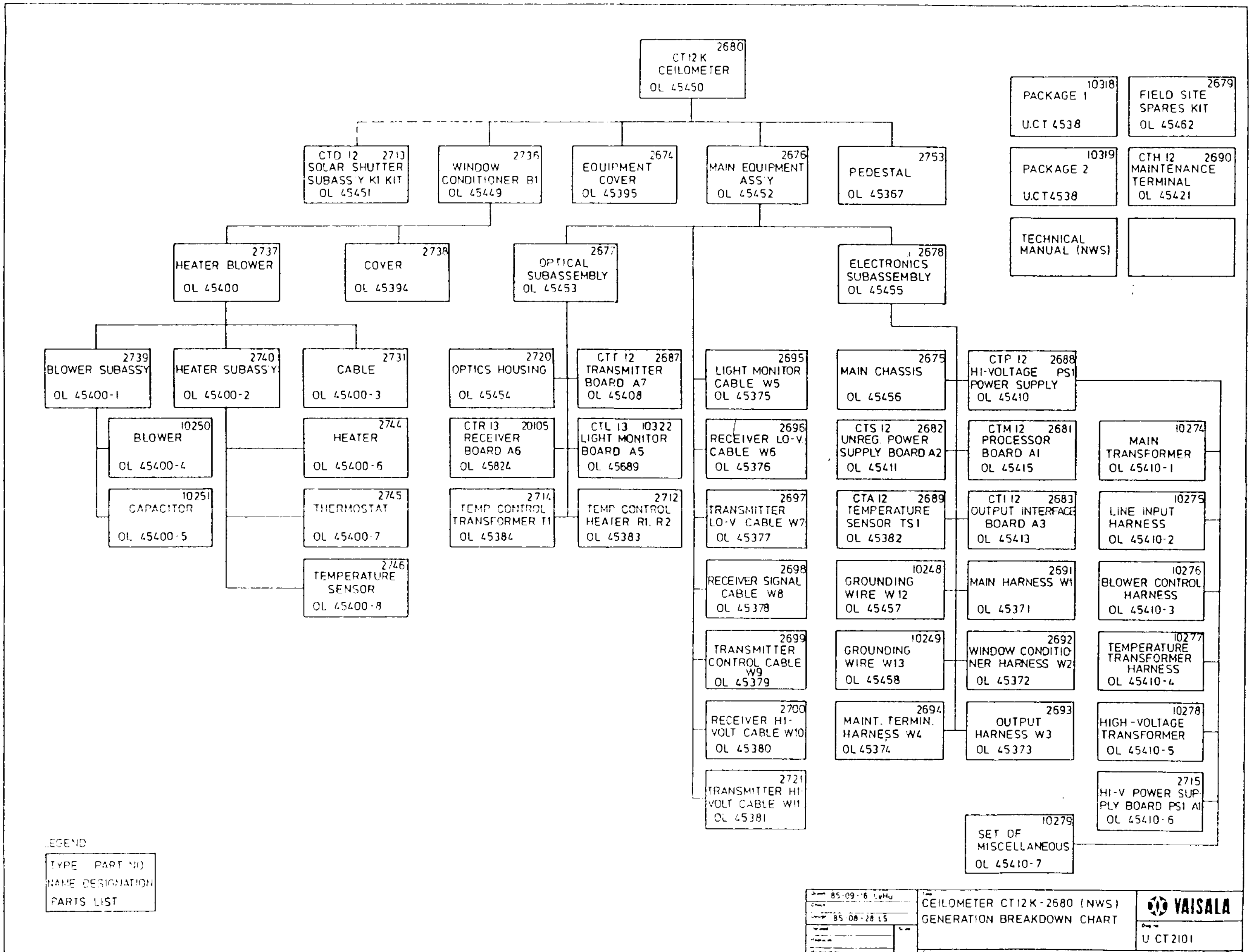
The Window Conditioner is controlled by two outputs from the Processor Board. These are routed through the Unregulated Power Supply Board A2 connector Jll to High Voltage Power Supply PSl to drive two relays. These switch Line Power to the blower and the heater of the Window Conditioner via connector J2. The relays are connected so that the heater can never get power without the blower being on.

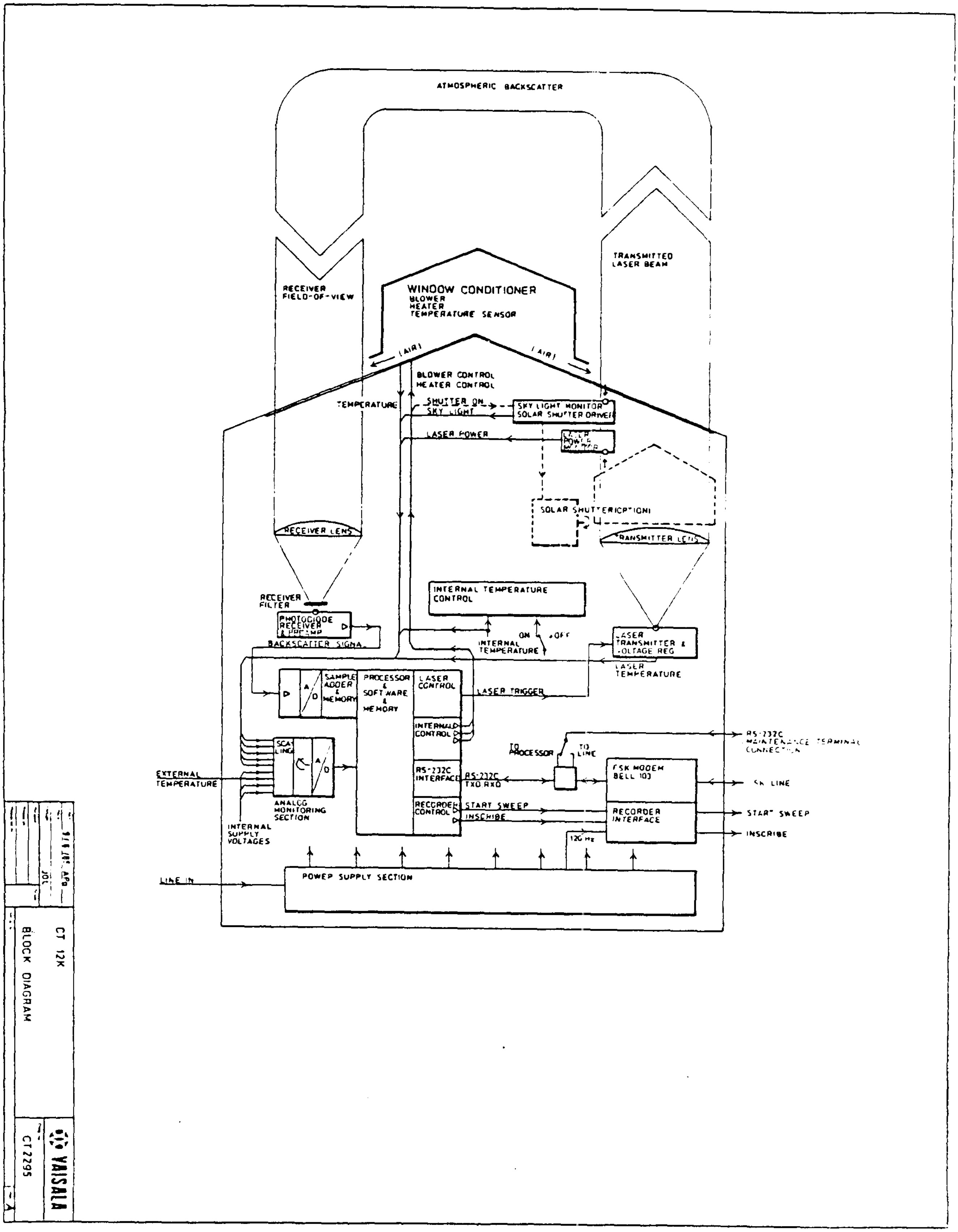
Window Conditioner line power has its own circuit breaker CB2 in PS1.

The Window Conditioner is monitored with a temperature sensor, software reference TB, which is placed in the warm air stream. This senses both the effect of the heater, and a potential blower motor failure that would cause a rapid increase in TB (when the heater is "ON"). For safety reasons, the heater also has a thermostat which breaks its current at about 250°F (120°C).

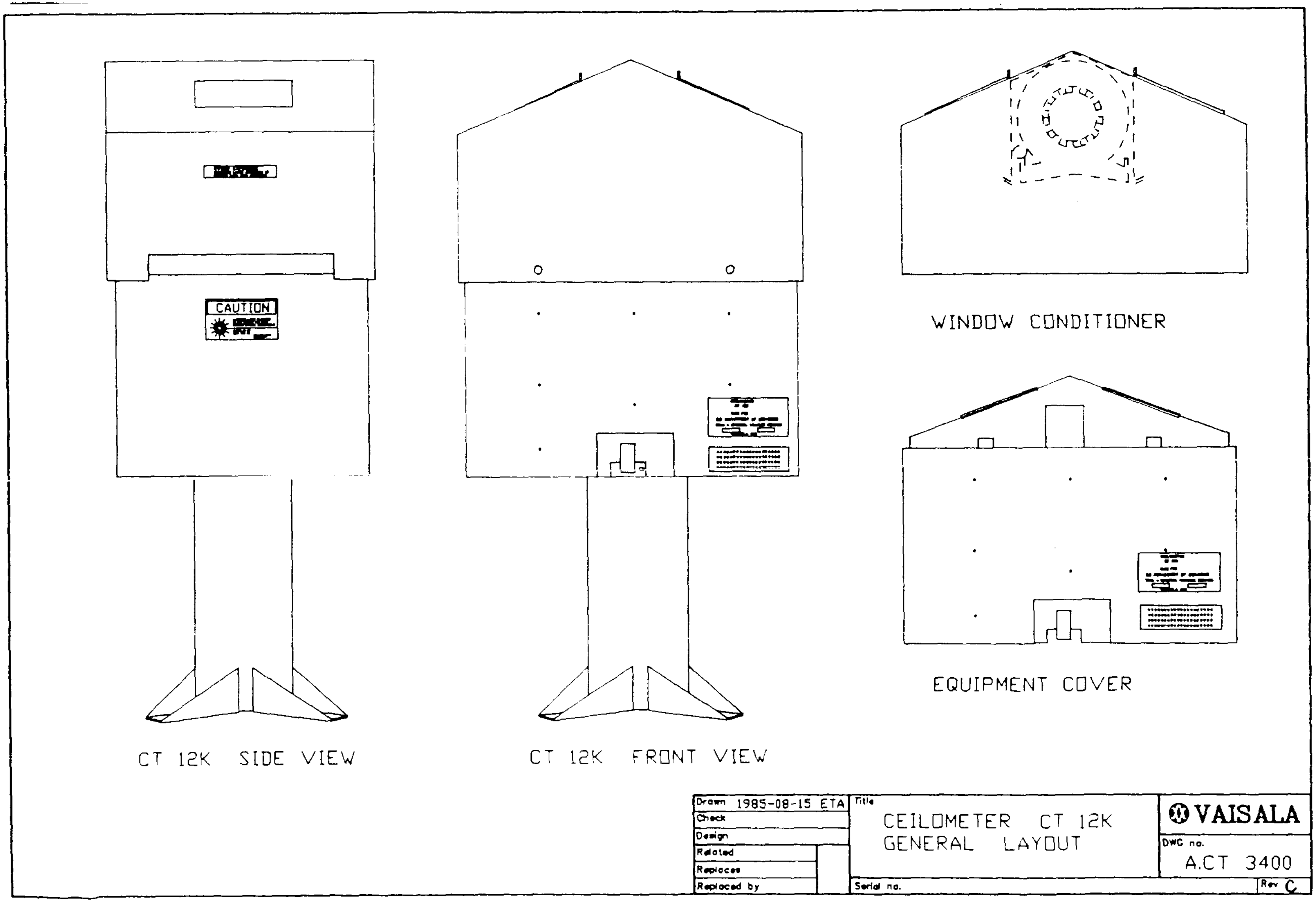


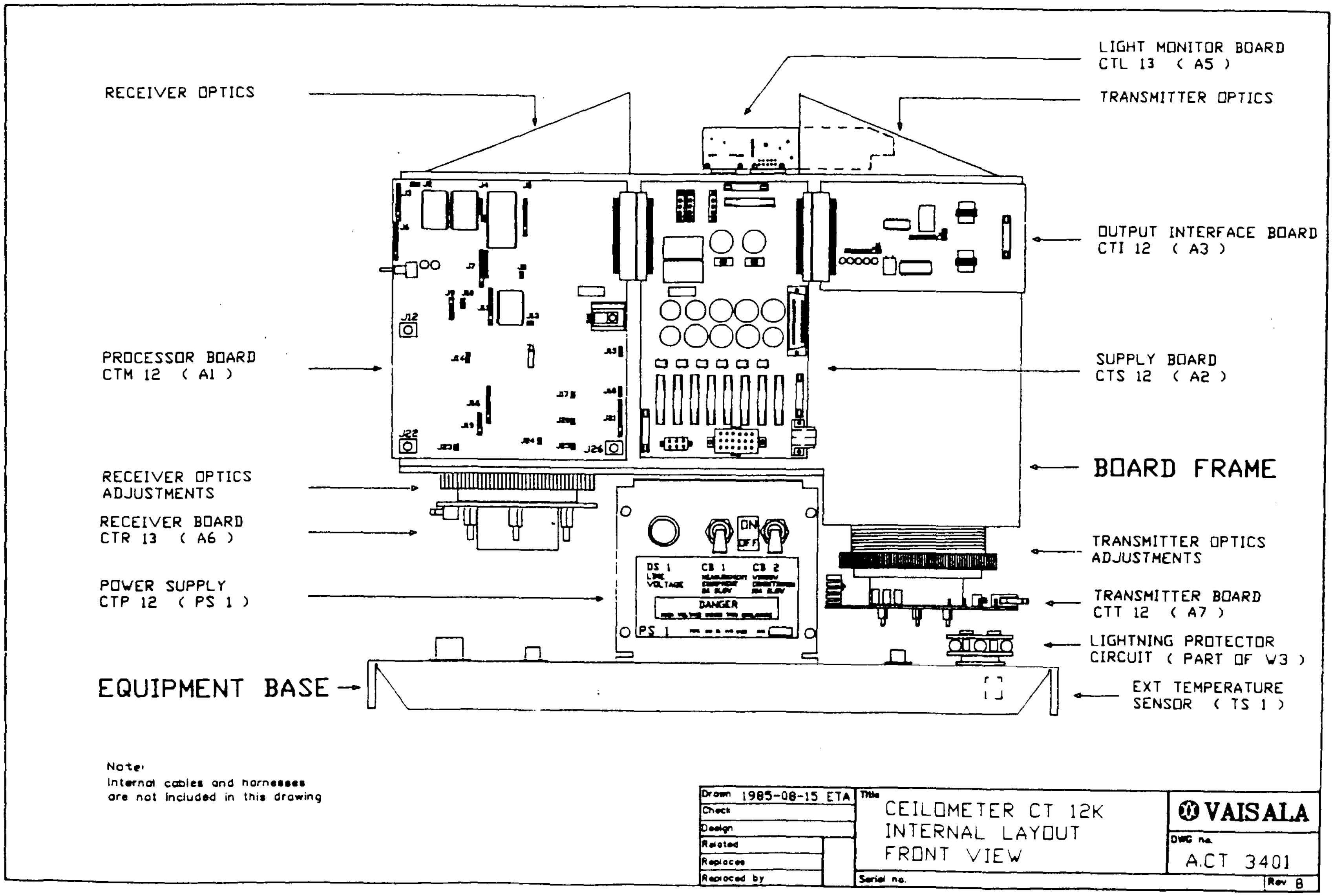
CEILOMETER CT12K
WIRING DIAGRAM
VAISALA
U.CT1104
85-10-23 LeHu
JOL

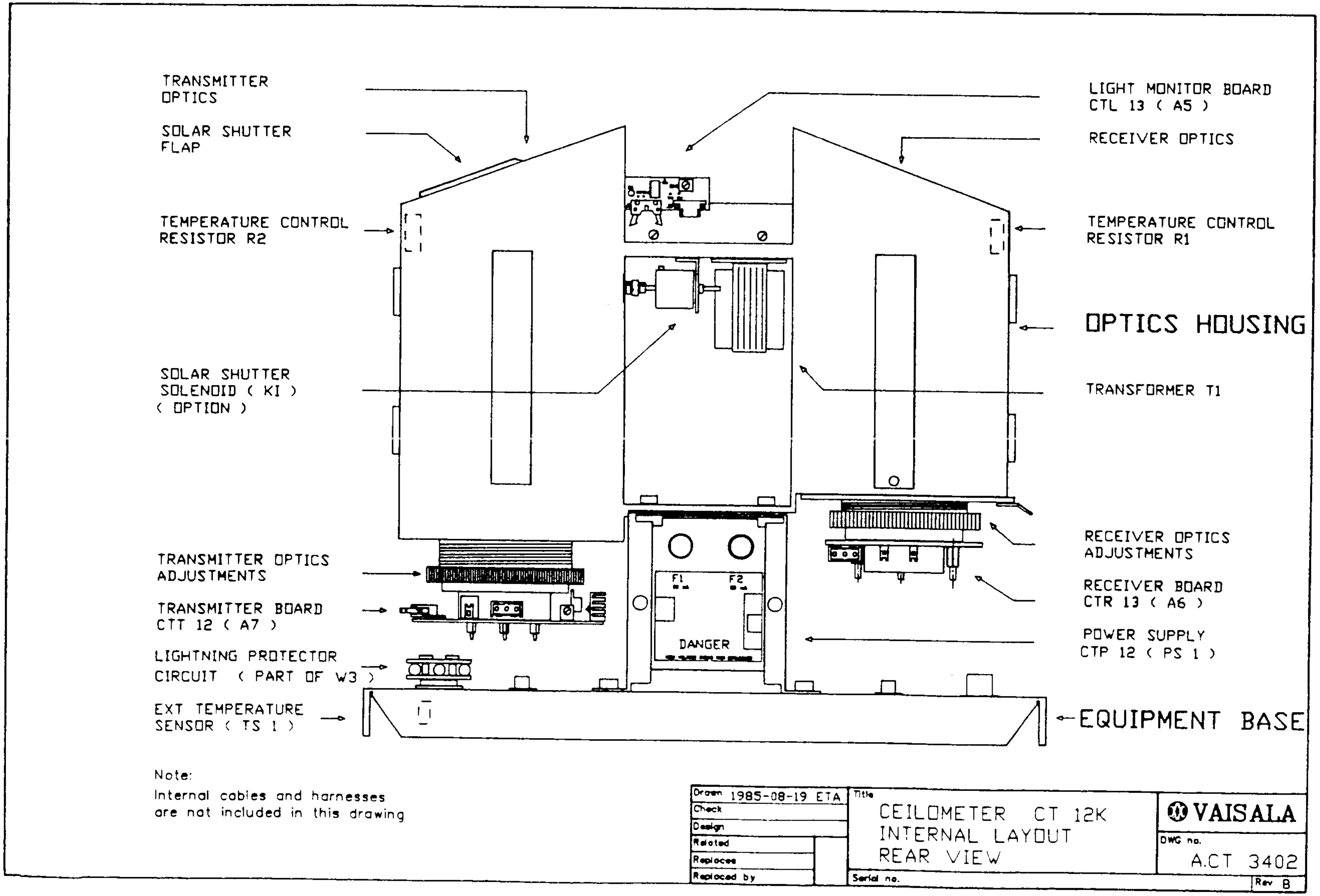

2680 CT12K CEILOMETER OL 45450
CTD 12 2713 SOLAR SHUTTER SUBASS'Y K1 KIT OL 45451
2736 WINDOW CONDITIONER B1 OL 45449
2674 EQUIPMENT COVER OL 45395
2676 MAIN EQUIPMENT ASS'Y OL 45452
2753 PEDESTAL OL 45367
10318 PACKAGE 1 U.CT 4538
2679 FIELD SITE SPARES KIT OL 45462
10319 PACKAGE 2 U.CT4538
CTH 12 2690 MAINTENANCE TERMINAL OL 45421
TECHNICAL MANUAL (NWS)
2737 HEATER BLOWER OL 45400
2738 COVER OL 45394
2677 OPTICAL SUBASSEMBLY OL 45453
2678 ELECTRONICS SUBASSEMBLY OL 45455
2739 BLOWER SUBASS'Y OL 45400-1
2740 HEATER SUBASS'Y OL 45400-2
2731 CABLE OL 45400-3
10250 BLOWER OL 45400-4
10251 CAPACITOR OL 45400-5
2744 HEATER OL 45400-6
2745 THERMOSTAT OL 45400-7
2746 TEMPERATURE SENSOR OL 45400-8
2720 OPTICS HOUSING OL 45454
CTR 13 20105 RECEIVER BOARD A6 OL 45824
2714 TEMP. CONTROL TRANSFORMER T1 OL 45384
CTT 12 2687 TRANSMITTER BOARD A7 OL 45408
CTL 13 10322 LIGHT MONITOR BOARD A5 OL 45689
2712 TEMP. CONTROL HEATER R1, R2 OL 45383
2695 LIGHT MONITOR CABLE W5 OL 45375
2696 RECEIVER LO-V CABLE W6 OL 45376
2697 TRANSMITTER LO-V CABLE W7 OL 45377
2698 RECEIVER SIGNAL CABLE W8 OL 45378
2699 TRANSMITTER CONTROL CABLE W9 OL 45379
2700 RECEIVER HI-VOLT CABLE W10 OL 45380
2721 TRANSMITTER HI-VOLT CABLE W11 OL 45381
2675 MAIN CHASSIS OL 45456
CTS 12 2682 UNREG. POWER SUPPLY BOARD A2 OL 45411
CTA 12 2689 TEMPERATURE SENSOR TS1 OL 45382
10248 GROUNDING WIRE W12 OL 45457
10249 GROUNDING WIRE W13 OL 45458
2694 MAINT. TERMIN. HARNESS W4 OL 45374
CTP 12 2688 HI-VOLTAGE PS1 POWER SUPPLY OL 45410
CTM 12 2681 PROCESSOR BOARD A1 OL 45415
CTI 12 2683 OUTPUT INTERFACE BOARD A3 OL 45413
2691 MAIN HARNESS W1 OL 45371
2692 WINDOW CONDITIONER HARNESS W2 OL 45372
2693 OUTPUT HARNESS W3 OL 45373
10279 SET OF MISCELLANEOUS OL 45410-7
10274 MAIN TRANSFORMER OL 45410-1
10275 LINE INPUT HARNESS OL 45410-2
10276 BLOWER CONTROL HARNESS OL 45410-3
10277 TEMPERATURE TRANSFORMER HARNESS OL 45410-4
10278 HIGH-VOLTAGE TRANSFORMER OL 45410-5
2715 HI-V POWER SUPPLY BOARD PS1 A1 OL 45410-6
LEGEND
TYPE PART NO
NAME DESIGNATION
PARTS LIST
85-09-16
85-08-28
CEILOMETER CT12K-2680 (NWS)
GENERATION BREAKDOWN CHART
VAISALA
U CT2101

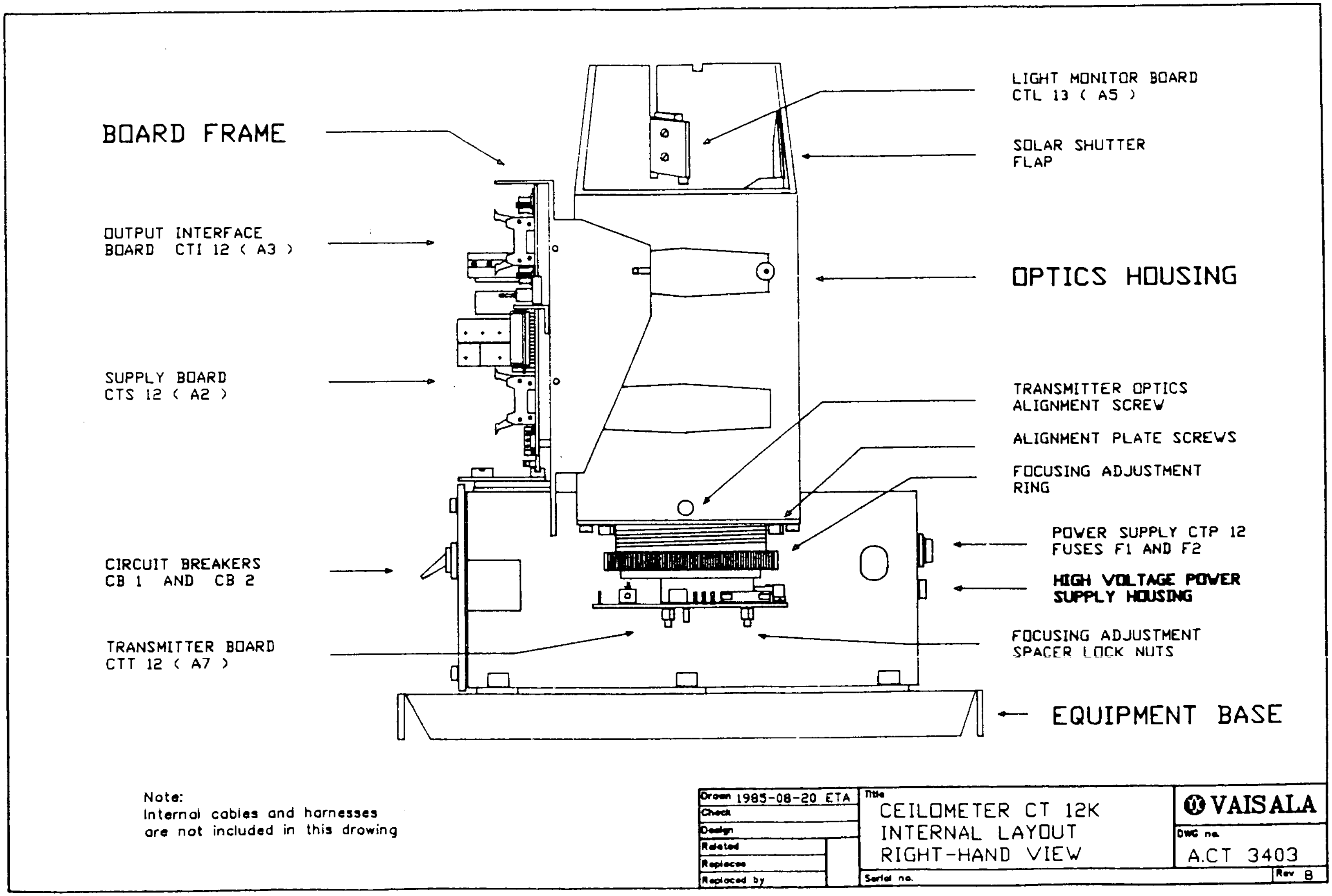


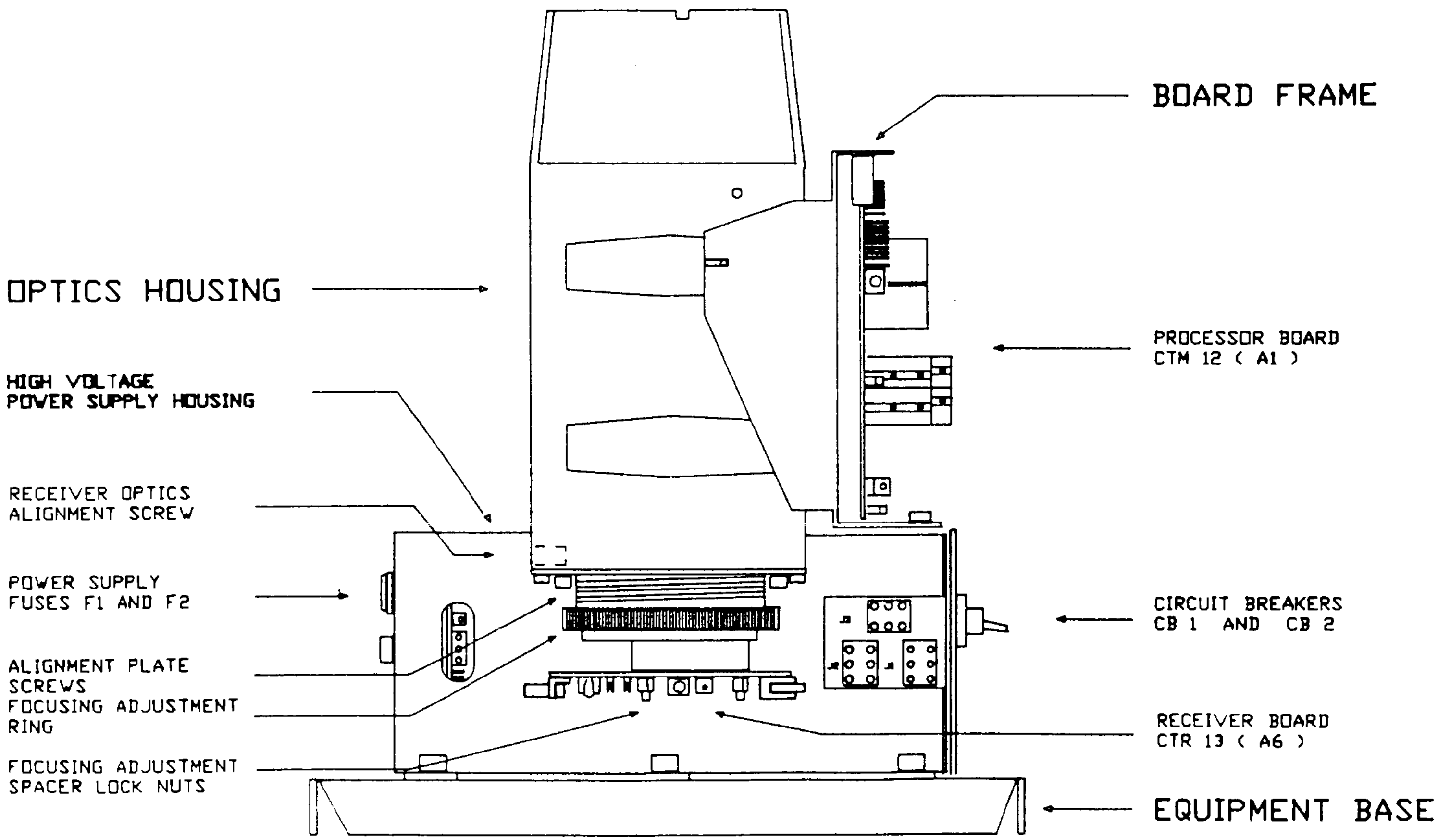
ATMOSPHERIC BACKSCATTER
RECEIVER FIELD-OF-VIEW
TRANSMITTED LASER BEAM
WINDOW CONDITIONER
BLOWER
HEATER
TEMPERATURE SENSOR
(AIR)
(AIR)
BLOWER CONTROL
HEATER CONTROL
TEMPERATURE
SHUTTER ON
SKY LIGHT
SKY LIGHT MONITOR
SOLAR SHUTTER DRIVER
LASER POWER
RECEIVER LENS
RECEIVER FILTER
PHOTODIODE RECEIVER & PREAMP
BACKSCATTER SIGNAL
INTERNAL TEMPERATURE CONTROL
ON
OFF
INTERNAL TEMPERATURE
LASER TRANSMITTER & VOLTAGE REG
LASER TEMPERATURE
SAMPLE ADDER & MEMORY
PROCESSOR & SOFTWARE & MEMORY
LASER CONTROL
LASER TRIGGER
INTERNAL CONTROL
EXTERNAL TEMPERATURE
ANALOG MONITORING SECTION
INTERNAL SUPPLY VOLTAGES
RS-232C INTERFACE
RS-232C TXD RXD
TO PROCESSOR
TO LINE
FSK MODEM BELL 103
RECORDER CONTROL
START SWEEP
INSCRIBE
RECORDER INTERFACE
LINE IN
POWER SUPPLY SECTION


CAUTION
WINDOW CONDITIONER
EQUIPMENT COVER
CT 12K SIDE VIEW
CT 12K FRONT VIEW
Drawn 1985-08-15 ETA
Check
Design
Related
Replaces
Replaced by
Title
CEILOMETER CT 12K
GENERAL LAYOUT
Serial no.
VAISALA
DWG no.
A.CT 3400
Rev C


RECEIVER OPTICS
LIGHT MONITOR BOARD
CTL 13 (A5)
TRANSMITTER OPTICS
OUTPUT INTERFACE BOARD
CTI 12 (A3)
PROCESSOR BOARD
CTM 12 (A1)
SUPPLY BOARD
CTS 12 (A2)
BOARD FRAME
RECEIVER OPTICS
ADJUSTMENTS
RECEIVER BOARD
CTR 13 (A6)
TRANSMITTER OPTICS
ADJUSTMENTS
POWER SUPPLY
CTP 12 (PS 1)
TRANSMITTER BOARD
CTT 12 (A7)
LIGHTNING PROTECTOR
CIRCUIT (PART OF W3)
EQUIPMENT BASE
EXT TEMPERATURE
SENSOR (TS 1)
ON
OFF
DANGER
PS 1
J12
J22
J26
Note:
Internal cables and harnesses
are not included in this drawing
Drawn 1985-08-15 ETA
Check
Design
Related
Replaces
Replaced by
Title
CEILOMETER CT 12K
INTERNAL LAYOUT
FRONT VIEW
Serial no.
VAISALA
DWG no.
A.CT 3401
Rev B

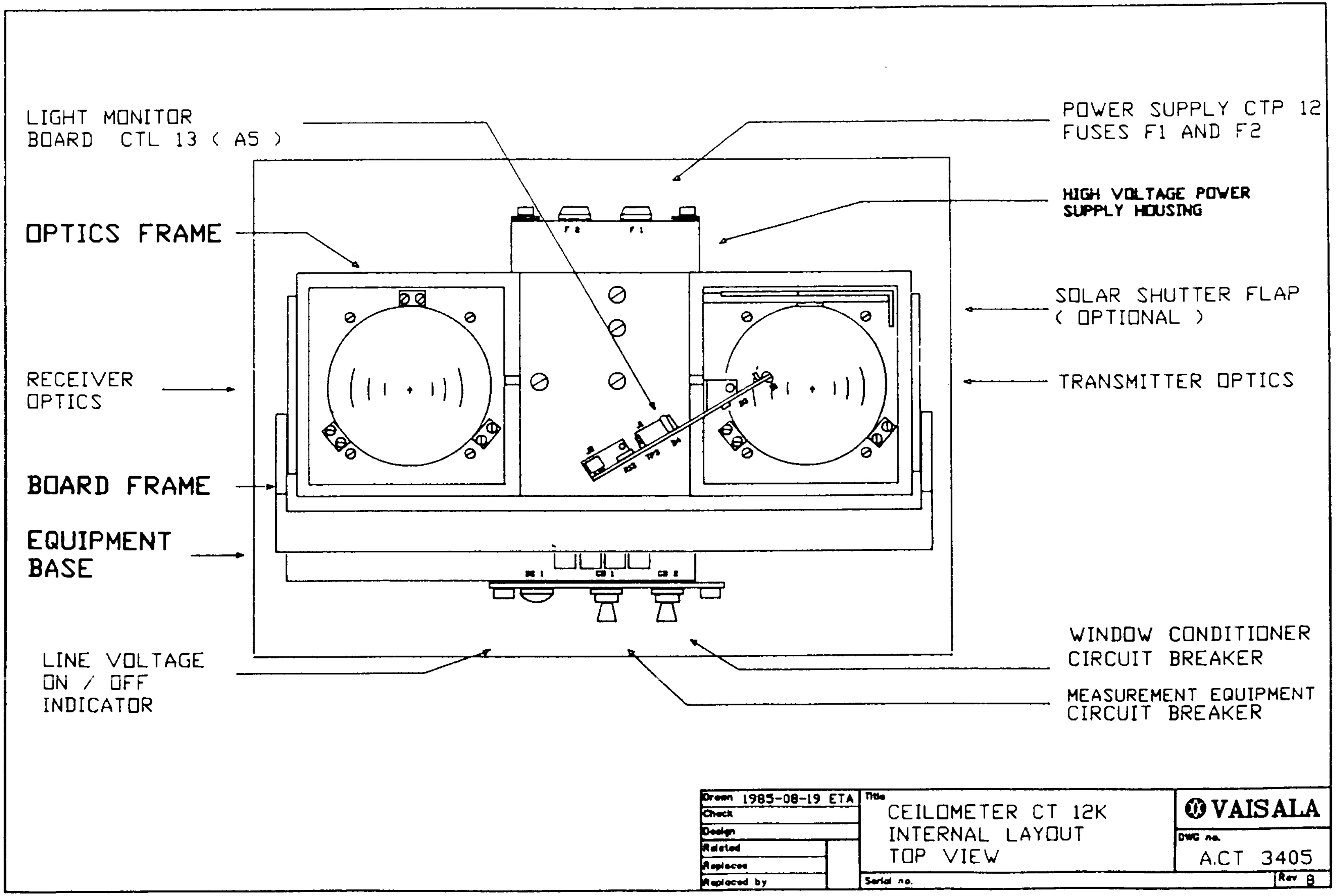

TRANSMITTER OPTICS
SOLAR SHUTTER FLAP
TEMPERATURE CONTROL RESISTOR R2
SOLAR SHUTTER SOLENOID (KI) (OPTION)
TRANSMITTER OPTICS ADJUSTMENTS
TRANSMITTER BOARD CTT 12 (A7)
LIGHTNING PROTECTOR CIRCUIT (PART OF W3)
EXT TEMPERATURE SENSOR (TS 1)
LIGHT MONITOR BOARD CTL 13 (A5)
RECEIVER OPTICS
TEMPERATURE CONTROL RESISTOR R1
OPTICS HOUSING
TRANSFORMER T1
RECEIVER OPTICS ADJUSTMENTS
RECEIVER BOARD CTR 13 (A6)
POWER SUPPLY CTP 12 (PS 1)
EQUIPMENT BASE
F1
F2
DANGER
Note:
Internal cables and harnesses are not included in this drawing
Drawn 1985-08-19 ETA
Check
Design
Related
Replaces
Replaced by
Title
CEILOMETER CT 12K
INTERNAL LAYOUT
REAR VIEW
VAISALA
DWG no.
A.CT 3402
Serial no.
Rev B

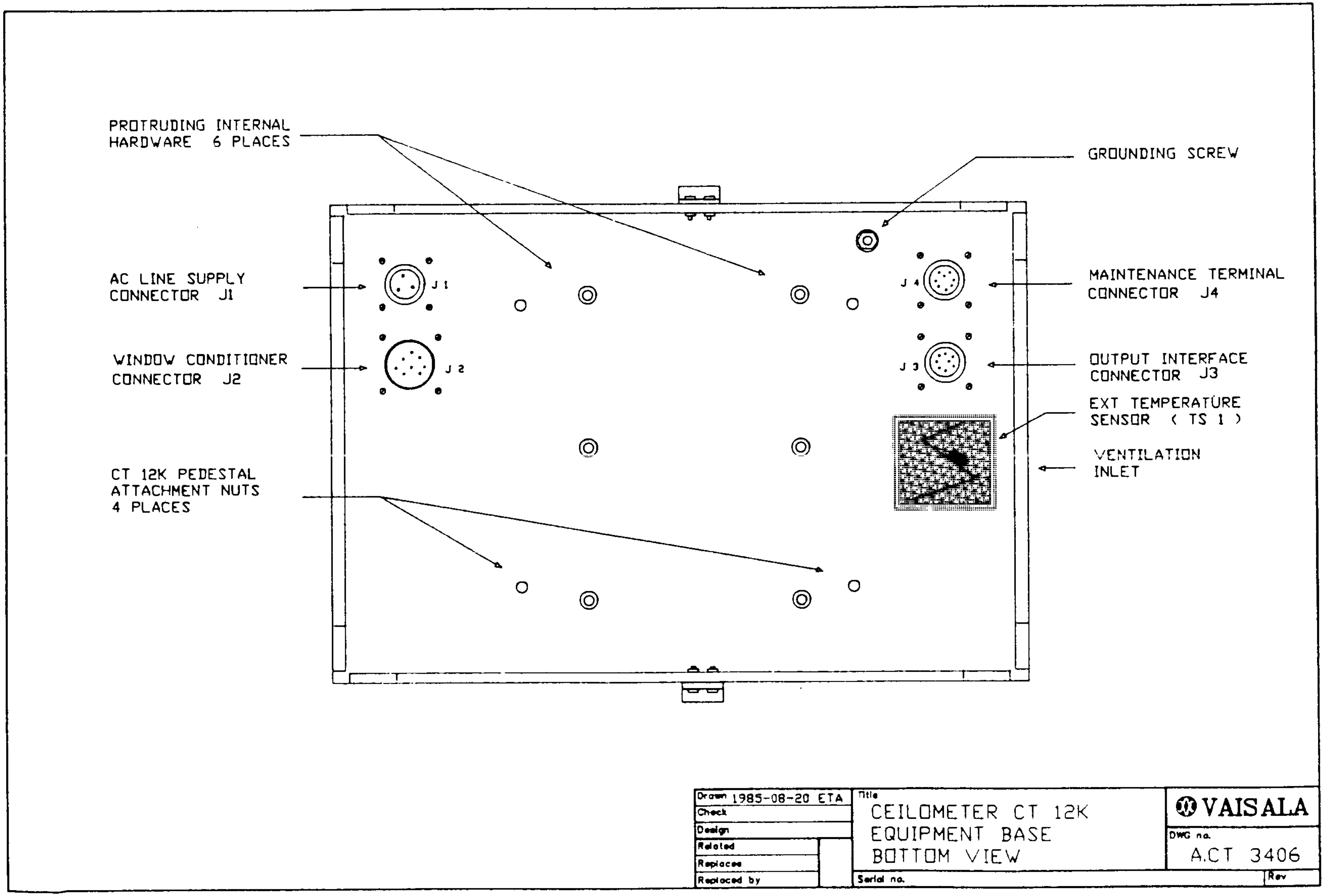

BOARD FRAME
OUTPUT INTERFACE BOARD CTI 12 (A3)
SUPPLY BOARD CTS 12 (A2)
CIRCUIT BREAKERS CB 1 AND CB 2
TRANSMITTER BOARD CTT 12 (A7)
LIGHT MONITOR BOARD CTL 13 (A5)
SOLAR SHUTTER FLAP
OPTICS HOUSING
TRANSMITTER OPTICS ALIGNMENT SCREW
ALIGNMENT PLATE SCREWS
FOCUSING ADJUSTMENT RING
POWER SUPPLY CTP 12 FUSES F1 AND F2
HIGH VOLTAGE POWER SUPPLY HOUSING
FOCUSING ADJUSTMENT SPACER LOCK NUTS
EQUIPMENT BASE
Note:
Internal cables and harnesses are not included in this drawing
Drawn 1985-08-20 ETA
Check
Design
Related
Replaces
Replaced by
Title
CEILOMETER CT 12K
INTERNAL LAYOUT
RIGHT-HAND VIEW
VAISALA
DWG no.
A.CT 3403
Serial no.
Rev B



Note:
Internal cables and harnesses
are not included in this drawing

Drawn 1985-08-20 ETA	Title	CEILOMETER CT 12K INTERNAL LAYOUT LEFT-HAND VIEW	VAISALA
Check			DWG no. A.CT 3404
Design			
Related			
Replaces			
Replaced by		Serial no.	Rev B


LIGHT MONITOR BOARD CTL 13 (A5)
POWER SUPPLY CTP 12 FUSES F1 AND F2
HIGH VOLTAGE POWER SUPPLY HOUSING
OPTICS FRAME
SOLAR SHUTTER FLAP (OPTIONAL)
RECEIVER OPTICS
TRANSMITTER OPTICS
BOARD FRAME
EQUIPMENT BASE
WINDOW CONDITIONER CIRCUIT BREAKER
LINE VOLTAGE ON / OFF INDICATOR
MEASUREMENT EQUIPMENT CIRCUIT BREAKER
Drawn 1985-08-19 ETA
Check
Design
Related
Replaces
Replaced by
Title
CEILOMETER CT 12K
INTERNAL LAYOUT
TOP VIEW
VAISALA
DWG no.
A.CT 3405
Serial no.
Rev B


PROTRUDING INTERNAL
HARDWARE 6 PLACES
GROUNDING SCREW
AC LINE SUPPLY
CONNECTOR J1
J 1
J 4
MAINTENANCE TERMINAL
CONNECTOR J4
WINDOW CONDITIONER
CONNECTOR J2
J 2
J 3
OUTPUT INTERFACE
CONNECTOR J3
EXT TEMPERATURE
SENSOR (TS 1)
VENTILATION
INLET
CT 12K PEDESTAL
ATTACHMENT NUTS
4 PLACES
Drawn 1985-08-20 ETA
Check
Design
Related
Replaces
Replaced by
Title
CEILOMETER CT 12K
EQUIPMENT BASE
BOTTOM VIEW
VAISALA
DWG no.
A.CT 3406
Serial no.
Rev

4.3 MODULE DESCRIPTIONS

4.3.1 PROCESSOR BOARD Cl-M 12 REF. Al

4.3.1.1 General

The CTM 12 is the main signal conditioning and processing unit for the CT 12K Ceilometer. On a single size PC board it contains all the electronics to:

- control laser pulse triggering at software determined intervals.
- buffer and amplify by software controlled gain the backscattered echo signal from the Receiver Board.
- sample, convert, and store the amplified echo signal.
- digitally integrate the stored series of samples throughout the detecting range.
- process the echo signal data and calculate the cloud base levels and other relevant data according to software rules.
- transfer data and commands through the on-board serial RS-232C port.
- monitor the unregulated power supply voltages, Transmitter and Receiver operating voltages, laser power, ambient light level, and temperatures measured at four points of the system.
- control the Window Conditioner and optional Solar Shutter according to monitored parameter values and software rules.
- automatically control internal heating of the Ceilometer.

The Principal Data and Control Flow of the CTM 12 is illustrated in Drawing CT 4532 and further described below:

Main data processing in the unit is carried out by an 8031-type of microprocessor and its related hardware: 64 k byte EPROM for instruction memory and 8 k byte RAM for data memory. Furthermore the on-board EEPROM provides for 1 k bit nonvolatile storage for scaling factors and other important parameters. Through its integral UAR/T and two integral timers, the processor maintains serial asynchronous communication and time-keeping in the system. A watch-dog timer provides for forced resetting of the processor in case of temporary malfunction.

The echo signal from the Receiver Board is first amplified and then converted into a digital form by a 6 bit Flash ADC taking one sample every 100 ns. This corresponds to 50 ft (15m) steps in backscattered laser light pulse path. These 254 converted samples are stored into the fast RAM and then added by hardware to the respective sum of previously taken samples. The cumulated samples sums, which form the integrated results for each 50 ft range gate, are then stored into the fast RAM.

Monitoring the power supply voltages and other relevant system parameters is carried out by a specific 19-channel ADC circuitry which features S-bit conversion resolution and a bit-by-bit serial interface for interchanging channel addresses and conversion results with the processor.

The operating voltages of the CTM 12 are all supplied by on-board voltage regulators, some of which also feed the Output Interface Board CTI 12, Ref. A3. Several on-board precision reference supplies for measurement needs are also provided.

The board was designed and realized to be easily maintainable. Seventy-eight (78) test points provide for easy access to the most important signals. Jumper strappings on selected feed-back signal paths facilitate testing on component level. The board includes a test pulse generator, from which several different echo signal combinations are attainable for simulating cloud base conditions without the need of an optical path. Parameter monitoring capability further provides for easy isolation of failures both on component and board level.

The CTM 12 Processor Board was specified and designed for low power operation in a wide temperature range. The total power consumption of the board is typically 6 Watts, about 40% of which is dissipated by the on-board voltage regulators.

4.3.1.2 Specifications

Type:	CTM 12 Processor Board
Part Number:	2681
Reference Designation:	A1
Functions:	Central Processing Unit for CT 12K Ceilometer, with the following Main Functional Blocks: - CPU - I/O Monitor - Sequence Control - Signal Amplifier
Mechanical:	Size E2 plug-in board, 64-pin two-part connector. PCB: 1.6 mm glass fiber, solder resist and component silk screen printed. Dimensions: 160mm x 233 mm, height 21 mm max.
Environmental:	Temperature: -40°C... + 70°C operational -55°C.. + 85°C storage Humidity: Non-Condensing
Power Input:	Logic Supply (+ 10V): + 6... + 12 VDC, 330mA typical Analog Supply (+ 20V): + 16...+24 VDC, 110mA typical -16...-24 VDC, 50mA typical Interface Supply (+ 20V): + 15.. +25 VDC, 15mA typical -15...-25 VDC, 30mA typical
Power Output: (regulated DC-Voltages)	Logic Supply (+ 5V): +5 ± 0.25 VDC, 100mA maximum Interface Supply (+ 12V): +12.2 ±0.8 VDC, 30mA maximum -12.2 ± 0.8 VDC, 20mA maximum

On-Board Regulated Voltages:	Logic Supply (+5V): +5V ± 0.25V, 300mA typical Interface Supply (+ 12V): + 12.2 ± 0.8V, 10mA typical -12.2 ± 0.8V, 25mA typical Analog HI Supply (+ 13V): + 12.7 ± 0.8V, 45mA typical -12.7 ± 0.8V, 45mA typical Analog LO Supply (+6V): + 6.1 ± 0.3V, 15mA typical - 6.1 ± 0.3V, 15mA typical Flash ADC Supply (+9V): + 9.0 ± 0.5V, 40mA typical
On-Board Precision Reference Voltages:	Basic Reference (VR): + 10.0 ± 0.03V, 2.5mA typical Flash ADC Ref. (RP, RC): + 8.30 ± 0.1V, 11mA typical + 1.72 ± 0.03V, 7mA typical (sink)
CPU:	System Control and Data Processing Section
Processor:	Type 8031 single-chip Microprocessor, with: - Integral UAR/T and RTC - 128 Byte RAM - Two I/O Ports Operating Clock: 10 MHz Cycle Time: 1.2 µs Instruction Execution Rate: 0.83 MIPS
Instruction Memory:	64 kB EPROM
Data Memory:	8 kB Static RAM (optional 16 kB)
Parameter Memory:	1 kB Nonvolatile EEPROM
Watch-Dog Timer:	CPU Reset after 5 seconds inoperation

I/O Monitor:	I/O Signal Interfacing and Monitoring Section
Serial Communication:	RS-232C I/O-interface for asychronous full-duplex serial data mterchange. One output (TXD), two inputs (IRXD and MRXD, not for simultaneous use).
Speed:	300Bd (optionally std. ranges 1 10...2400 Bd practicable)
Frame:	8 data bits, 1 stop bit, No Parity (optionally any std. 10 bit frame)
I/P Levels:	SPACE Uin < + 1.5V MARK Uin > +4.5V
O/P Levels:	SPACE -9V typical MARK +9V typical
Protection:	Typical withstanding +50V line transients (1 ms expo.). Further protection external.
Modem Control O/P:	Two logic level signals: ALB, loop-back test, when HI SQT, carrier ON/OFF (O/l)
Gifft RBC Recorder O/P:	Two logic level signals: RBCE, rec. inscribe (HI for MARK RBCT, rec. start (HI for BREAK)
Solar Shutter	Logic level signal: SSON, solar shutter forced shut

(HI)

Heating and Window Conditioning Control O/P:	Two open collector signals (60V/0.5A): BON, blower ON (LO) HON, heater ON (LO) Two automatic Internal Heating control signals RELl, REL2 (+ 11V/10mA): 20W heating: ON below + 18°C (RELl LO, REL2 HI) OFF above +26°C (RELl HI, REL2 I-II) 80W heating: ON below - 5°C (RELl HI, REL2 LO) OFF above + 2°C (RELl LO, REL2 LO)
Flag Inputs:	Two logic level signals (zener protected): CD, modem carrier detect (HI) FLAG, hand terminal detect (LO)

Monitor I/P: Continuous monitoring of 19 parameters:

- 11 unregulated operating voltages:

  +25V, ±20VI, ±20VA,
  +12VM, +10VD, +10VX,
  +10VR, MRHV, PXHV

- 4 temperature levels:

  TI (internal)
  TE (external
  TL (laser)
  TB (heater/blower)

- 2 optically measured parameters:

  LLAS (Laser Power)
  LSKY (Ambient Light)

- 2 systems parameters:

  GND (measured offset)
  ADC (internal reference)

Monitor ADC Resolution: 8 bits/5V (corresponding to 2°C/hit for temperature and 20... 150mV/bit for operating voltages)

LED Indicators: Two LED's, Green and Red, indicating CPU status:

Green Blinking:	OK
Red Blinking or ON:	Not OK
Both OFF:	Not OK (+5V low)

Sequence Control: Echo Signal Sampling Sequencer and Hardware Processor

General Features:	* Sample Convert and Store sequencing by 10MHz clock rate * Hardware Add and Store sequencing by 1.25 MHz data rate * Laser Trigger and Frequency Control
Sample Convert and Store Feature Data Rates:	100ns/range gate 25.8µs/total range (256 samples whereof 254 useful)
Sample Add and Store Feature Data Rates:	800ns/byte-to-byte add 3.2µs/total sum for one level (three bytes) 816.1µs/total range (255 sums whereof 254 useful)
Laser Frequency Control Software Alterable Delay:	51.2 - 768µs (in 8 steps)
Total Sequence Timing:	Cycle Time: 893.1 - Cycle Frequency: 621 - 1102 Hz
Sample Storage:	2 kB Static RAM (1 kB of capacity utilized) Access Time: 70ns
Laser Trigger O/P (LTRG) Logic Level Drive:	Impedance: ca. 100 ohm O/P conn.: coaxial/SMB Timing: 60ns single-pulse repeated every 893.1...1609.9µs
Signal Amplifier:	Echo Signal Amplifier and Converter
General Features:	Two-Stage AC-Amplifier and Buffer with two software selectable gains Flash Analog-to-Digital Converter with two-slope conversion scale
Signal Input (RECO):	Impedance: 50 ohms to GND Signal Range: 0 - 33mV (non-clamped) I/P Connector: coaxial/SMB

Amplifier Gain:	First Stage:	ca. 60 (trim. pot adjustable)
	Second Stage:	Software alterable; Gain 0: ca. 4 Gain 2: ca.16
	Total Gain:	Factory Adjusted to Values Gain 0: 250 Gain 2: 930
Flash ADC:	Conversion Rate:	10MHz
	Conversion Resolution:	
	0<Uin< l.N : 33 steps, 52mV each	
	1.7V < Uin < 8.3V : 31 steps, 213mV each	
Conversion output:	6 bits + overflow	
Testing Aids:	Test Pulse Feed to Amplifier I/P.	
	Jumper selectable pulse forms:	
	Width:	230/430ns
	Occurrence:	single/double
	Amplitude:	three alternatives

4.3.1.3 General Overview

The electronics of the CTM 12 can be functionally divided into four Main Sections, namely:

1) CPU Section

2) Monitor Section

3) Sequence Control Section

4) Amplifier Section

The operation of each of these is described in the following:

- o System division into Main Sections is shown in the drawing CT 3501, Principal Block Diagram

- o A less detailed illustration of the system as a whole is given in the drawing CT 4532, Main Functions and Primary Data/ Control Flow

- o For each of the Main Sections, a separate Circuit Diagram is provided:

  CT 3385...Circuit Diagram l/4 (CPU)
  CT 3386...Circuit Diagram 2/4 (Monitor)
  CT 3387...Circuit Diagram 3/4 (Sequence Control)
  CT 3388...Circuit Diagram 4/4 (Amplifier)

- o Component locations on the PC-Board are given in the drawing CT 2492, Components Layout.

- o Two timing diagrams are provided for illustrating the operation of the CPU Section and Monitor Section, namely: CT 3544, CPU Cycle Timing. The second diagram concerns Monitor Section devices (ADC, EEPROM, RS-232C Channel) controlled by the Processor in the CPU Section.

- o One timing diagram illustrates the operation of the Test Pulses: CT3536, Pulse Diagram, Test Pulse Timing and Forms.

4.3.1.4 Functional Description

4.3.1.4.1 CPU Section:

The Microprocessor U4 is an 8031-type single-chip NMOS-device mounted on a socket. Beside the typical processing elements, it contains:

128 bytes of data memory, in this application most is used for the stack and general purpose registers

two 16-bit timers, one of them is used as a Baud rate clock, the other is used as a Real Time Clock (RTC)

integral Universal Asynchronous Receiver/Transmitter (UAR/T)

two general purpose I/O ports, Pl and P3

For instruction set and other details, see REFERENCE.

The Processor's AD-bus is pulled high by resistors in the array RA8. This is to better meet the input level demands of the standard CMOS devices on the bus. It also enables testing of the board with the EPROM removed. In that case, the Processor repeatedly fetches the code FFH from the bus, which corresponds to a nonbranch internal operation instruction. Thereby, the Processor keeps running with its address outputs incrementing through the address space, which is a convenient condition for isolating failures on the bus.

<u>The Address Latch U13</u> is a transparent type of latch. When ALE (pin 11) is high, its input states show in the output. When ALE goes low, the current output states (address) are latched.

<u>The Instruction Memorv U3</u> is a 64-k byte CMOS-EPROM, type 27C512 (mounted on socket). The EPROM is continuously activated with its chip select pin 20 grounded. Its output buffers are enabled, when pin 22 is driven low by PSEN.

It should be noted that the EPROM is erased by UV-light, and thus the label on its window should not be removed. EPROM with no shield on its window will be erased in approximately one week when exposed to direct sunlight.

The Data Memorv U2 is an 8 k byte static CMOS-RAM device, type TC 5564 or equivalent (mounted on socket). Its chip select pin 20 is driven by A14, activating the device only when the RAM area of the I/O address space is addressed. Its output buffers are enabled with pin 22 driven low by RRO. Writing is carried out by driving pin 27 low by RWO. Provisions have been made on the board (Ul) for another similar or 2 kB device.

The RD/WR Decoder U9 is a double 2-to-4 line decoder device. Low state on its pin 15 activates one of its Read strobe outputs. Low state on its pin 1 activates one of its Write strobe outputs.

The Watch-Dog; Timer consists of the 14-bit ripple counter U12 clocked by the RC-oscillator: U11/8, RA7/5-6, C15. Counter reset (pin 12) is activated via Ul l/2-3 by WDR generated by software. If not reset, the counter will count up until after 8192 clock pulses (ca. 5 seconds), and it raises PRES high via diode DA2/15-2, thus resetting the processor. For testing purposes, Jumper J8 can be removed thus eliminating the Watch-Dog.

The Reset circuitry consists of the three Schmitt-trigger gates of U20 and some passive components. During the PWR-ON transition POR is low driving U20/3 high, thus resetting the Processor via diode DA2/14-3. U20/11 produces System Reset (RS low). Via Ull/l-3 also, the Watch-Dog counter is reset. The capacitance Cl6 is discharged through the 22 k resistor in the POR line (Monitor Section) and will hold the Reset approximately 400 ms after PWR-ON. Reset can also be activated manually by actuating the momentary switch Sl (upwards) and so grounding the POR line via the resistors in RA7.

The Sample Data Latch U19 is a similar transparent type of device as U13. In the initial state, RL is high thus making the latch transparent via its pin 11. On the other hand, it disables the latch output buffers via pin 1. When reading the sample RAM, RL is strobed low, which makes U19 latch the data on the SD-bus and output them into the AD-bus to be loaded in by the Processor. Latching is used because the data on the SD-bus changes invalid soon after the falling edge of RL.

System Clock for the Monitor ADC is provided by the RC-oscillator: Ul l/6, RA7/7-8, C9. Two Schmitt-trigger gates, Ull/ll and U20/6, are unused and their inputs are tied to stable levels.

RS-232C signals IRXD and MRXD are OR'ed by diodes in DA2 and filtered by RA7/7-8 and C18. U20/8 inverts the results and also provides level clamp by its integral input protecting diodes, which limit the signal level between +5 V and GND.

Input Signals FLAG and CD coming from the outside of the board are transient protected by resistors in RAl and 5.1 V zener diodes Dl and D3.

Test points are provided for the following signals:

J3/10-3:	AO-7, Address LO byte
J7/10-3:	ADO-7, AD-bus
J5/3:	X2, CPU clock
J5/4:	PRES, CPU reset
J5/5:	TXD, Serial Line Xmitted Data
J5/6:	RXD, Serial Line Received Data
J5/7:	ALE, Address Latch Enable
J5/8:	PSEN, Program Store Enable
J6/3:	RS, System Reset
J6/4:	WR, I/O Write Strobe
J6/5:	RD, I/O Read Strobe
J6/8:	+5 V, Logic Supply
J6/9:	RL, Sample Latch Enable

J3,
J5,
J6,
and J7/1: GND, Logic Ground

4.3.1.4.2 Monitor Section

The Monitored Signals are brought into the board via the edge connector Jl. The resistor arrays RA3, RA4, RA5, RAll (9x2k2, 4x4k7, 4x4k7, 4xl0k), and resistor R5 (14k7) perform scaling of the signals. The signals LLAS, LSKY, PXHV and MRHV are not attenuated but carried through series resistors. LLAS and LSKY lines are protected by diodes (DAl) clamping to +5 V, as they originate in the A5 op amps, powered from + 17 V (Ref. A5).

Negative bias for the Temperature Sensors is applied through 2k2 resistors (RA13) to the TL-, TE-, and TB-lines on Jl. The bias supply is regulated by D2, 5.1 V zener diode, giving but output of only -4.8 V due to restricted zener current. The negative level signals from the Temperature Sensors (TL+, TE+ , TB +) are brought in through 4k7 resistors.

The positive level signals connect to channel input pins l-9, 11 of the Monitor ADC U8. The negative level signals connect to U15, the Pre-MUX. This also includes the on-board Temperature Sensor (U16) output carried through the resistor RA12/5- 6. The channel i/p, full scale level and conversion resolution for all the Monitor inputs are defined in Table 3.

The Pre-Multiplexer U15 is a type 4051 CMOS analog MUX. It is an 8-channel device capable of switching also negative signal levels, provided that negative bias is applied to its pin 7. Multiplex address is applied to pins 11-9 (P14-16). Multiplex output from pin 3 is filtered by RA2/6-5 and C13, and then buffered by U14/7 op-amp prior to feeding it into the Amplifier Section (MB) where it is inverted and brought back (MI) to the Mon. ADC pin 12 (CH 10).

The monitor ADC U8 is a CMOS-device of type TLC 541. It converts one-by-one the signals applied to its 11 channel inputs into digital 8-bit form. The twelfth channel, internal self-test voltage brings out about a half of the full-scale reading (128 ± 3). The ADC control section provides for serial address/data interchange with the host. The I/O clock (18) carries out clocking in the channel address (17) and clocking out conversion data (16). Pin 15 is the low-active chip select input. The ADC reference voltage V5, which originates in the Amplifier Section, is applied to pin 14. As supplied by an op amp powered from + 13 V, the line is protected by the DA1 diodes. This applies also to the signal input MI.

Signal ID	J1 pin(s)	ADC Channel	MUX Channel	FS Level on J1	Conversion Resolution per bit
P201	ac2	0	x	+27.7 V	108 mV
P20A	ac30	1	x	+27.7 V	108 mV
P25V	ac11	2	x	+38.4 v	150 mV
P10D	ac27	3	x	+ 15.6 V	61 mV
P10R	c9	4	x	+ 15.6 V	61 mV
P10X	a9	5	x	+ 15.6 V	61 mV
P12M	c8	6	x	+ 15.6 V	63 mV
PXHV	a8	7	x	+ 5.0 v	20 mV 4)
LLAS	c6	8	x	+ 5.0 v	20 mV
LSKY	a6	9	x	+ 5.0 v	20 mV
MTE	c14	10	0	- 4.8 V 2)	20 mV 3)
MTB	c15	10	1	- 4.8 V 2)	20 mV 3)
MTI	-	10	2	1)	20 mV 3)
MTL	c13	10	3	- 4.8 V 2)	20 mV 3)
M201	ac3	10	4	-26.6 V	108 mV
MRHV	ac10	10	5	- 4.8 V 2)	20 mV 4)
M20A	ac10	10	6	-26.6 V 2)	108 mV
GND (-)		10	7	1)	20 mV
INT SELF TEST		11	x	1)	-

Table 3. Monitored Signals, with Channel I/P, Full-Scale Level and Conversion Resolution Shown

Note 1) On-Board Connected

Note 2) Limited by the Pre-Mux Negative Bias

Note 3) Corresponds to Temperature Resolution 2°C/Bit. Code 149 Decimal Corresponds to +25°C.

Note 4) Corresponds to Resolution of 2 V/Bit for original high-voltages. Notice that if Xmitter or Receiver coaxial cables are disconnected, both HIV and LOV values for the respective units are unmeasurable by the Monitor. After reconnecting the Xmitter cable, PXHV reading may be invalid for some time.

The EEPROM U5 is a 64x16 bit CMOS device of type NMC 9346, mounted on socket. It is an Electrically Erasable and Programmable Read Only Memory preserving its storage during power outages. This provides for handling of the EEPROM U5 like the EPROM (e.g., removing it from socket and placing into another CTM 12 so as to transfer the system parameters). Read and Write access are carried out serially. Transfer clock is applied to pin 2 (SK) and code/address/data to pin 3 (DI). Data is brought out to pin 4 (DO). Pin 1 is the active high chip select input.

The O/P Control Latches U10 and U21 are 8-bit addressable CMOS-latches. Access to the latch registers is carried out by pulling pin 14 (LENO, LENl) low, which accomplishes transferring the pin 13 input state to the output register determined by the address on pins 1 through 3. Returning pin 14 high will latch the output.

The Latch 1 output pins 11, 12 are buffered by transistors Ql and Q2 which drive the coils of Heater and Blower Relays in the HIV PWR Supply (Ref. PSl). The HON and BON lines are protected against inductive transients by diodes on the Unregulated Power Supply Board (Ref. A2). The Latch 0 output pins 11, 12 drive the Green and Red LED indicators through the RA6 resistors. The LED’s provide for high brightness with only 6mA current sunk by the Latch outputs.

The Internal Heating Control is composed of two op-amps of U14, resistor arrays RA9, RA10 (4x47k, 4x100R), and diode DA2/9-8, and, furthermore, the resistor dividers R7/R8 and R6/RA12 (1-2) which supply the temperature-controlled voltages to the inv. inputs of the op-amps (13,2). U14 is a quad op-amp LM 124, also providing for the Pre-MUX and TxD buffers on the board. The op-amps, capable of sinking 10mA min. provide for the Heating Relay coil drives REL1 and REL2 through 100R resistors. The other couple of 100R resistors in the HC-line, together with the 47k feedback resistors RA9/ 3-4, 1-2) achieve typ. +200 mV hysteresis in the control system. The on-board Temperature Sensor U16 (LM 335), biased through RA12/3-4, controls the circuitry through its linear temperature-dependent voltage drop.

The +5 V Regulator U29 is a special PNP-type device, LM 2935, mounted on heat-sink. It features very low voltage drop between its input (1) and output (2). Only 5.6 volts is needed at the input for maintaining the regulation. The Regulator's output pin 4 produces active-low PWR-ON Reset signal POR fed through 22k resistor RA20/7-8 to the CPU section. Pin 5 is a separate +5 V output intended to be used as low current standby supply, not used in this application and therefore pulled up by resistors to avoid oscillation. The unregulated input voltage + 10VD is filtered by L1 and C26. Bypass capacitors, total number of 18, are connected to the +5 V line. Diode D9 protects against reverse voltages. The Regulator is capable of producing 750 mA output current. Less than half of this is used in the system.

The + 12V Regulator U6 is of adjustable type LM317LZ. Its output voltage is determined by the adjust resistors in the following way:

$$U_{out} = (1 + R4/R3) \times 1.25\ V + R3 \times 50\mu A - 12.2\ V$$

The input and output capacitors C5, C4 do the by-passing, as does C17 between the ± supplies. Diode DA1/8-9 protects against reverse voltages. The Regulator is capable of producing 100 mA, less than one-third of which is used in the system.

The -12 V Regulator U7 is of adjustable type LM337LZ, with the same characteristics and similar circuit realization as the + 12 V Regulator.

The RS-232C Output TxD is driven by one of U14 op-amps, which inverts and level-scales the TxD signal from the Processor. RA1/1-2 and RA2/1-2 provide for input signal threshold. The output is protected by the series resistor RA14/7-8 and the clamp diodes in DA2.

Test Points are provided for the following signals:

J5/10:	+ 12 V, I/F Positive Supply
J5/9:	-12 V, I/F Negative Supply
J6/10:	Gl, Amplifier Gain Control
J6/7:	V5, Mon. ADC Ref. Supply
J6/6:	MI, Pre-MUX Inverted O/P

4.3.1.4.3 Sequence Control Section

The Time Base is obtained from the four unbuffered inverters in U33. One of them is the oscillator, controlled by crystal Z1. RA23/7-8 and R34 provide for bias and by-pass, C38 and Xl, X2. U33/4 outputs the Seq. Control Clock Xl applied to U38/9 and U43/13 in Freq. Divider and Control block.

The Frea. Divider and Control is composed of the JK-Flip-Flop in U43 and the NOR-gates U38/8 and 6. The clock Xl is fed either through the F-F, its frequency divided by two (LTE) SQO applied to U38/10, 11 and the J-input of U43. SQO low or high results in 10 MHz or 5 MHz on U38/6, respectively. ST low applied to the set input of U43 entirely inhibits the clock feed-through and sets U38/6 low.

The Write Pulse Shaper is formed by the NAND-gate U52/6 and the delay generating circuits U38/6 and U45/2 (its input capacitance driven through paralleled resistors). During SQPHO, the NAND-gate outputs a 10 MHz pulse freq. with ca. l/3 duty cycle, suitable for Write accessing the Sample RAM.

The Sea. Control Counter consists of the three similar 4-bit synchronous counter circuits U42, U37, and U32 which feature synchronous operation. Load Control (pin9) is used in two of the counters: in U42, to inhibit the first counter stage by loading in all-ones; and, in U32, for loading in Pll through 13 to the third counter stage. RS applied to pin 1 resets the counters at PWR-ON or Manual Reset.

The Sea. Control Register consists of the JK-Flip-Flops of U51, and the AND-gates of U50, and the NAND-gate U53/12. The circuitry, by most of its action, behaves like a two-bit shift-register operating synchronously witb the Seq. Control counter. It is driven by the clock from U33/10 applied to F-F clock inputs U51/1, 13. The operation is described below:

- During SQPHO, the Register outputs SQO, SQl (U51/5, 9) are both low. As the Seq. Control Counter overflows, the carry pins 15 of U42, U37, U32 are all high, which achieves high state on U50/12. As it connects to the J-input pin 3, the next falling edge of the clock raises SQO high, and so SQPHl is started.

- The next time the Counter overflows, both U50/12 and 6 are high. Thus, the next clock raises SQl high. Prior to this transition, U53/12 applies low state to U32/9 (CLD) which results in Load action on U32 by the rising edge of CCK at the beginning of SQPH3.

- The last time the Counter overflows, the outputs of all three AND-gates are high. Now, U50/8 applying high state to the K-inputs of the Flip-Flops achieves toggle action on the next falling edge of the clock, and so both SQO and SQl return low.

The Sample RAM U25 is a 2 kB static CMOS RAM of the type HM 65161 (mounted on socket). It is a fast device, doing data access in less than 70 ns. The RAM enables its output buffers onto RDO-7, when RSM (pin 20) is low. It loads in the data on RDO-7 when WSM (pin 21) is low. The device is continuously activated by its chip select pin 18 grounded. The RAM MS-address pin 10 grounded permanently disables the high order half of the memory.

The Read/Write Decoder and Control block is composed of the three NOR-gates of U44, and AND-gate U46/12, the NAND-gates U53/8, U52/8, and inverters U45/10, 12.

Read Decoding is made by U44/12 producing its output RSM high, when CB0, CBl (U42/14, 13) are low. Low-active Read RSM is generated by inverter U45/12. During SQPHO, RSM is disabled as CBO, CBl are high. During SQPH3, SQl high disables RSM.

Write Decoding is carried out by U46/12, U44/8, and U53/8. During SQPHO, as SQO and SQl are both low, U44/8 is high. As also CBO is high, the Fast Write signal from U52/6 will run through U53/8 (WSM). During SQPHl, as SQO is high, WSM is decoded from the combinatory state of CBO, CBl (01 generates low-active Write). During SQPH3, WSM is totally inhibited by SQO = SQl= 1. The Sum Write Buffer Enable signal WEN supplied by U52/8 acts simultaneously with WSM, except during SQPHO as disabled by SQO low.

The Sample Adding Logics consist of the full adders U34, U35, and one of the two D Flip-Flops in U36. U34 forms the sum of BDO-3, RDO-3, and one bit carrying from U36/9, then applying the sum results to SDO-3 and carrying to U35/7. U35 forms the sum of BD4-7, RD4-7, and one bit carrying from U34, then applying the sum results to SD4-7 and carrying to the D-input of U36. The F-F stores the carry by rising edge of the clock (RSM) applied to its pin 11. Otherwise, adding operation is asynchronous. SQO applied to U36/10 sets the F-F when low.

The Temporarv Store U28 contains eight D Flip-Flops triggered by rising edge of common clock (RSM) applied to pin 11. Its reset pin 1 is driven by the EX-OR gate U41/11 which produces active low Reset either with SQO and Pl0, both high (SQPHO) or both low (STOP condition).

The Re-Linearizer is composed of the two quadruple 2-to-1 line multiplexers U39, U40, and the surrounding gates and inverters. The Sample Data bit FD5 via U45/6 and U38/12 determines which of the two 8-bit lines are carried through multiplexers to BDO-7 in the following way:

FD5 = 0: MUX outputs show the states of the input pins 2, 5, 11, and 14. This is FDO-5 and BDO-5 and BD6=BD7=0.

FD5 = 1: MUX outputs show the states of the input pins 3, 6, 10, and 13. This is FD6 (overflow) on BDO-1, FDO-2 on DB2-4 (as so multiplied by 4) and the function 4x((FD,3,4,5)-32) + 32 on BD5-7.

As to the last mentioned function add 32 is performed by the EX-OR gates U41/8 and 6, NAND-gate U53/6, and inverter U45/4 which, together, make a full adder. Multiplying by 4 is simply made by shifting up bit weights by two. Subtract 32 is done by leaving FD5 out.

The MEN control from U44/6 via the inverter U45/8 enables the MUX outputs when RA8, RA9 are both low (Bank 0). Otherwise, outputs are all low. GL high disables FD5 control.

The Samule RAM Read Control logics consist of the one JK Flip-Flop in U43 and the NAND-gate U52/12. With P17 high, and SQ0 going low, triggers STOP high and Pl0 low. Low state on SQl will set back the initial states. ST goes low, stopping the sequence only when STOP, RSM, and RL are all high.

The Laser Trigger is composed of the two AND-gates U46/6 and 8, the inputs and outputs of which are driven in parallel. The outputs provide for low-impedance drive for LTRG through resistor R60 and coaxial connector 526. The trigger line is raised high by SQO going high at the beginning of SQPHO. About 60 ns later, LTE from U43/9 goes low, dropping the trigger low again. LTON low will disable triggering.

The Test Pulse Generator is composed of the D Flip-Flop U36/5, EX-OR gate U41/3 and Jumper Sets J15, J18. During normal operation, jumper connections should be left open so as to disable test pulsing. With the test jumpers connected, either RA6 or RA7 is applied to U36/3 triggering U36/5 high, since SQO applied high state to U36/2. Either RAl or RA2 going high will reset the F-F via U41/3. Since RA7 rises once and RA6 twice during SQPHO, single or double pulse is generated, respectively. Since RA2 rises 400 ns and RAl 200 ns after RA6 or RA7 rising edge, respective pulse widths are achieved, added by the delay generated by U41/3 and C52. The main function of C52 is to filter out hazard pulses due to slightly non-equal timing of the Counter outputs (Ref. Dwg. CT 3536).

Test Points are provided for the following signals:

J16/7	RAO, Sample RAM Address 0
J16/6	WEN, Sum Write Buffer Enable
J16/5	Xl, System Clock
J16/4	CBO, Seq. Control Counter Bit 0
J16/3	CCK, Seq. Control Counter Clock
J21/10	SQl, Seq. Phase Control 1
J21/9	LTRG, Laser Trigger
J21/8	LTON, Laser Trigger Control
J21/7	WSM, Sample RAM Write Enable
J21/6	LTE, Laser Trigger Enable (5 MHz Clock)
J21/5	RSM, Sample RAM Read Enable
J21/4	SCK, Sample Clock
J21/3	SQO, Seq. F'hase Control 0, Inverted
J21, and J16/1	GND, Logic Ground

Jumper Strappings are provided for the following signals:

J13	WEN, Sum Write Buffer Enable
J17	MEN, Re-Linearizer MUX Enable
J20	STOP, Stop Control
J24	SQO, Seq. Phase Control 0
J25	CLD, Delay Counter Load

4.3.1.4.4 Amplifier Section

The First Amnlifier Stage U48 is a differential video op-amp of type LM733 which features 125 MHz bandwidth and 250 kohm input resistance. The signal RECO is brought in via J22 and applied to pin 2. The other of the differential inputs (1) is grounded. R59 provides for approximately 50 ohm termination, C78 does low-pass filtering. Total gain for the amplifier chain is adjusted by R55. The output pin 6 connects to the input of the Second Amplifier Stage as AC-coupled via paralleled capacitors C66, C67. The other of the differential outputs (7) connects to ground via filter components C64 and R54. The static output level on the output pin 6 (ATl) is normally around +3V. The device is powered from +6V lines consuming approximately 15mA. It is normally packaged. in a lo-lead hermetic metal can, but the board also provides for 14-lead DIP.

The test pulse signal TP can be connected via jumper set J23 into the op-amp input. For proper operation, the cable connector in J22 should be removed. Since TP is brought in via two resistors R60, R61, three alternative pulse amplitudes can be selected by connecting the resistors separately or in parallel. R59 attenuates TP signals down to the millivolt region. Drawing CT 3536 illustrates TP generation and signal response waveforms on each test point of the Amplifier, also showing the jumper strapping alternatives and data response in the. sample RAM. The waveforms are typical and may vary some between different devices.

The Second Amnlifier Stage consists of the three transistors Qll, 8, 6, and surrounding passive components.

Qll, and Q8 make the amplifier, and Q6 is an emitter follower buffering the output, which connects to the Signal Buffer via capacitors C40, 41. Input is biased by R48, 49 to about -3.7 V level. R43 and R41 are the emitter resistors for Qll, the latter bypassed by C54, and 61, to let through the AC. Similar bypassing is done by C46, 47 and Q8 collector resistor R35. D12 Schottky-diode effectively clamps too high signal levels. AC-gain of the amplifier is determined by the ratio of the feedback resistor R42 and emitter resistor R43.

The Gain Selector is formed by Q12 FET, transistors Q7, Ql0, and some passive components. The Gl control, when high, feeds base current through Q7 to Q10 which so applies -13V to the gate of Q12. This indicates that Q12 is not conducting, which leaves R42 the only path for feedback current, and so high gain is selected (Gain 2). With Gl low, no base current is supplied for Q10 which so leaves Q12 gate floating. Now, Q12 conducts and R44 is connected in parallel with R42, so selecting low gain (Gain 0). In practice, the source-drain resistance of Q12 adds typically 40 ohms to the parallel resistor value. Capacitors C55, 87 are to filter off the 10 MHz system noise but they also reduce the slew rate of the amplifier.

The Signal Buffer is input-biased by the resistor divider R24, 25 fed from VR. Diode DA3/1-16 compensates for temperature-dependence of Q4 base-emitter voltage drop. Schottky-diode D 1 0 clamps too high signal levels. Transistor Q4 is connected as an emitter follower, straight-driven from +9V. Although Q4 emitter is pulled down to -13V by R28, negative voltages do not normally appear except by undershoot caused by high signal levels. D8 protects the ADC input against undershoot.

The Flash ADC U23 is a 6-bit CMOS device of type CA3300. In its input stage, 64 paralleled comparators simultaneously compare the input voltage with the tap voltages of a resistor ladder, fed by the reference supplies. Conversion is done simply by decoding the comparator output results into 6-bit digital form (plus overflow) transferred into output registers. The ADC outputs are enabled by pin 5 high. Sampling and conversion is operated by the clock applied to pin 7 (SCA).

The Level Shifter is a quad AND gate U32 of type 74HCT08 which features TTL-level inputs ("0" : Uin < 0.8V; "1" : Uin > 2.0V). It is powered from the resistor/zener connection R47, 46, 30, Dll, which gives approximately 7V supply and 2V to pins 14 and 7. Two of the gates are unused and two provide for level shifting: one for SCK (SCA as level-shifted), the other for SQO (ADC Enable as level-shifted). SQO, as applied to pin 4, also performs disabling SCA when low (SQPHl and 3). Resistors in RA22 and RA21 do primary level-shifting.

The Sample Write Buffer U25 is a CMOS-buffer enabled by SQO low applied to pins 1, 19. Its inputs are fed by the ADC via resistors dividers (RA17, 2.1, 18) which attenuate the output levels to meet the +5V logic input level demands.

The Flash ADC Reference Supply consists of two op-amps in U22 which is a quad op-amp, type LM124. The + 10.0V reference VR is divided by R15, R17 precision resistors to nominally +8.30V. Op-amp U22/7 and transistor Q3 make a unity gain buffer; this applies RP to the ADC pin 9. RP is further divided by R21,22,18 to nominally 1.72V. Op-amp U22/1, as a unity gain buffer, applies RC to the ADC pin 16. The GLL control high applies ca. 4.5W to U22/3 via D6. The op-amp so aims to drive 4.5 V into RC, but, because of the diode in its feedback loop, it cannot do so and RC level is set to ca.4.2V by the ADC internal resistor ladder.

The Monitor ADC Reference= divides VR by R14, R13 precision resistors and buffers the result by U22/8 which so supplies +5.0V reference (V5) to the Monitor ADC. The one op amp still left in U22 inverts the Pre-MUX buffered output signal MB and applies the result MI to the Monitor ADC channel 10.

The + 13V Regulator U18 is of adjustable type LM317LZ. Its output voltage is determined by the adjust resistors, as follows:

$$Uout = (1 + R9/Rl0) \times 1/25V + R10 \times 50\mu A - 12.7V$$

The input voltage is filtered by L2, C23. Diode in DA13 protects against reverse voltages. C81 performs bypassing in the adjust terminal, C20 in the output. The system consumes about 45mA from the regulator.

The -13V Regulator U17 is of the type LM337LZ with the same characteristics and similar circuit realization as the + 13 Regulator.

The + 6V Regulator U47. U49 is of a similar type with about similar circuit realization as the + 13V Regulators. The system consumes ca. 20mA from both. supplies.

The + 9V Regulator U24 is of' type LM317LZ. Its input voltage level is attentuated by R63 and R20, as it would otherwise cause overheating in extreme conditions. The other of the adjust resistors is composed of two paralleled resistors in RA18 D7, the 10V zener diode in the output, protects the ADC against over-voltages. The system consumes ca 45mA from the regulator.

Test Points are provided for the following signals:

J9/7	GNDA	Analog Ground
J9/5	+9V	Flash ADC Supply
J9/4	RP	Flash ADC High Ref., 8.3V
J9/3	RC	Flash ADC Low Ref., 1.7V
J9/2	IN	Flash ADC Input
J9/1	VR	Basic System Ref., 10.0V
Jll/l0-3	RDO-7	Sample Data Bus
J11/l	GND	Logic Ground
J14/3	AT4	Amplifier Test Point 4
J14/2	+ 13v	Analog HI Supply, positive
J14/1	AT3	Amplifier Test Point 3
J16/10	+7.1V	Level Shifter Source Supply
J16/9	+ 1.9V	Level Shifter Return Supply
J16/8	SCA	Flash ADC Clock, level-shifted
J19/7	AT2	Amplifier Test Point 2
J19/6	-13V	Analog HI Supply, negative
J19/5	AT1	Amplifier Test Point 1
J19/4	-6V	Analog LO Supply, negative
J19/3	+6V	Analog LO Supply, positive
J19/1	GNDA	Analog Ground

Notice that Analog Ground is connected to Digital Ground only in one point (near U25); otherwise, they are completely separated.

4.3.1.5 Parts List

Integrated Circuits

U2	2993	TC5564P-1	CMOS RAM
U3	12850	27C512-25	CMOS EPROM
U4	2996	TD8031	NMOS uPROC
U5	10341	NMC9346EN	CMOS EEPROM
U6,U18,U24 U47	1016	LM317LZ	Reg.
U7,U17,U49	2989	LM337LZ	Reg.
U8	2987	TLC541IN	CMOS ADC
U9	1047	74HC139	CMOS
U10,U21	1048	74HC259	CMOS
U11,U20	1056	74HC132	CMOS
U12	2977	74HC4060	CMOS
U13,U19	1049	74HC373	CMOS
U14,U22	2456	LM124J	Op-amp x 4
U15	2976	4051	CMOS
U16	1832	LM335H	Temp. sensor
U23	2991	CA3300CE	CMOS ADC
U25,U27	2980	74HC244	CMOS
U26	2992	HMl-65161-9	CMOS RAM
U28	2979	74HC273	CMOS
U29	2998	LM2935T	Reg.
U30	2988	LH0070-1	Ref.
U31	1833	74HCT08	CMOS
U32,U37,U42	2330	74HC161	CMOS
U33,U45	2986	74HCU04	CMOS
U34,U35	2978	74HC283	CMOS
U36	1910	74HC74	CMOS
U38,U44	2983	74HC27	CMOS
U39,U40	2981	74HC157	CMOS
U41	1046	74HC86	CMOS
U43,U51	2982	74HC113	CMOS
U46,U50	2984	74HC11	CMOS
U48	2990	LM733H	Op-amp, video
U52,U53	2985	74HC10	CMOS

Transistors

Q1-Q4,Q6, Q10,Q11	5416	2N2222A	NPN
Q7,Q8	0285	2N2907A	PNP
Q12	2975	2N4392	N-JFET

Diodes

DAl-DA3	2974	TND903	Diode Array, 8 x IN4148
D1-D3,Dll	4171	IN75 1A	Zener Diode, 5.1V
D4	5429	5082-4655	LED, Red
D5	1159	ESBG 5531	LED, Green
D6,D8,Dl0,D12	4685	5082-2008	Schottky Diode
D7	0024	IN4740	Zener Diode,lOV
D9	4336	IN4005	Diode

Crystals

Zl	10000	10.000 MHz

Resistor Arrays

all Single-in-Line (SIL) unless otherwise mentioned

RAl,RA2,RA4 RA5,RA12, RA15	0965	5 x 4k7
RA3,RA18	0942	9 x 2k2
RA6,RA14, RA17,RA21 RA23	4989	4 x 1k0
RA7,RAll	0057	4 x 10k
RA8,RA19	4633	9 x 10k
RA9	0967	4 x 47k
RAl0,RA16	10001	4 x 100R
RA13,RA22	2960	4 x 2k2
RA20,RA24	1199	4 x 22k
RA22	2960	4 x 2k2

Resistors

all 1% l/4 W 50 ppM, metal foil, unless otherwise mentioned

R l,R3,R30, R47	3167	383R	
R2,R4,R40, R42	5791	3k32	
R5,R24,R39 R49	5126	14k7	
R6	0556	8k66	
R7,R 19,R48	1677	8k25	
R8,R36,R41	7393	4k87	
R9,R 12,R28, R33	5156	2k74	
R10,Rll	7479	301R	
R13,R14,R21	3532	20k0	0, 1% l/4 W 25 ppM
R15	0331	lk00	0, 1% l/4 W 15 ppM
R16,R22	3191	322k	
R17,R18	0520	4k87	0, 1% l/4 w 15 ppM
R20,R35,R54	6375	lk00	
R25,R68	7026	lk78	
R26,R43,R53 R56	6355	215R	
R27,R62	3 163	10R0	
R31,R61,R65 R66	3186	48k7	
R34	5434	5M60	
R37	6373	100R	
R44,R52,R57	0955	825R	
R46,R58,R59 R63	5116	48R7	
R50,R67	3189	82k5	
R55	1681	100R	Trim. pot. l/2 W 150 ppM
R60	5444	21k5	
R64	5700	178R	

Capacitors

Cl-C4,C7,C8, Cl0-C12,C14, C15,C17,C24, C28-C33,C36, C37,C42-C45, C49,C5 l,C53, C56,C58,C62, C63,C65,C68- C71,C73,C76, C78,C79-C86	4507	100n	63V	cer.
C5,C6,C19, C23,C72,C74, C89	6920	10µ	35V	tant.
C9,C52,C78	4782	220p	100V	polycarb.
C13,C35, C40,C47,C54 C57,C66	10008	1µ	50V	polyest.
C16,C20-C22, C25,C27,C34 C48,C60,C75	0610	22µ	25V	tant.
C18,C64,C78	5705	820p	63V	cer.
C26	3258	l00µ	20V	tant.
C38,C50, C55,C88	5726	22p	63V	cer.
C4l,C46, C6l,C67	4822	10n	100V	polycarb.
C87	5722	10p	63V	cer.

Inductors

Ll	1181	100µH min. choke
L2-L5	2321	220µH min. choke

Connectors

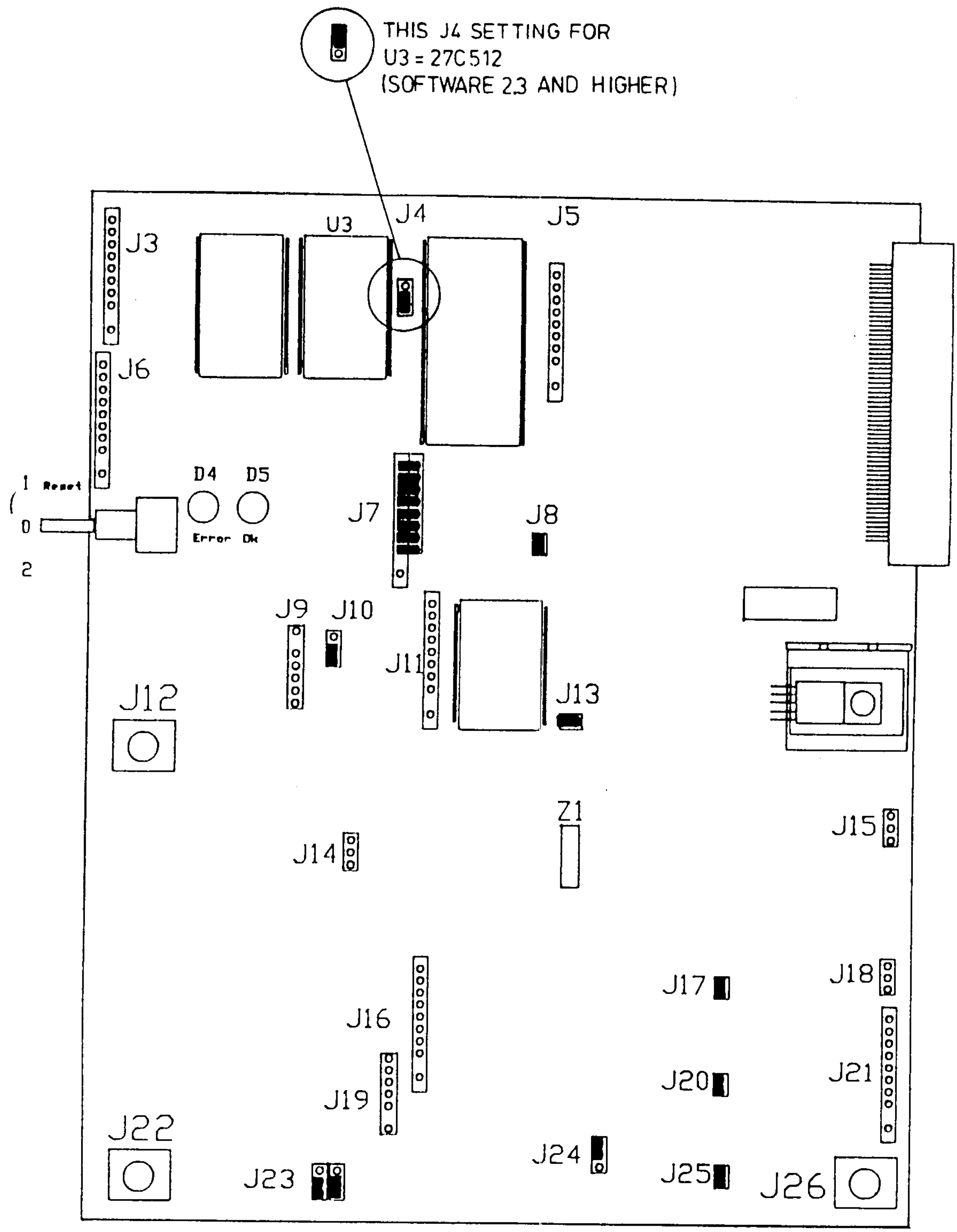
Jl	6800	64-pin (ac) EURO connector
J3-J11 J13-J21, 523,525	5498 -	Pin strip
522,526	5158	82 SMB-50-0-l coax.

Switches

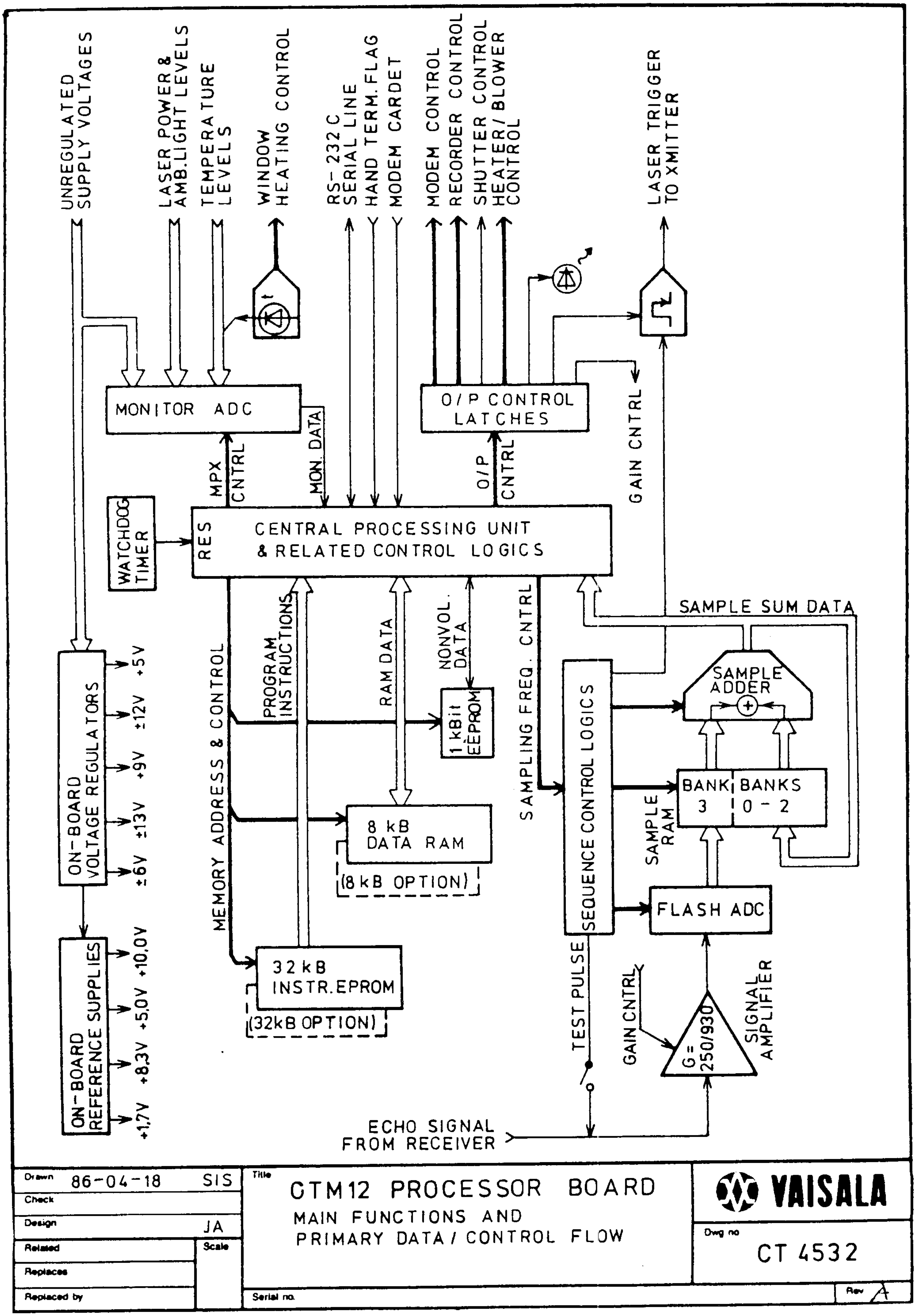
Sl	10019	E107-M-Dl-A-B-E	SPDT (on/off/mom.)

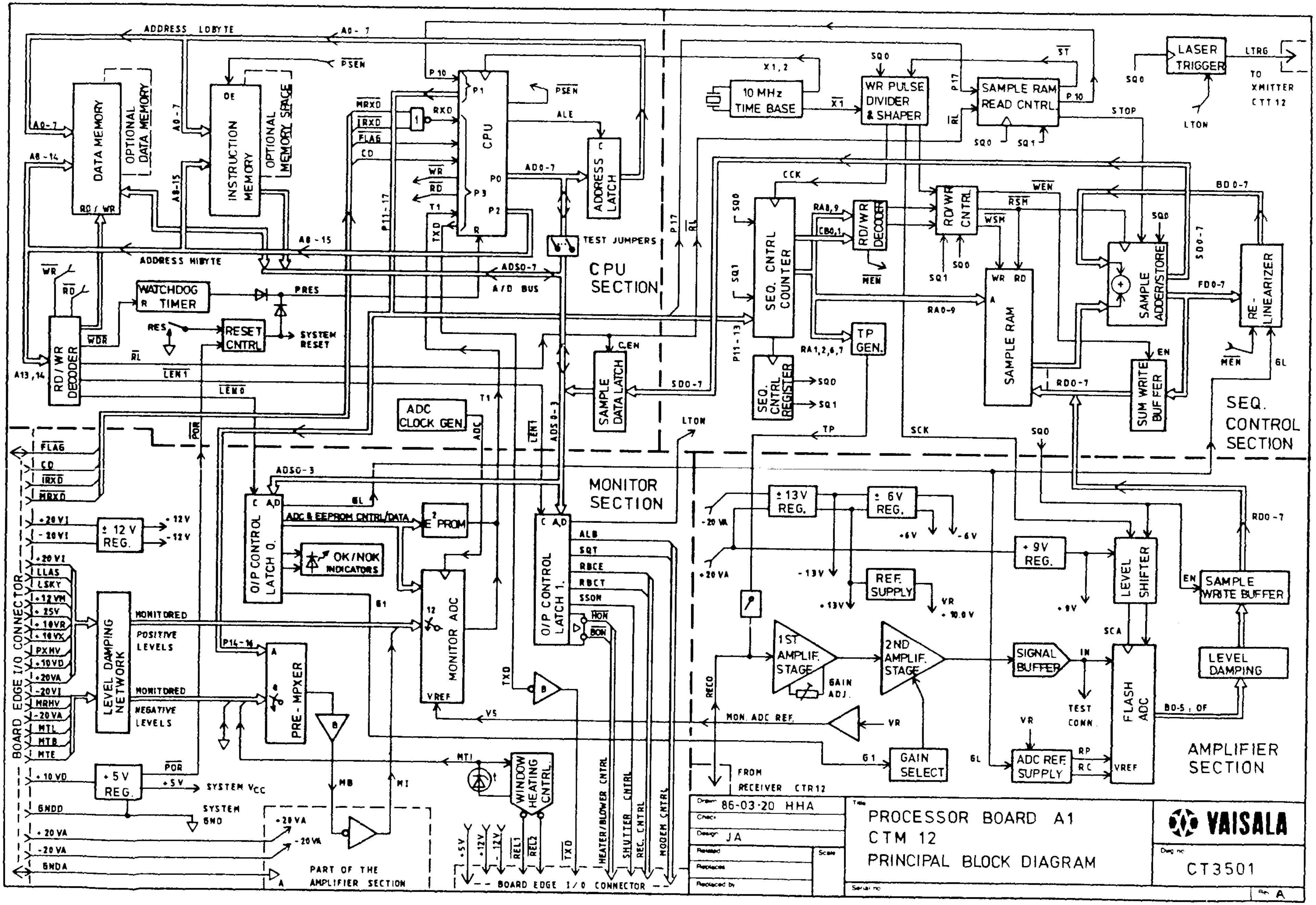
Miscellaneous

	0677	IC-socket 28-pole
	5046	IC-socket, 40-pole
	7439	IC-socket, 8-pole
	1768	IC-socket, 18-pole
	4684	IC-socket, 24-pole
	5143	Female Shorting Plug, 2-Pole
	2997	Heat Sink, THM 6107B-14
	10014	PCB Ejector, CBE-8-18

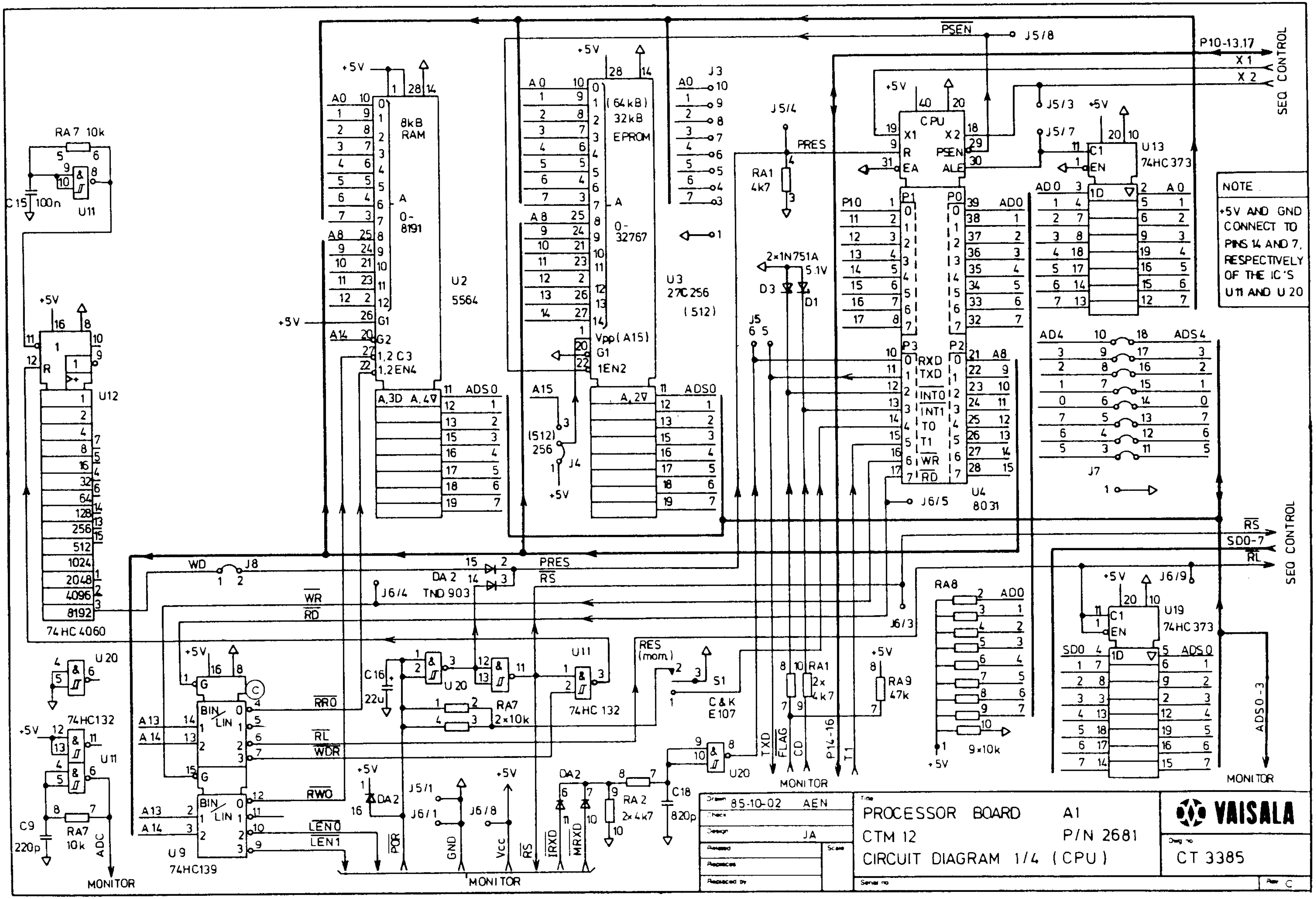


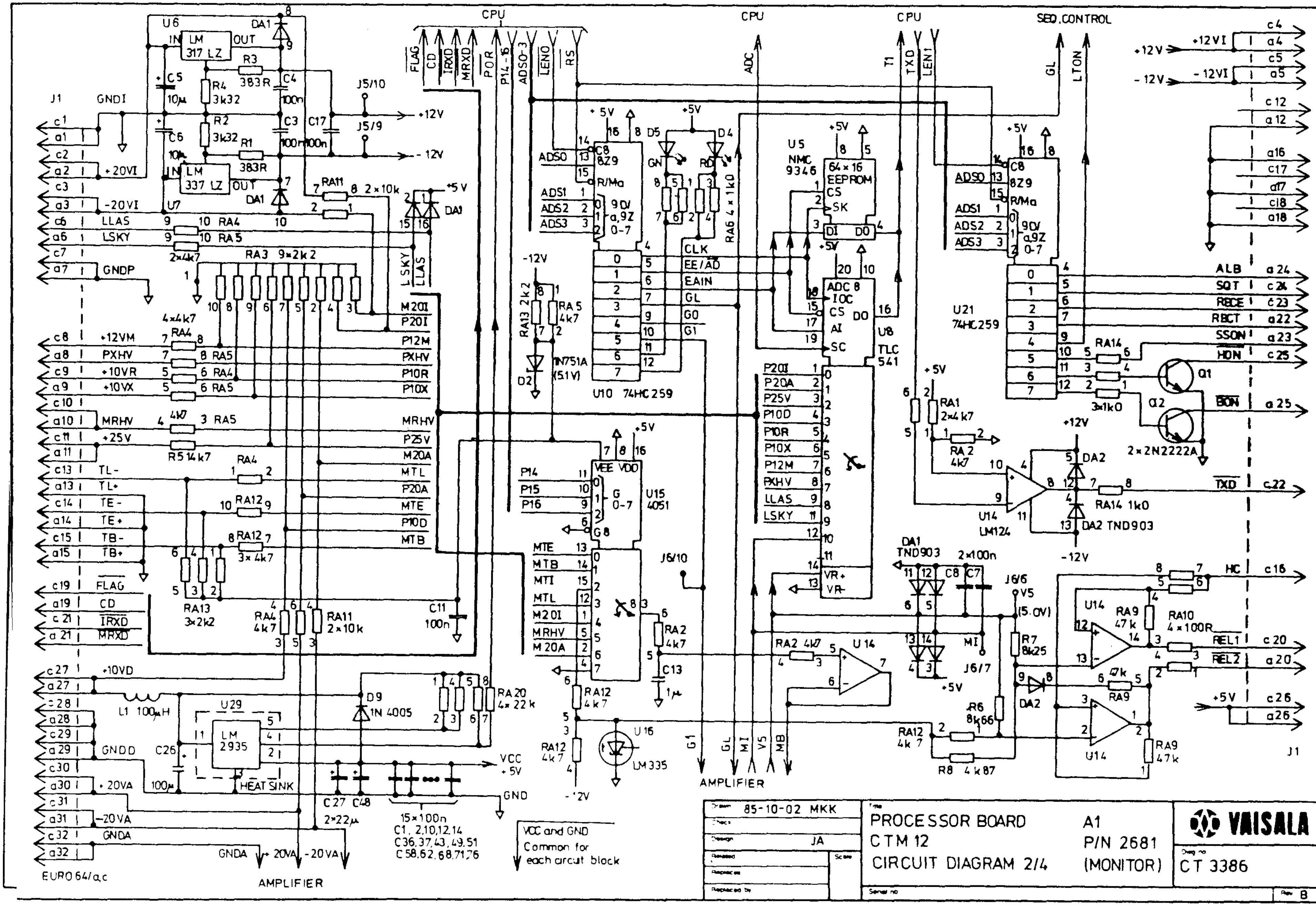
Drawn 1985-08-23 ETA		Title CEILOMETER CT 12K PROCESSOR BOARD CTM 12 JUMPERINGS AND CONNECTORS	VAISALA
Check			Dwg no A.CT4407
Design			
Related	Scale		
Replaces			
Replaced by		Serial no	Rev B


UNREGULATED SUPPLY VOLTAGES
LASER POWER & AMB.LIGHT LEVELS
TEMPERATURE LEVELS
WINDOW HEATING CONTROL
RS-232 C SERIAL LINE
HAND TERM. FLAG
MODEM CARDET
MODEM CONTROL
RECORDER CONTROL
SHUTTER CONTROL
HEATER/BLOWER CONTROL
LASER TRIGGER TO XMITTER
MONITOR ADC
MPX CNTRL
MON. DATA
O/P CONTROL LATCHES
O/P CNTRL
GAIN CNTRL
WATCHDOG TIMER
RES
CENTRAL PROCESSING UNIT & RELATED CONTROL LOGICS
PROGRAM INSTRUCTIONS
RAM DATA
NONVOL. DATA
SAMPLING FREQ. CNTRL
SAMPLE SUM DATA
SAMPLE ADDER
MEMORY ADDRESS & CONTROL
1 kBit EEPROM
8 kB DATA RAM
(8 kB OPTION)
32 kB INSTR.EPROM
(32kB OPTION)
SEQUENCE CONTROL LOGICS
BANK 3
BANKS 0 - 2
SAMPLE RAM
FLASH ADC
ON-BOARD VOLTAGE REGULATORS
+5V
±12V
+9V
±13V
±6V
ON-BOARD REFERENCE SUPPLIES
+10,0V
+5,0V
+8,3V
+1,7V
TEST PULSE
GAIN CNTRL
G = 250/930
SIGNAL AMPLIFIER
ECHO SIGNAL FROM RECEIVER
Drawn 86-04-18 SIS
Check
Design JA
Related
Scale
Replaces
Replaced by
Title
CTM12 PROCESSOR BOARD
MAIN FUNCTIONS AND PRIMARY DATA / CONTROL FLOW
VAISALA
Dwg no
CT 4532
Serial no.
Rev A

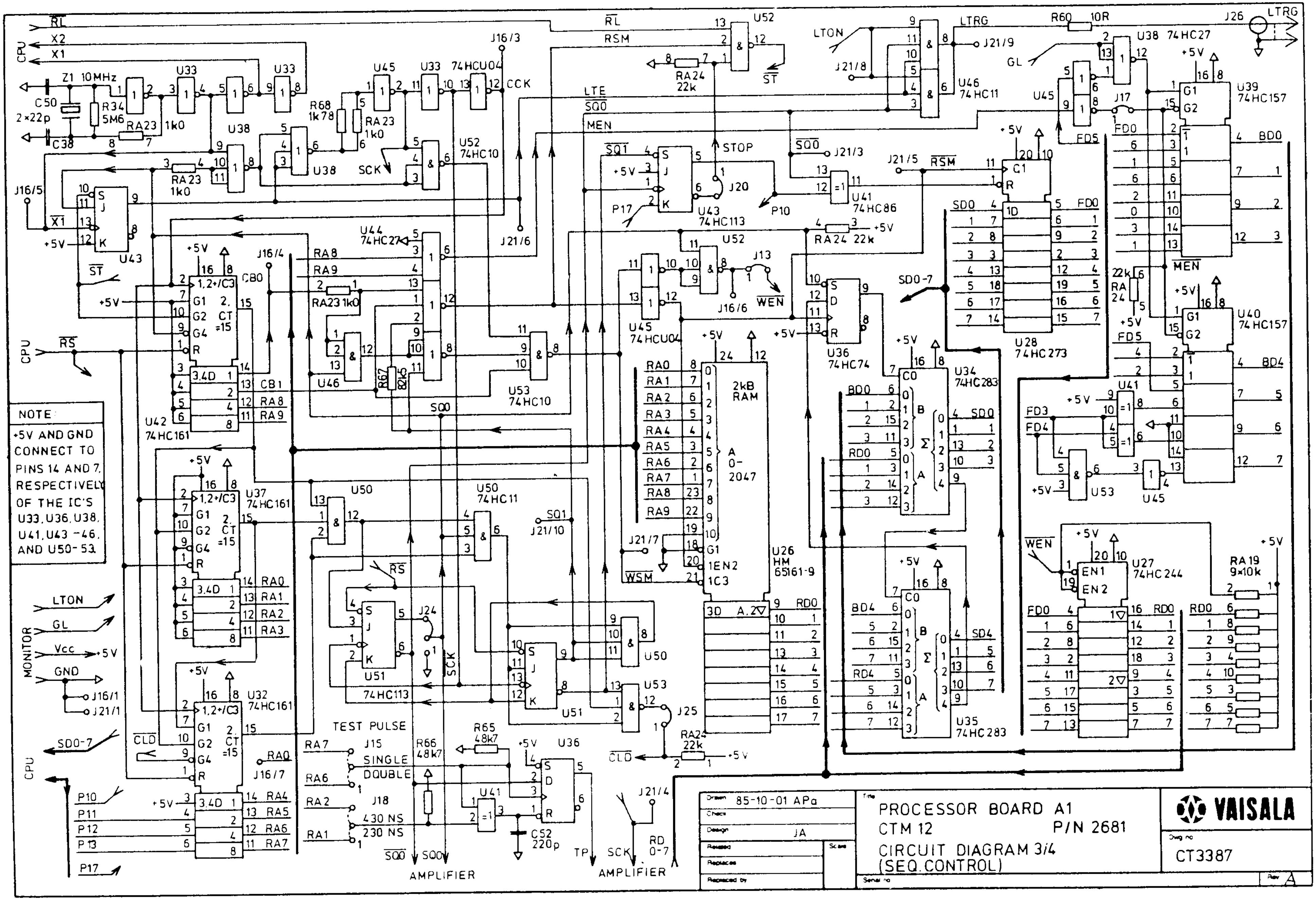


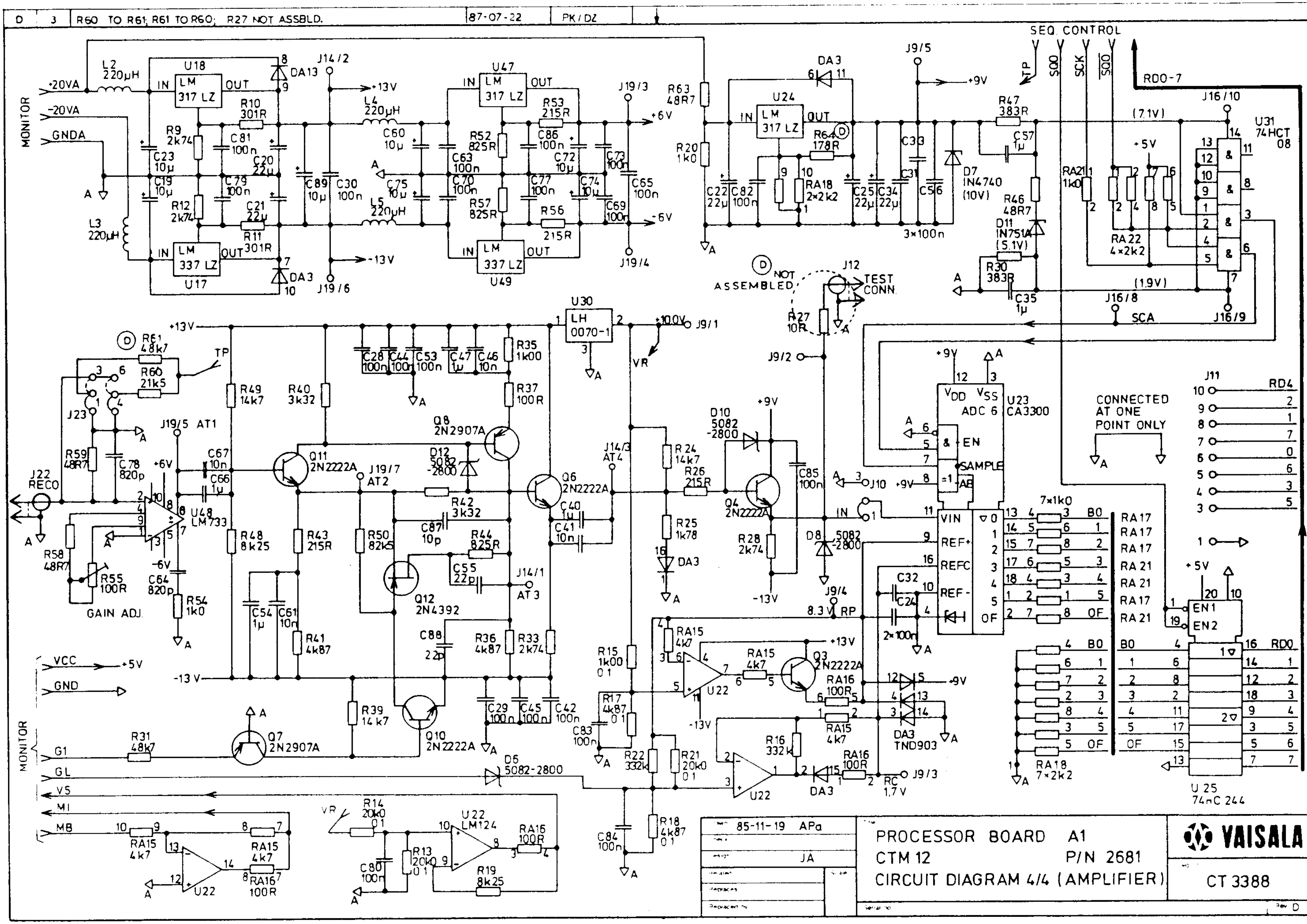
ADDRESS LOBYTE
DATA MEMORY
OPTIONAL DATA MEMORY
INSTRUCTION MEMORY
OPTIONAL MEMORY SPACE
CPU
ADDRESS LATCH
TEST JUMPERS
ADDRESS HIBYTE
A/D BUS
WATCHDOG TIMER
RESET CNTRL
SYSTEM RESET
RD / WR DECODER
CPU SECTION
ADC CLOCK GEN
SAMPLE DATA LATCH
10 MHz TIME BASE
WR PULSE DIVIDER & SHAPER
SAMPLE RAM READ CNTRL
LASER TRIGGER
TO XMITTER CTT 12
SEQ. CNTRL COUNTER
RD/WR DECODER
RD/WR CNTRL
SAMPLE RAM
SAMPLE ADDER/STORE
RE-LINEARIZER
TP GEN.
SEQ. CNTRL REGISTER
SUM WRITE BUFFER
SEQ. CONTROL SECTION
MONITOR SECTION
O/P CONTROL LATCH 0.
ADC & EEPROM CNTRL/DATA
E²PROM
OK/NOK INDICATORS
MONITOR ADC
O/P CONTROL LATCH 1.
PRE-MPXER
LEVEL DAMPING NETWORK
MONITORED POSITIVE LEVELS
MONITORED NEGATIVE LEVELS
± 12 V REG.
+ 5 V REG.
SYSTEM Vcc
SYSTEM GND
WINDOW HEATING CNTRL
BOARD EDGE I/O CONNECTOR
PART OF THE AMPLIFIER SECTION
± 13 V REG.
± 6 V REG.
+ 9 V REG.
REF. SUPPLY
LEVEL SHIFTER
SAMPLE WRITE BUFFER
1ST AMPLIF. STAGE
2ND AMPLIF. STAGE
GAIN ADJ.
SIGNAL BUFFER
TEST CONN.
FLASH ADC
LEVEL DAMPING
MON. ADC REF.
GAIN SELECT
ADC REF. SUPPLY
FROM RECEIVER CTR12
AMPLIFIER SECTION
HEATER/BLOWER CNTRL
SHUTTER CNTRL
REC. CNTRL
MODEM CNTRL
Drawn 86-03-20 HHA
Design JA
PROCESSOR BOARD A1
CTM 12
PRINCIPAL BLOCK DIAGRAM
VAISALA
CT3501
Rev A

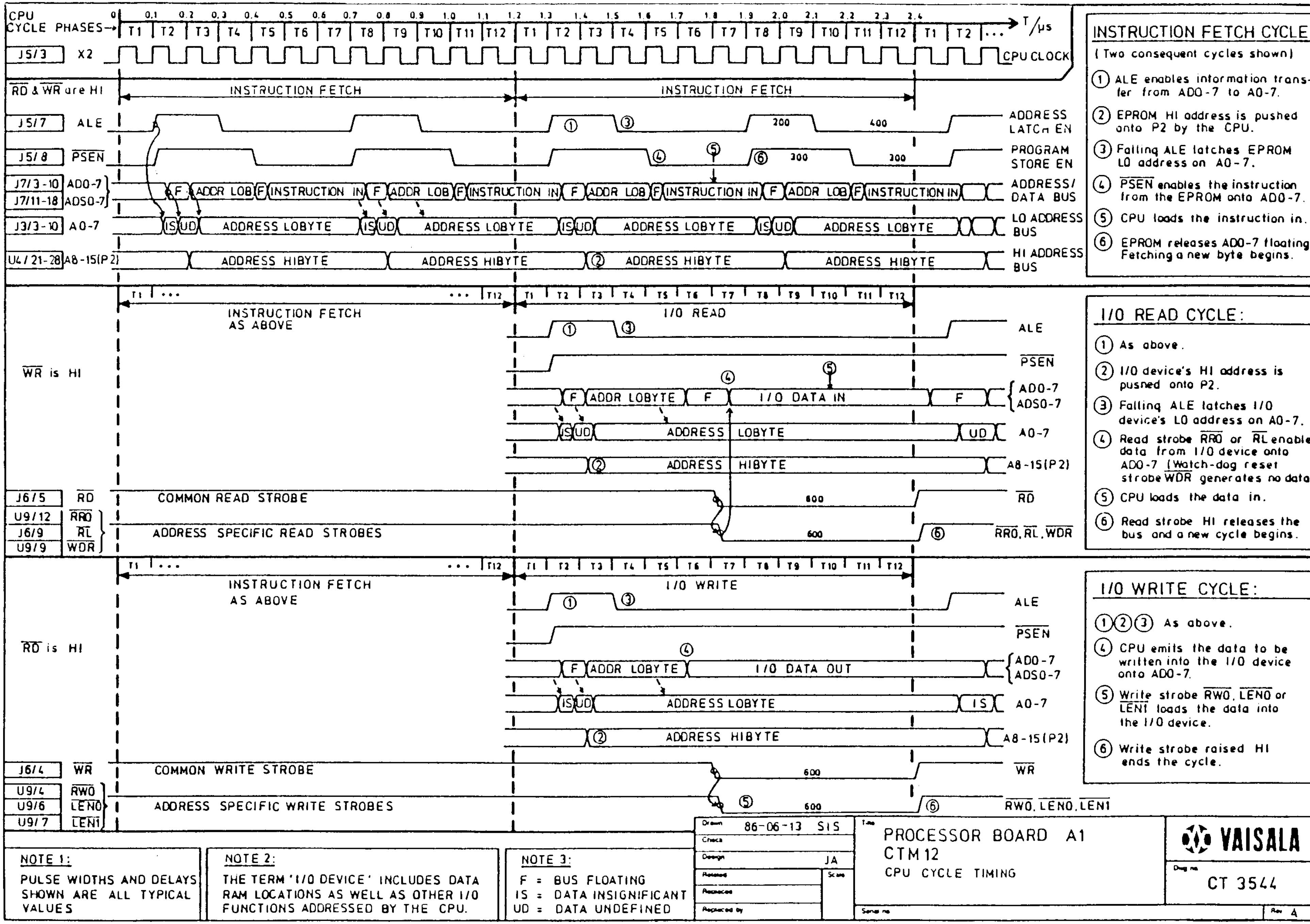

NOTE
+5V AND GND CONNECT TO PINS 14 AND 7, RESPECTIVELY OF THE IC'S U11 AND U20
SEQ CONTROL
MONITOR
8kB RAM
U2 5564
U3 27C256 (512)
(64kB) 32kB EPROM
CPU
U4 8031
U13 74HC373
U19 74HC373
U12 74HC4060
U9 74HC139
U11 74HC132
S1 C&K E107
Drawn 85-10-02 AEN
Design JA
PROCESSOR BOARD A1
CTM 12 P/N 2681
CIRCUIT DIAGRAM 1/4 (CPU)
VAISALA
CT 3385
Rev C

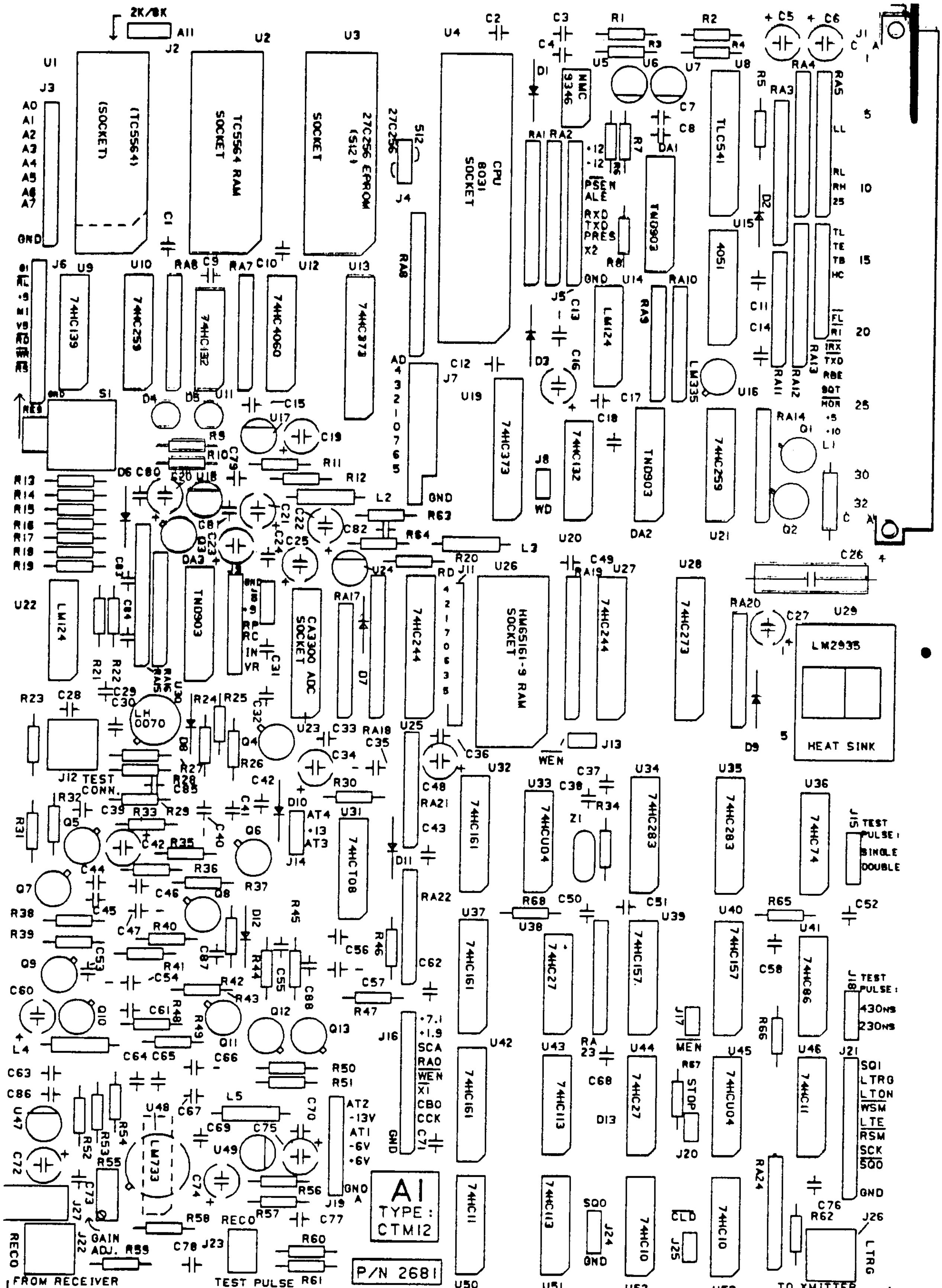


PROCESSOR BOARD
CTM 12
CIRCUIT DIAGRAM 2/4
A1
P/N 2681
(MONITOR)
CT 3386
VAISALA
85-10-02 MKK
JA
Rev B
VCC and GND
Common for
each circuit block
15×100n
C1, 2,10,12,14
C36,37,43,49,51
C58,62,68,71,76
EURO 64/a,c
AMPLIFIER
CPU
SEQ.CONTROL
U6 LM 317 LZ
U7 LM 337 LZ
U29 LM 2935
U5 NMC 9346 64×16 EEPROM
U8 TLC 541
U10 74HC259
U21 74HC259
U15 4051
U14 LM124
U16 LM335
Q1 Q2 2×2N2222A
DA2 TND903
DA1 TND903
D9 1N 4005
D2 1N751A (5.1 V)
L1 100µH
HEAT SINK
J1

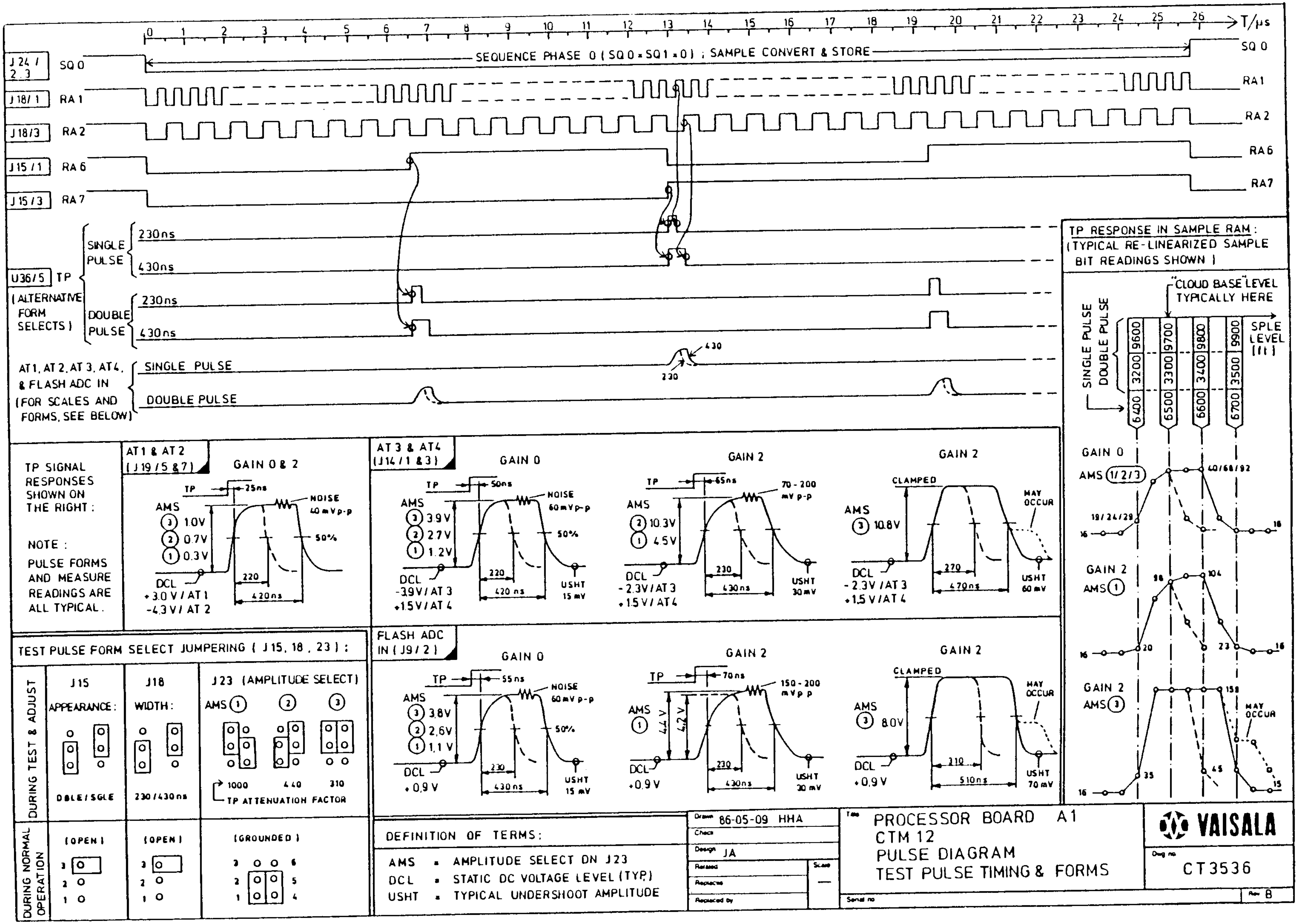

NOTE
+5V AND GND CONNECT TO PINS 14 AND 7, RESPECTIVELY OF THE IC'S U33, U36, U38, U41, U43 -46, AND U50-53.
CPU
MONITOR
LTON
GL
Vcc
GND
TEST PULSE
SINGLE
DOUBLE
430 NS
230 NS
AMPLIFIER
AMPLIFIER
2kB RAM
U26 HM 65161-9
U28 74HC273
U39 74HC157
U40 74HC157
U34 74HC283
U35 74HC283
U27 74HC244
U42 74HC161
U37 74HC161
U32 74HC161
U46 74HC11
U38 74HC27
U41 74HC86
U43 74HC113
U36 74HC74
U53 74HC10
U50 74HC11
U45 74HCU04
Z1 10MHz
Drawn 85-10-01 APa
Design JA
PROCESSOR BOARD A1
CTM 12 P/N 2681
CIRCUIT DIAGRAM 3/4
(SEQ.CONTROL)
VAISALA
CT3387
Rev A


D 3 R60 TO R61; R61 TO R60; R27 NOT ASSBLD. 87-07-22 PK/DZ
MONITOR
+20VA
-20VA
GNDA
U18 LM 317 LZ
U17 LM 337 LZ
U47 LM 317 LZ
U49 LM 337 LZ
U24 LM 317 LZ
J14/2
+13V
-13V
J19/3
+6V
-6V
J19/4
J19/6
J9/5
+9V
SEQ. CONTROL
TP
SQ0
SCK
SQ0
RD0-7
J16/10
U31 74HCT 08
(7.1V)
(1.9V)
+5V
D7 IN4740 (10V)
D11 IN751A (5.1V)
D NOT ASSEMBLED
J12 TEST CONN.
J16/8
SCA
J16/9
U30 LH 0070-1
J9/1
10.0V
VR
J9/2
R61 48k7
R60 21k5
J23
J19/5 AT1
J22 RECO
U48 LM733
GAIN ADJ.
R55 100R
Q11 2N2222A
Q8 2N2907A
D12 5082-2800
Q6 2N2222A
J19/7 AT2
Q12 2N4392
J14/1 AT3
J14/3 AT4
D10 5082-2800
Q4 2N2222A
D8 5082-2800
J10
IN
U23 ADC 6 CA3300
VDD VSS
EN
SAMPLE
VIN
REF+
REFC
REF-
OF
CONNECTED AT ONE POINT ONLY
J11
RD4
8.3V RP
J9/4
U22
Q3 2N2222A
DA3 TND903
J9/3
RC 1.7V
U25 74HC 244
EN1
EN2
RD0
B0
VCC +5V
GND
MONITOR
G1
GL
VS
MI
MB
Q7 2N2907A
Q10 2N2222A
D6 5082-2800
U22 LM124
85-11-19 APa
JA
PROCESSOR BOARD A1
CTM 12 P/N 2681
CIRCUIT DIAGRAM 4/4 (AMPLIFIER)
VAISALA
CT 3388
Rev D


CPU CYCLE PHASES
T/µs
CPU CLOCK
INSTRUCTION FETCH
I/O READ
I/O WRITE
INSTRUCTION FETCH AS ABOVE
ADDRESS LATCH EN
PROGRAM STORE EN
ADDRESS/ DATA BUS
LO ADDRESS BUS
HI ADDRESS BUS
ADDRESS LOBYTE
ADDRESS HIBYTE
I/O DATA IN
I/O DATA OUT
COMMON READ STROBE
ADDRESS SPECIFIC READ STROBES
COMMON WRITE STROBE
ADDRESS SPECIFIC WRITE STROBES
RD & WR are HI
WR is HI
RD is HI
INSTRUCTION FETCH CYCLE:
(Two consequent cycles shown)
1 ALE enables information transfer from AD0-7 to A0-7.
2 EPROM HI address is pushed onto P2 by the CPU.
3 Falling ALE latches EPROM LO address on A0-7.
4 PSEN enables the instruction from the EPROM onto AD0-7.
5 CPU loads the instruction in.
6 EPROM releases AD0-7 floating. Fetching a new byte begins.
I/O READ CYCLE:
1 As above.
2 I/O device's HI address is pusned onto P2.
3 Falling ALE latches I/O device's LO address on A0-7.
4 Read strobe RR0 or RL enables data from I/O device onto AD0-7 (Watch-dog reset strobe WDR generates no data.)
5 CPU loads the data in.
6 Read strobe HI releases the bus and a new cycle begins.
I/O WRITE CYCLE:
1 2 3 As above.
4 CPU emits the data to be written into the I/O device onto AD0-7.
5 Write strobe RW0, LEN0 or LEN1 loads the data into the I/O device.
6 Write strobe raised HI ends the cycle.
NOTE 1: PULSE WIDTHS AND DELAYS SHOWN ARE ALL TYPICAL VALUES
NOTE 2: THE TERM 'I/O DEVICE' INCLUDES DATA RAM LOCATIONS AS WELL AS OTHER I/O FUNCTIONS ADDRESSED BY THE CPU.
NOTE 3: F = BUS FLOATING IS = DATA INSIGNIFICANT UD = DATA UNDEFINED
Drawn 86-06-13 SIS
Design JA
PROCESSOR BOARD A1
CTM12
CPU CYCLE TIMING
VAISALA
CT 3544
Rev A



DRAWN 86-01-13 MT		CTM 12 COMP. SIDE SILK SCREEN E/A P.CT01	VAISALA
CHECK			
DESIGN JA			
REL. C.CT3237	1:1		
REPLACES			
		SERIAL NO.	REV A


T/µs
SEQUENCE PHASE 0 (SQ0 = SQ1 = 0) ; SAMPLE CONVERT & STORE
J24/2.3 SQ0
J18/1 RA1
J18/3 RA2
J15/1 RA6
J15/3 RA7
U36/5 TP (ALTERNATIVE FORM SELECTS)
SINGLE PULSE 230ns 430ns
DOUBLE PULSE 230ns 430ns
AT1, AT2, AT3, AT4, & FLASH ADC IN (FOR SCALES AND FORMS, SEE BELOW)
SINGLE PULSE
DOUBLE PULSE
TP RESPONSE IN SAMPLE RAM: (TYPICAL RE-LINEARIZED SAMPLE BIT READINGS SHOWN)
"CLOUD BASE" LEVEL TYPICALLY HERE
SINGLE PULSE
DOUBLE PULSE
SPLE LEVEL (ft)
GAIN 0 AMS (1/2/3)
GAIN 2 AMS (1)
GAIN 2 AMS (3)
MAY OCCUR
TP SIGNAL RESPONSES SHOWN ON THE RIGHT:
NOTE: PULSE FORMS AND MEASURE READINGS ARE ALL TYPICAL.
AT1 & AT2 (J19/5 & 7)
GAIN 0 & 2
AMS (3) 1.0V (2) 0.7V (1) 0.3V
NOISE 40 mV p-p
DCL +3.0 V / AT1 -4.3 V / AT2
AT3 & AT4 (J14/1 & 3)
GAIN 0
AMS (3) 3.9V (2) 2.7V (1) 1.2V
NOISE 60 mV p-p
DCL -3.9V / AT3 +1.5V / AT4
USHT 15 mV
GAIN 2
AMS (2) 10.3V (1) 4.5V
70 - 200 mV p-p
DCL -2.3V / AT3 +1.5 V / AT4
USHT 30 mV
GAIN 2
CLAMPED
AMS (3) 10.8V
DCL -2.3V / AT3 +1.5 V / AT4
USHT 60 mV
FLASH ADC IN (J9/2)
GAIN 0
AMS (3) 3.8V (2) 2.6V (1) 1.1 V
NOISE 60 mV p-p
DCL +0.9 V
USHT 15 mV
GAIN 2
AMS (1)
150 - 200 mV p p
DCL +0.9V
USHT 30 mV
GAIN 2
CLAMPED
AMS (3) 8.0V
DCL +0.9 V
USHT 70 mV
TEST PULSE FORM SELECT JUMPERING (J15, 18, 23):
DURING TEST & ADJUST
J15 APPEARANCE: DBLE / SGLE
J18 WIDTH: 230 / 430 ns
J23 (AMPLITUDE SELECT) AMS (1) (2) (3)
1000 440 310 TP ATTENUATION FACTOR
DURING NORMAL OPERATION
(OPEN) (OPEN) (GROUNDED)
DEFINITION OF TERMS:
AMS = AMPLITUDE SELECT ON J23
DCL = STATIC DC VOLTAGE LEVEL (TYP.)
USHT = TYPICAL UNDERSHOOT AMPLITUDE
Drawn 86-05-09 HHA
Design JA
PROCESSOR BOARD A1
CTM 12
PULSE DIAGRAM
TEST PULSE TIMING & FORMS
VAISALA
CT3536
Rev B

4.3.2 UNREGULATED POWER SUPPLY BOARD CTS 12 REF. A2

4.3.2.1 Introduction

Unregulated Power Supply Board CTS 12 (Ref. A2), is a central support board of the CT 12K Ceilometer. The CTS 12 performs the following:

- rectifies and filters several low AC voltages from High-Voltage Power Supply CTP 12 (Ref. PSl) and Temperature Control Transformer Tl for supply to other parts.
- relays and switches logic for operating internal Temperature Control Heaters Rl and R2 with signals from Processor Board Al.
- connects signals between the eleven (11) other input/output connectors of the board.
- interfaces RS-232C connector (J7) with related over-voltage protection and switches connection to FSK Modem for troubleshooting the remote data line.

4.3.2.2 SPECIFICATIONS

Type: CTS 12

Part Number: 2682

Reference Designation: A2

Dimensions:	W	x	D	x	H	
	5.9	x	8.86	x	1.77	Inches
	150	x	225	x	45	Millimeters

Environmental (Inside Ceilometer)	Temperature:	-40°F...+ 140°F -40°C...+ 60°C
	Humidity:	Non-Condensing

4.3.2.3 Functional Description

Refer to Circuit Diagram CT 3196.

The following Ceilometer CT 12K parts are connected to the board:

Connector	Part
J1	Processor Board A1
J2	Temperature Control Heater R1
J3	Temperature Control Transformer T1
J4	Temperature Control Heater R2
J5	Light Monitor Board A5 via W5
J6	Output Interface Board A3
J7	RS-232C external connector J4 via W4 (doubles as Maintenance Terminal interface)
J8	Transmitter Board A7 via W7
J9	Temperature Sensor TS1
J10	High-Voltage Power Supply PS1
J11	High-Voltage Power Supply PS1
J12	Receiver Board A6 via W6

4.3.2.3.1 Power Supply

The following voltages are fuse-protected, rectified, filtered.

Input Connector	Input Voltage	Fuse and Value	Output Voltage	Test Point	Soft-ware Ref.	Supplied To
J10:1-2	8 VAC	F2:250mA	+10VDC	TP8	P10R	A6(J12)
J10:4-5	8 VAC	F3:600mA	+10VDC	TP4	P10D	A1(J1)
J10:3-6	15 VAC	F4:250mA	+20VDC	TP6	P20A	A1(J1)
J10:9-12	15 VAC	F5:250mA	-20VDC	TP5	M20A	A1(J1)
J10:7-8	15 VAC	F6:250mA	+20VDC	TP3	P20I	A1(J1)
J10:10-11	15 VAC	F7:250mA	-20VDC	TP2	M20I	A1(J1) A3(J6)
J10:13-14	10 VAC	F8:600mA	+12VDC	TP7	P12M	J7 1)
J10:16-17	8 VAC	F9:250mA	+10VDC	TP9	P10X	A7(J8)
J3:1-3	20 VAC	F1:10A	20 VAC	---		R1(J2),R2(J4)
			+25 VDC	TP1	P25V	A5(J5), PS1(J11)

Notes: 1) The connector for external RS-232C supplies + 12V to the Maintenance Terminal via circuits not reserved by RS-232C standard.

All voltages listed are unregulated (i.e., line input and load fluctuations cause variations).

All DC voltages are further connected to the Analog Monitoring section of the Processor Board A1 (connector J1) and have reference codes for software messages, etc.

The Maintenance Terminal + 12V supply (Ref. P12M) has a series diode, D7, for isolating the full-wave rectified 120Hz signal from the filter capacitors; and thus provides the signal required for the Gifft RBC Recorder output; signal “120Hz' to the Interface Board A3 connector j6 A28.

Diode D1 prevents the (optional) Solar Shutter Supply (via Light Monitor Board A5 connector J5) from discharging capacitor C3; and thus creates two separate +25VDC sources.

4.3.2.3.2 Temperature Control

The RELl and REL2 signals are derived from an internal temperature sensor through comparators and drivers, all located on the Processor Board Al.

At temperatures above approx. 20°C, neither relay is activated and the Temperature Control Heaters Rl and R2 (connectors J2 and J4 are OFF.

At temperatures between approx. 0°C and 20°C, signal RELl activates relay Kl. This will connect Rl and R2 in series across the 20 VAC source from Tl (J3), and provide two lo-watt sources of power.

At temperatures below approx. 0°C, signal REL2 activates relay K2 while signal RELl opens relay Kl. This will connect Rl and R2 in parallel1 across the 20 VAC from Tl (J3) and provide two 40-watt sources of power.

By turning switch Sl to the "OFF" position, the relay drivers release relays Kl and K2. This should be used only for temporary maintenance or service operations.

Control signals RELl and REL2 operate without the interaction of the processor or software.

4.3.2.3.3 RS-232C Interface

The RS-232C signals come through connector J7, which is a D25 Male type. There are two active signals which are the serial asynchronous data signals MTXD, pin 2, Data Transmitted from Ceilometer; and MRXD, pin 3, Data Received by Ceilometer. This corresponds with the Ceilometer appearing as Data Terminal Equipment (DTE).

Signals MRXD and MTXD are over-voltage protected by resistors Rl and R2, and transient zeners D5 and D6 which are bi-directional.

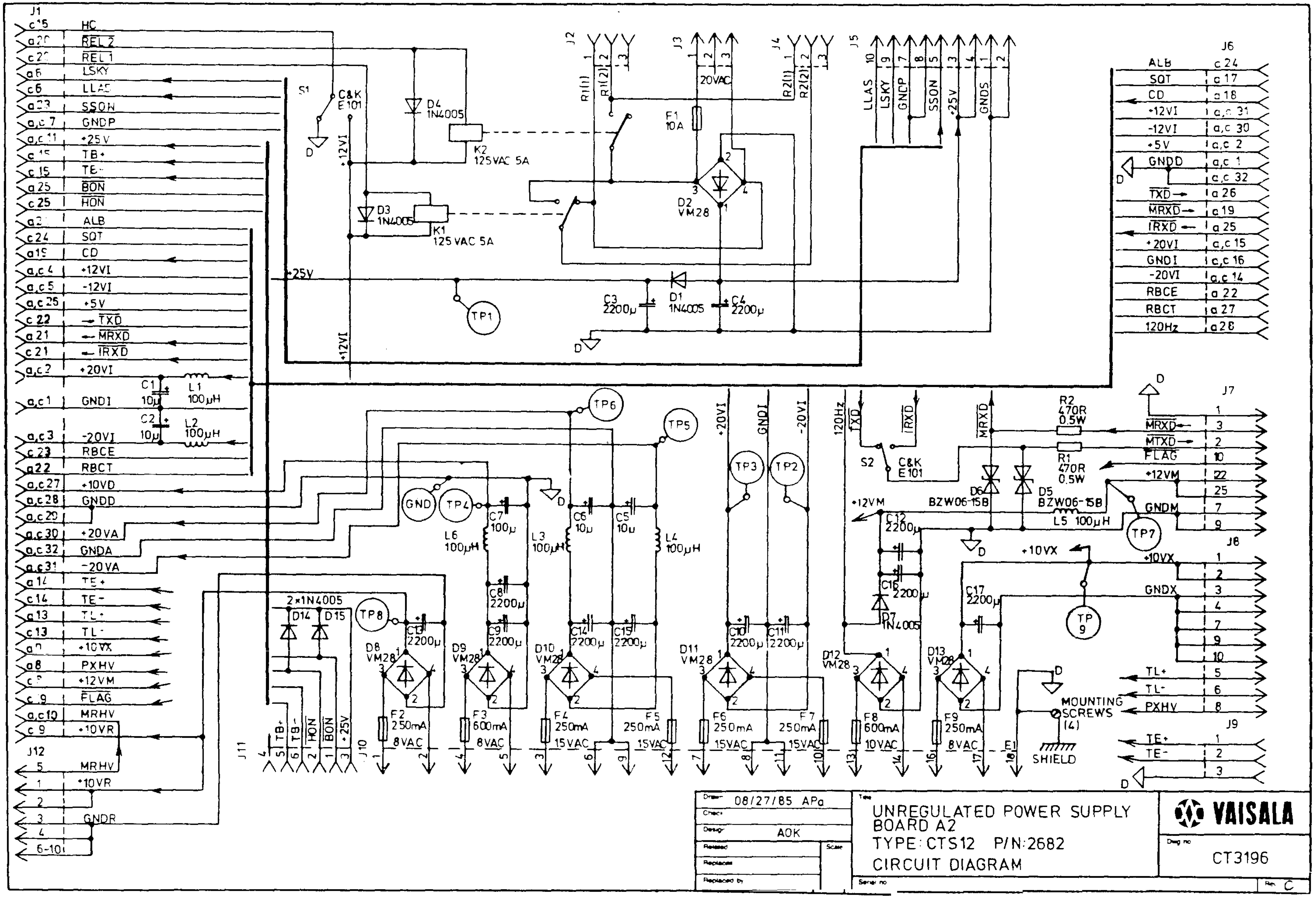
Data from the RS-232C Interface (MRXD) is "OR-ed" with input data both on the Processor Board Al and the Output Interface Board A3.

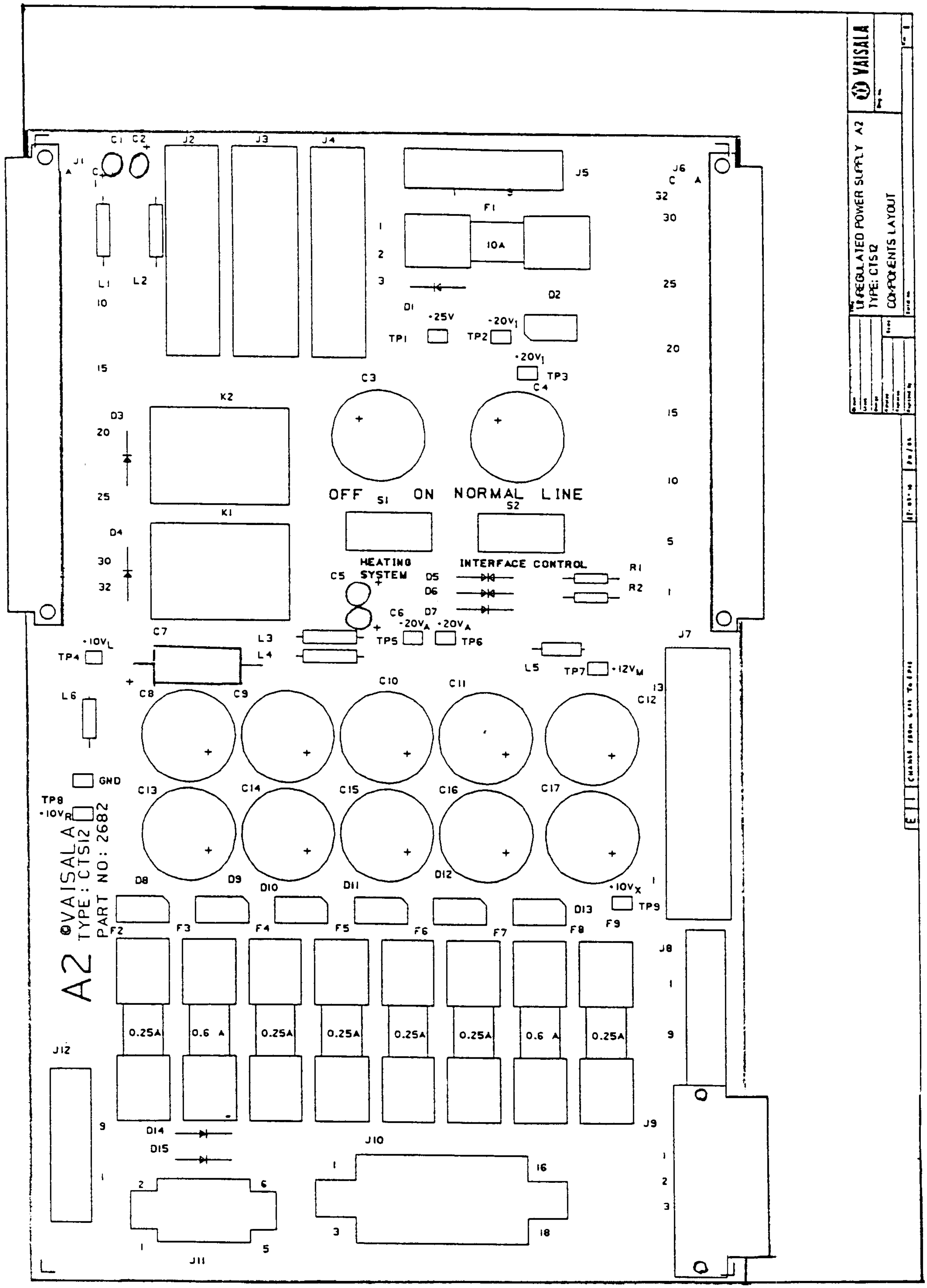
Data from Processor Board Al (TXD) is normally connected via switch S2 to the RS-232C interface as output data (MTXD). Switch S2 can also be set to connect the Ceilometer FSK line input data (IRXD) as output data (MTXD) of the RS-232C interface to enable communication from local RS-232C device via FSK line to the central site (e.g., for maintenance and service purposes).

Further, the RS-232C interface connector J7 carries a + 12V supply to the maintenance terminal, and a FLAG signal which, . when activated, indicates the presence of a CTH 12 Maintenance Terminal so that messages can be formatted appropriately. These signals are positioned as circuits not reserved by the RS-232C standard.

4.3.2.4 Parts List

Designation	Part Number	Description
Dl,D3,D4,D7, D14, D15	4336	Diode, 600V lA, lN4005
D2,D8-D13	0555	Bridge Rectifier, Varo, VM28
D5,D6	1080	Transient Zener Bipol. 15V, 600W lms, BZW06-15B
Rl,R2	4285	Resistor Carbon Film, 4,70R, 5% 0.5W
Cl,C2,C5,C6	6920	Capacitor, Tantalum, 10µ, 20%, 35V
C3,C4,Cl0, Cl l,C12,C14, C15,C16	10005	Capacitor, Al. Elec., 2200µ 35V
C7	3258	Capacitor, Tantalum, 100p 20%, 20V
C8,C9,C13, Cl7	10004	Capacitor, Al. Elec., 2200µ, 16V
Ll-L6	1181	Choke, l00µH, 10%
Kl,K2	10020	Relay, SPDT, 24V/5A 125VAC
Sl,S2	10018	Switch, SPDT, 0.4VA, C&KEl0lV30
1	2951	Fuseholder, Schurter 0675 1.0099
Fl	10183	Fuse, 10A, Slow, 0.25 X 1.25 inches
F2,F9,F4-F7	10180	Fuse, 250mA, Slow, 0.2.5 x 1.25 inches
F3,F8	10181	Fuse, 600mA Slow, 0.25 x 1.25 inches
Jl,J6	10010	Connector, DIN 64192, 64 pos, Female 90”
J2,J4	2922	Connector, 3-pos. Female, PCB AMP 207609-3
J3	2921	Connector, 3-pos. Male, PCB AMP 207635-3
J5,J8,J12	2952	Connector, MIL-C-83503, 10-pos. PCB
J7	10344	Connector, 25-pos. Male, PCB Cannon DB25P
J9	2924	Connector, 3-pos. Female, PCB 90° AMP 207608-3
J10	2932	Connector, 18-pos. Made, PCB AMP 207442- 1
Jll	2927	Connector, 6-pos Female, PCB AMP 207524-3


Drawn 08/27/85 APa
Design AOK
UNREGULATED POWER SUPPLY
BOARD A2
TYPE: CTS12 P/N:2682
CIRCUIT DIAGRAM
VAISALA
Dwg no CT3196
Rev. C


A2 ©VAISALA
TYPE : CTS12
PART NO: 2682
OFF S1 ON
NORMAL S2 LINE
HEATING SYSTEM
INTERFACE CONTROL
10A
0.25A
0.6 A
UNREGULATED POWER SUPPLY A2
TYPE: CTS12
COMPONENTS LAYOUT
VAISALA

4.3.3 OUTPUT INTERFACE BOARD CTI 12 REF A3

4.3.3.1 Introduction

The Output Interface board CTI 12 is the communication module of the CT 12K.

It provides for simple connection with devices that have 300 Baud FSK (Bell 103) or Gifft RBC Recorder interfaces. All communication signals are isolated.

The board provides a trigger break to initiate the sweep of the stylus and a 120 Hz cloud signal to interface with the Gifft RBC Recorder.

The onboard integrated modem circuit provides a Bell 103-compatible modem output that is routed, together with the Gifft RBC Recorder signals, to output connector J3 located on the equipment base.

Onboard LED's provide for an easy way to monitor the board operation when necessary (e.g., during maintenance).

4.3.3.2 SPECIFICATIONS

Type: CTI 12

Part Number: 2683

Designation: A3

Operational Voltages:	+ 5V ± 5%	17mA nominal
	+ 12V ±20%	8mA nominal
	-12V ±20%	1lmA nominal
	-20V ±20%	15mA nominal
	- 5V (regulated onboard from -20V)	

Dimensions:	W	x	D	x	H	
	4.1	x	6.9	x	1.2	inches
	103	x	175	x	30	millimeters

Modem Circuit:	National Semiconductor MM 74HC942 300 Baud, FSK, Bell 103 Standard (Ref. Technical Note MM 74HC942)	
Interface Signals:	All interface signals are electrically isolated and protected against line transients.	
FSK:	300 Baud, Bell 103 Transmit level adjustable in 5 steps: -12, -9, -6, -3, 0 dBm.	
Gifft RBC Recorder:	Trigger Signal:	
	Relay Contacts:	Normally Closed (NC)
	Ratings:	2A at 150V max.
	Data Signal: 120 Hz Transmit level adjustable in 4 steps: -2, 0, +2, + 5 dBm.	

4.3.3.3 Functional Description

The Output Interface board CTI 12 can be divided into the following functional circuits:

- Modem Circuit

- Control and Supply Circuits

- Gifft RBC Recorder Interface

Modem Circuit

The integrated modem circuit U2 provides all functions and signals needed to create a Bell 103-compatible modem.

Data Transmission:

The RS-232C level data for transmission is applied through connector Jl, pin a26 (signal TXD; data from the processor board), or pin al9 (signal MRXD; data from the maintenance terminal connector).

The two input data lines for the Interface board are “OR-ed” together, with diodes D3 and D4.

The signal is limited to 5V levels by the resistors of resistor array RA3 (pins 3-4 and 7-8). The signal is inverted by Ul and applied to the input pin TXD of the modem circuit U2.

The monitoring LED D10, ‘TXD,” indicates the presence of data at the TXD-input of the modem circuit U2.

The modem circuit U2 modulates internally the input serial data of 300 Baud and outputs the modulated data via pin TXA.

The modulated data is transmitted through the coupling transformer T2 (600 ohms) and output via connector J2, pins 1 and 2 (signals MOD1 and MOD2).

The zener diodes D15 and D16 protect the modem circuit U2 from line transients.

The transmit level of the modem output can be adjusted in the range of -12 dBm...0dBm by jumper J8. For the adjustment of the line transmit level, refer to jumper setting table in the Circuit Diagram CT 2277.

Data Recention;

The line signal, through coupling transformer T2, produces a voltage across resistor R18 sensed by the input terminals RXA1 and RXA2 of the modem circuit.

The demodulation is performed and the serial data is available at the output pin RXD of the modem circuit. The 5V level data is converted to RS-232C levels and inverted by transistors Q4, Q5, and diodes D5 and D6.

The LED Dll, “RXD,” indicates the presence of data after the demodulation by the modem circuit at transistor Q5. The data is available for the processor via connector Jl, pin a25 (signal IRXD).

The presence of the carrier frequency is indicated by LED D12, “CD,” and sensed by the processor via connector Jl, pin a18 (signal CD).

Control and Supply Circuits

The "Originate/Answer" mode can be selected by jumper J7, according to the jumper setting table in Circuit Diagram CT 2277.

Signal SQT of connector Jl, pm a24, enables the processor to control the modulation of the modem circuit U2. The modulation is disabled, when signal SQT is held "high," and it also prevents the data transmission to the modem circuit communication lines.

The function of the modem circuit U2 can be tested by the control signal ALB at connector Jl, pin a24. The processor can test the operation of the modulation/demodulation circuits with signal ALB in a "high" condition. The data from the TXD input is then echoed back from the RXD output of the modem circuit u2.

The "power-down" mode of the modem circuit can be activated, when signals SQT and ALB are simultaneously held "high" by the processor.

The basic clock frequency of 3.58 MHz for modem circuit U2 is generated by crystal Z1.

The onboard -5V regulator, U3, uses the -20V voltage supplied through connector Jl, pins al4 and c14. The output voltage of the regulator is adjusted by resistor R16 and R17.

The +5V voltage supplied thorugh connector Jl, points a2 and c2, is filtered by capacitors Cl5 and C16, and inductor L2, to prevent possible interference from entering the power supply.

The Gifft RBC Recorder Interface

The general operating principle of the recorder is to produce lines or dots whenever backscattered energy or clouds are detected by the Ceilometer. The dots are generated by continuously sweeping the recorder pen, over dry electrosensitive recorder paper.

The Trigger Break signal:

The sweep of the Gifft RBC Recorder stylus is started by the processor's RBC-message output routine through relay Kl.

The processor board provides an active-high start pulse through connector Jl, pin a27 (signal RBCT). The pulse width is 80 ms nominally.

The signal RBCT switches transistor Q3 "on." The relay contact is opened when RBCT is held 'high" active).

The "high-low" transition of signal RBCT closes the relay contact. A regulated current of 4mA (from the Field Junction Box of the Gifft Recorder) passes through the relay contact to the recorder (open circuit voltage approximately 90V).

When signal RBCT is held "high," LED D1.3, "RBCT," is on.

The inductive transients caused by the coil of Kl are suppressed by diode D7.

The Trigger Break signal for the Recorder is available at output connector J2, pins 9 and 10 (signals RBCTl and RBCC2).

The Cloud Data Signal

A modulating signal referred to as "120 Hz" is applied through connector Jl, pin a28. The frequency of the "120 Hz" signal is obtained from the Power Line supply. The signal is filtered by inductor Ll, resistor Rl, and capacitor C3.

The transmit level of the signal can be adjusted by jumper J3 in the range of -2dBm... + 5dBm. Refer to the "jumper setting table" of the Circuit Diagram CT 2277.

When the recorder sweep has reached a position proportional to the height of a cloud hit, signal RBCE is raised "high" by the processor. This signal is applied through Jl, pin a22.

The RBCE signal "high" switches the modulating "120 Hz" signal via transistors Ql and Q2, and the coupling transformer Tl, to the output connector Jl, pins 5 and 6 (signals RBCEl and RBCE2).

LED D14, "RBCE," indicates the presence of the cloud data signal at the output of gating transistor Ql. Line transients are suppressed by transient zeners Dl and D2.

4.3.3.4 Parts List

Semiconductors

Ul	1056	74 HC 132	Nand Quad
U 2	2968	74 HC 942	300 Baud Modem
U 3	2989	LM 337 LZ	Voltage Reg.
Q&Q4	0285	2N 2907 A	Transistor PNP
Q2,Q3,Q5	5416	2N 222 A	Transistor NPN
Dl,D2	4011	1N 759 A	12 Zener Diode
D3,D4,D5,D6	3884	1N 4148	Diode
D7	4336	1N 4005	Diode
D8,D9	2969	BZW 06-94	Transient Zener
Dl0,Dll,D13 D14	1431	ESAY 5531	LED Yellow
D12	1159	ESBG 5531	LED Green
D15,D16	4171	1N 751 A	5.1 V Zener Diode
Zl	2967	3.579545 MHz	Crystal

Resistors

(All Metal Film 1% 0.25 W 50 ppm)
(unless otherwise stated)

Rl	6375	lk00
R2	7480	lk21
R3,R16	0955	825R
R4,R18,R21	6358	562R
R5	5453	487R
R6,R7,R8	7393	4k87
R9,Rl0,R22 R23	2534	10R
Rll	3167	383R
R12,R15	5156	2k74
R13,R14	1920	47R
R17	1732	274R
R19	7026	lk78
R20	3176	5k62

Resistors Arrays

(All Single-in-line (SIL))
(unless otherwise stated)

RAl,RA3	0057	4 x 10K
RA2	0965	5 x 4K7
RA4	10070	4 x 680R

Capacitors

Cl-C5,C14, C15,C17,C18	6920	10µF	35V	Tantalum
C6,Cl0-C12, C16,C19,C20	4507	100nF	63V	Ceramic
C7	4802	1nF	100V	Polycarbonate
C8,C9	5726	22pF	63V	Ceramic
Cl3	4822	10nF	100V	Polycarbonate

Inductors

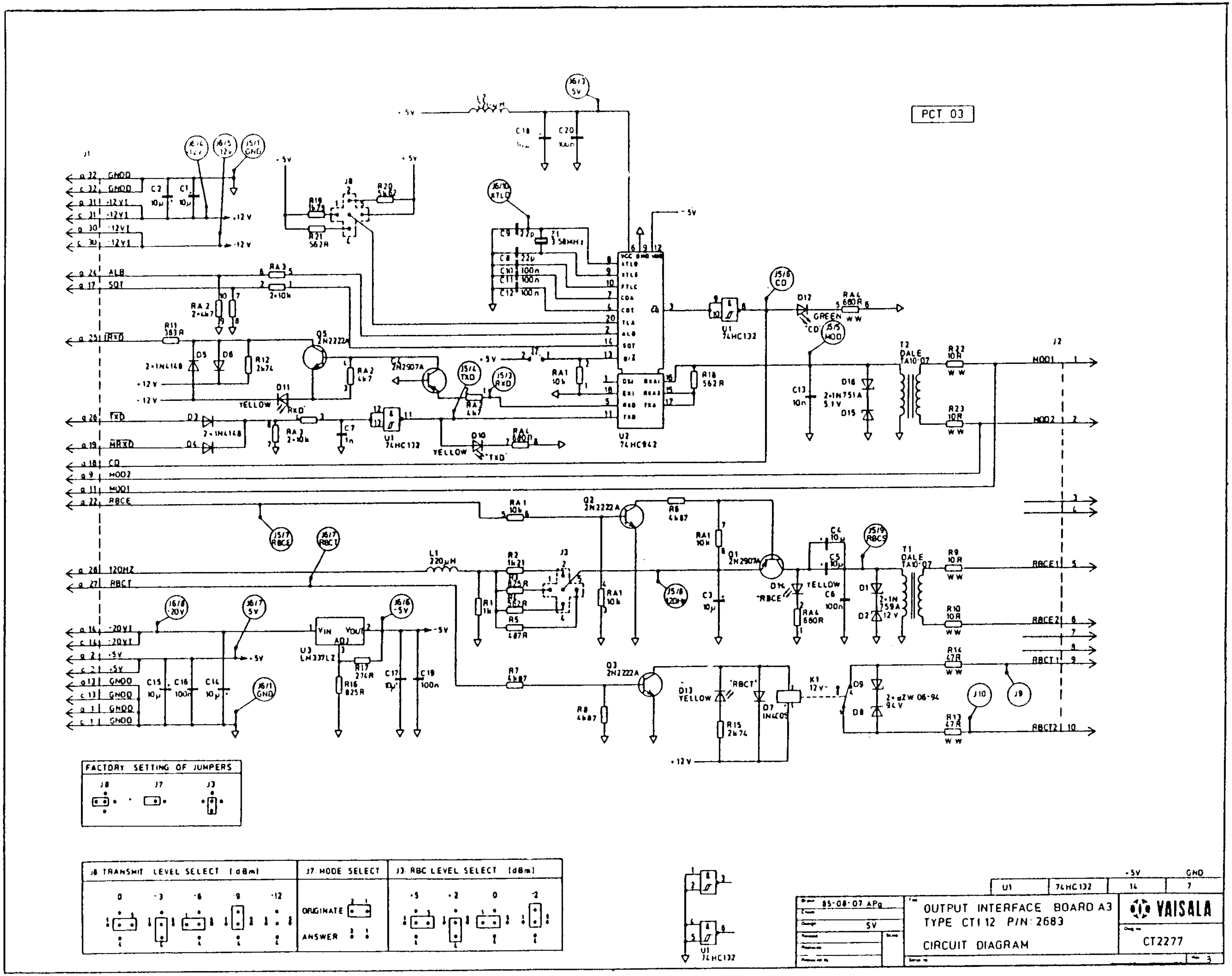
Ll,L2	2321	220µH	Miniature Choke
Tl,T2	10012	600/600	Coupling Transformer

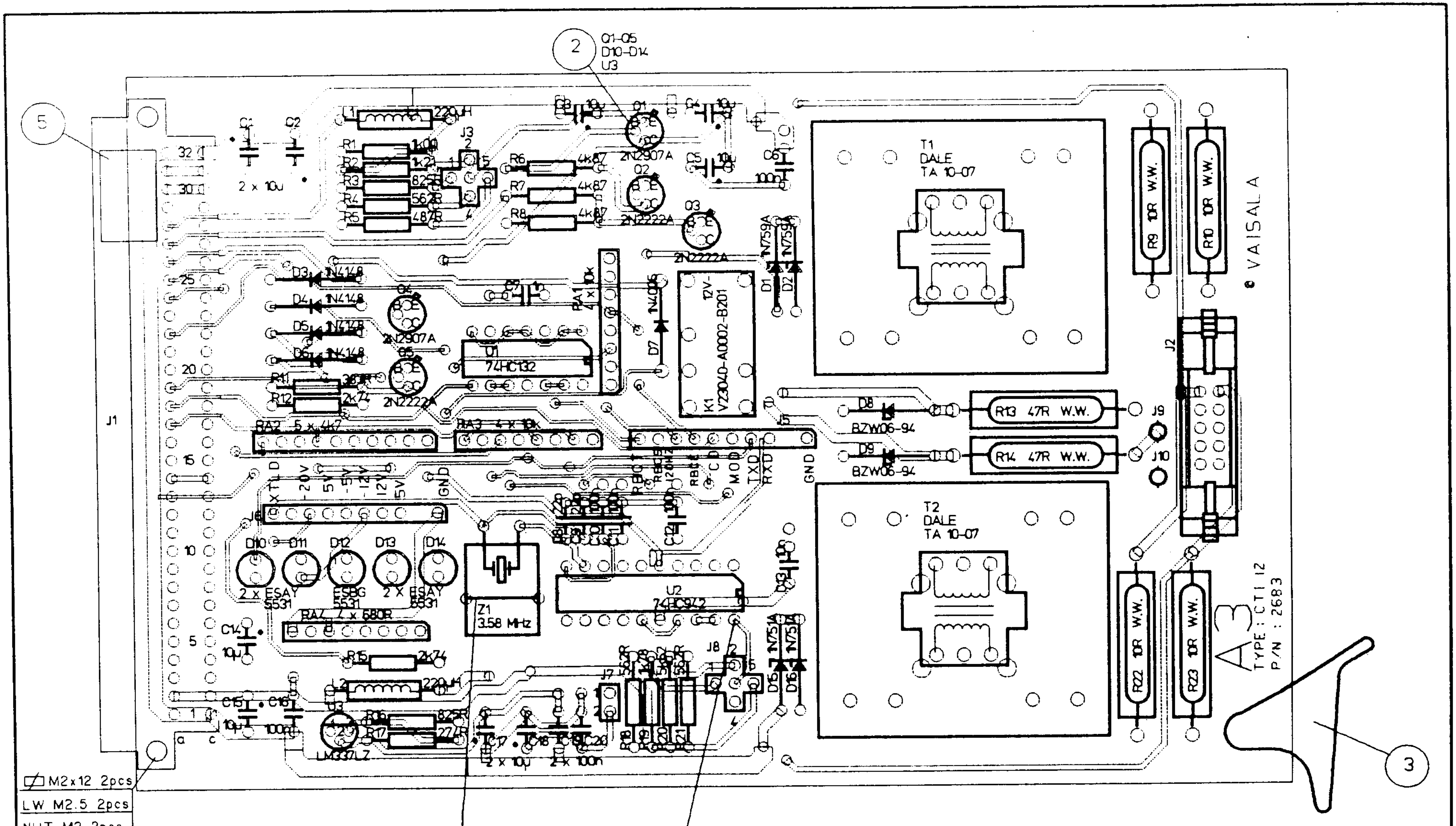
Connectors

Jl	6800	2x32C	Connector
J2	2592	10 pin	Ribbon Cable-Connector
J3,J5-J8	5498		Connector
J9,Jl0	0172		Connector
P3,P7,P8	5143		Jumper

Miscellaneous

Kl	0988	12v	Relay


PCT 03
FACTORY SETTING OF JUMPERS
J8 J7 J3
J8 TRANSMIT LEVEL SELECT (dBm)
0 -3 -6 -9 -12
J7 MODE SELECT
ORIGINATE
ANSWER
J3 RBC LEVEL SELECT (dBm)
+5 +2 0 -2
U1 74HC132
U2 74HC942
U3 LM337LZ
85-08-07 APg
SV
OUTPUT INTERFACE BOARD A3
TYPE CT112 P/N: 2683
CIRCUIT DIAGRAM
VAISALA
CT2277



M2x12 2pcs
LW M2.5 2pcs
NUT M2 2pcs

FACTORY SETTING OF JUMPERS:

J3 J7 J8

Drawn	85-08-23 AAK
Check	
Design	SV
Related	P.CT03
Scale	2:1
Replaces	
Replaced by	

Title: OUTPUT INTERFACE BOARD A3
TYPE: CTI 12 P/N: 2683
COMPONENTS LAYOUT

VAISALA

Dwg no. C.CT3278

Rev C

4.3.4 LIGHT MONITOR BOARD CTL 13 REF A5

4.3.4.1 Introduction

The Light Monitor Board of Ceilometer CT 12K is placed between the laser transmitter lens and the instrument cover window, in a position which minimizes attenuation of transmitted laser power (refer to CTL 13 Assembly A.CT 3410).

It contains the following circuits (Ref. Circuit Diagram CT 3564):

- Laser Power Monitor. Its silicon PIN photodiode is pointed down toward the collimated laser beam at a position which best represents the average power of the non-uniform beam.

- Skv Light Monitor. Its silicon PIN photodiode is pointed upward and its field-of-view is limited to a detection angle of approximately +5.7° from vertical. Its signal is used both by the Solar Shutter circuitry and by the processor, for monitoring purposes.

- Solar Shutter Driver. This circuit drives the optional external Solar Shutter Kl and shuts its flap for protection of the laser diode from focused sunlight, if the signal from the Sky Light Monitor should exceed the voltage set by a trimpot. It is fail-safe in operation (i.e., when no power is supplied, the flap is shut). The operation is also self-contained so that no processor activity is required for shutting.

- Voltage Regulator for providing an internal regulated + 17 V supply for the measurement circuits.

4.3.4.2 Specifications

Type:	CTL 13 Light Monitor Board				
Part Number:	10322				
Designation:	A5				
Supply:	22V...30V, 20mA typ. without shutter 650mA typ. with shutter				
Dimensions:	W	x	D	x	H
	6.7	x	2.1	x	0.9 inches
	170	x	54	x	23 millimeters

Laser Power Monitor:	V(LLAS) = 0.9V...4.5V at nominal laser power Filtering Time constant 100ms Factory calibrated; transmitter specific 100% value to be input in CT 12K for parameter LNOR
sky Light Monitor:	V(LSKY) = 1 V/16 W (typ.) from solid angle 0.03 srad Bandwidth 300 nm...1100 nm Filtering Time Constant 0.2 s
Solar Shutter Driver:	Factory set trip level 32 W (typ.) from solid angle 0.03 srad Hysteresis 16 W (typ.)

4.3.4.3 Functional Description

<u>Laser Power Monitor</u>

Laser power is detected by photodiode Dl which, in its normal operating position, is pointed downward toward the laser transmitter. Dl converts the short, powerful light pulses to current pulses. These are transferred via Schottky diode D2 to capacitor C2 (100nF). The charge collected by capacitor C2 discharges via resistor R3 (1 Megohm). The time constant C2 x R3 is 100 ms; thus, the laser pulse frequency which is 620 Hz...1120 Hz (1.6 ms...0.9 ms) will be converted to a DC voltage across R3, the magnitude of which will equal, in volts, the average of the pulse current in microamperes. The voltage will never rise so high that the negative bias across photodiode Dl will be significantly reduced.

Ambient light current which, at peak magnitude, is much less than the laser pulse current, passes to ground via resistor Rl. Diode D2 prevents it from being transferred to capacitor C2 because of the positive bias required for it to conduct (0.3V...0.4V) in all practical cases exceeding the voltage across Rl. On the other hand, Rl is big enough not to create any considerable error in actual laser pulse current measurement.

Capacitor Cl and resistor R2 block the sharp current pulse from the rest of the circuitry.

Op-amp l/4 Ul (LM124) amplifies the voltage across R3 to a level suitable for measurement by the processor board monitor A/D-converter (0V...5V). Gain is factory set.

The resulting signal can be measured at test point TPl. It also drives red LED D4. It is brought out at connector Jl, pin 10. It is referenced in the processor software as LLAS and measured by monitor A/D-converter channel 8 (analog monitoring command AN 8 or AN LLAS).

Because of the variation between individual photodiodes, each laser power monitor is factory calibrated. The norm value which corresponds to 100% of nominal laser power is marked as the value of parameter LNOR on the Ceilometer Transmitter board. This value is to be input in the processor prior to use.

Skv Light Monitor

Sky light power is monitored by upward-pointing photodiode D3 through an aperture which limits the viewing solid-angle to approximately 0.03 srad. Deflection from vertical is approximately 5.7" average non-circular cross-section because of the rectangular detector chip.

Its sensitivity is approximately 0.4 A/W. Pointed directly toward the sun in a clear-atmosphere sky (approximately 1200 W/m2) produces a current of l.lmA typically. A clear blue sky produces a current of l0µA typically, and indoor conditions produce less than 1µA.

The current produced by the sky light in photodiode D3 is converted to a voltage across resistor R4 (21k4) and filtered by capacitor C3 (10µF) which yields a time constant of 214 ms. The voltage is buffered by voltage follower l/4 Ul, the output of which can be measured at test point TP2. It is fed to the Solar Shutter Driver circuitry, and to the board output at connector Jl, pin 9. It is referenced as LSKY and may be monitored as analog channel 9 (monitor command AN9 or AN LSKY).

The voltage range of the monitor A/D-converter of the processor board, 0V...5V will yield a useful sky light power range of 0W/m2...80W/m2 based on assumption of clear, direct sun being 1200 W/m2.

Solar Shutter Driver

The voltage output of the Sky Light Monitor is brought to comparator l/4 Ul, pin 13. Its trip voltage is set by trimpot R13 to a value which is measured at test point **TP4.** Standard value is 2.0V corresponding to a sky light power of approximately 32 W which provides for adequate margin with respect to all sources of inaccuracy regarding the protection of the laser transmitter against focused sunlight from zenith.

Positive feedback resistors R10 and Rll create a hysteresis of 1 volt at comparator input, pin 12, corresponding to a light power of approximately 16 W/m2. Thus, the trip point must always exceed the l-volt value.

The output of the comparator Ul, pin 14, is high (+ 15V) when sky light power is low (i.e., below the trip point) and the output is low when sky light power is high. This output drives the Solar Shutter Darlington transistor Q2, the design being such that the Solar Shutter Solenoid (Kl) has to be energized to be open (collector of Q2 “low”) and de-energized to be closed (voltage of collector Q2 close to +24 V supply). This fail-safe mode of operation provides for high-reliability protection in all cases of power failure and most cases of equipment (component) failure. Resistor R12 provides for safety should the wiper of trimpot R13 fail.

The processor can close the solar shutter with signal SSON **(Jl,** pin 5) by raising it “high,” thereby switching transistor Ql “on” which will short the base of Q2 and prevent it from keeping shutter Kl energized. The processor cannot force the shutter to stay open should the light power detected by D3 cause a voltage exceeding the set point at TP4.

The shutter driver circuitry has a separate current return ground (GNDS) in order not to disturb the measurements. These have a low current return ground (GNDP) which is routed separately to the common ground. Diodes D5 and D6 protect the components in case of failure of any ground lead.

Voltage Regulator

The measurement circuits of the board are powered through an on-board, 3-lead voltage regulator U2 (LM 317LZ). Its supply is from the board’s +24V and resistors R14 and R15 determine the level of the internal supply voltage, + 17V ±1V. Capacitors C4 and C5 provide filtering.

4.3.4.4 Parts List

Semiconductors

Ul	2456	LM124	Quad Op Amplifier
u 2	1016	LM3 17LZ	Voltage Regulator
Ql	5416	2N 2222A	NPN Transistor
Q2	1384	TIP 120	NPN Darlington
Dl,D3	2973	UDT PIN 3CD	Photodiode
D2	4685	HP 5082-2800	Schottky Diode
D4	5429	HP 5082-4655	LED Red
D5,D6,D7	4336	lN4005	Diode

Resistors

(all resistors Metal Film 1% 50 ppm 0.25 W)
(unless otherwise stated)

R15	5156	2k74
R6,R 13	6372	10k Potentiometer
R8,R12	5388	10k
R2,R 14	6355	215R
R3,Rl0	6627	1MO
Rll	0791	68kl
R5	5453	487R
R4	5444	21k5

Resistor Array

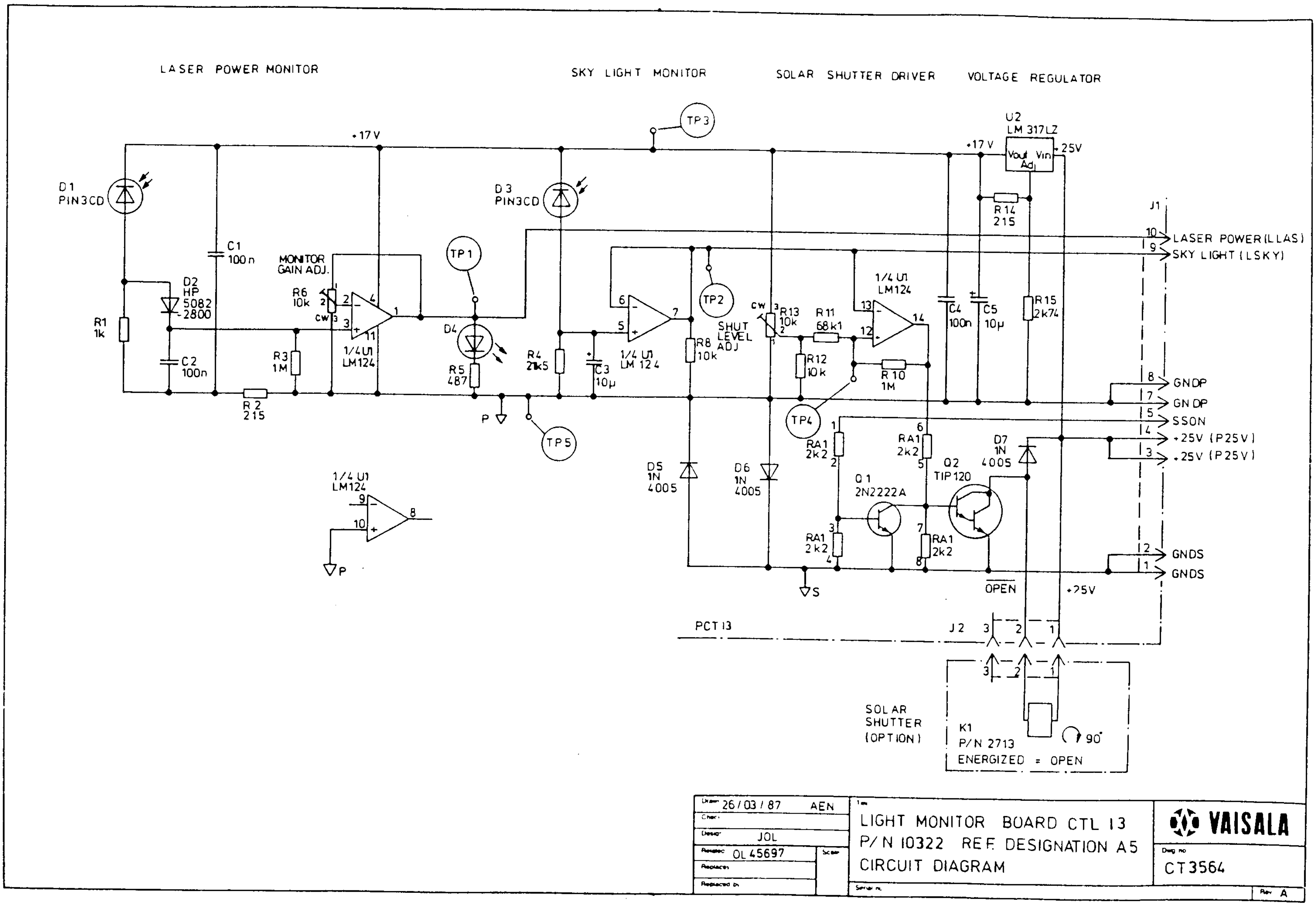
RA1	2960	4 x 2k2

Capacitors

Cl,C2,C4	0977	1OOnF 6 3 V	Polyester
C3,C5	0009	10µF 2 5 V	Tantalum

Connectors

Jl	2963	MIL-C-83503, 10 pos., Male, 90”
J2	2924	Amp Metrimate 207608-3, 3 pos., Header, Female PCB, 90”


LASER POWER MONITOR
SKY LIGHT MONITOR
SOLAR SHUTTER DRIVER
VOLTAGE REGULATOR
+17V
TP3
U2
LM 317LZ
Vout Vin
Adj
+25V
D1
PIN3CD
D3
PIN3CD
R14
215
J1
10
LASER POWER (LLAS)
9
SKY LIGHT (LSKY)
C1
100n
MONITOR
GAIN ADJ.
TP1
D2
HP
5082
-2800
R6
10k
CW
1/4 U1
LM124
TP2
R13
10k
SHUT
LEVEL
ADJ
R11
68k1
C4
100n
C5
10μ
R15
2k74
R1
1k
C2
100n
R3
1M
D4
R5
487
R4
21k5
C3
10μ
R8
10k
R12
10k
R 10
1M
8
GNDP
7
GND P
R 2
215
P
TP5
TP4
5
SSON
4
+25V (P25V)
3
+25V (P25V)
RA1
2k2
D7
1N
4005
D5
1N
4005
D6
1N
4005
Q1
2N2222A
Q2
TIP120
2
GNDS
1
GNDS
S
OPEN
+25V
PCT 13
J2
SOLAR
SHUTTER
(OPTION)
K1
P/N 2713
ENERGIZED = OPEN
90°
26 / 03 / 87
AEN
JOL
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LIGHT MONITOR BOARD CTL 13
P/N 10322 REF. DESIGNATION A5
CIRCUIT DIAGRAM
VAISALA
CT3564
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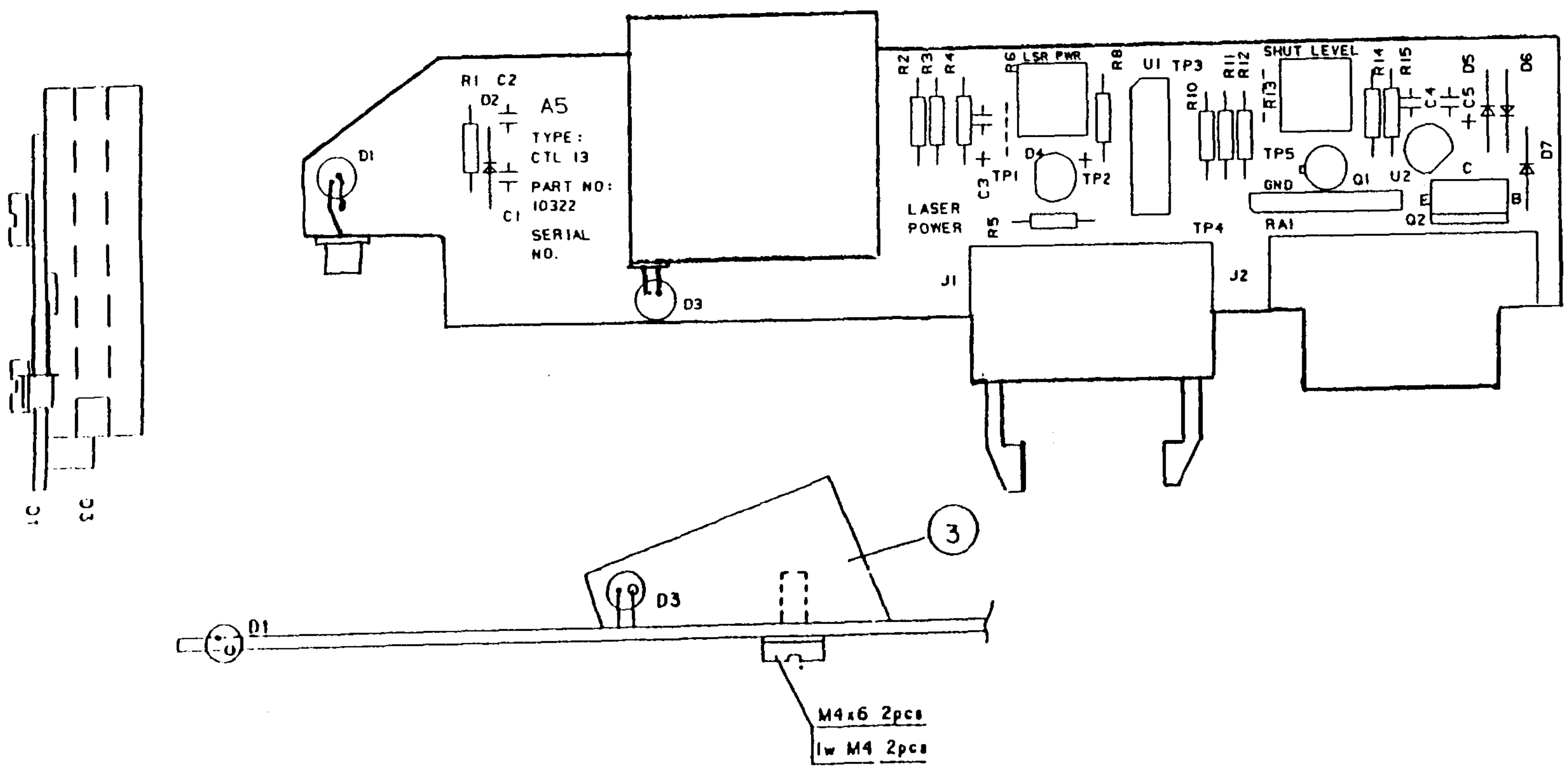
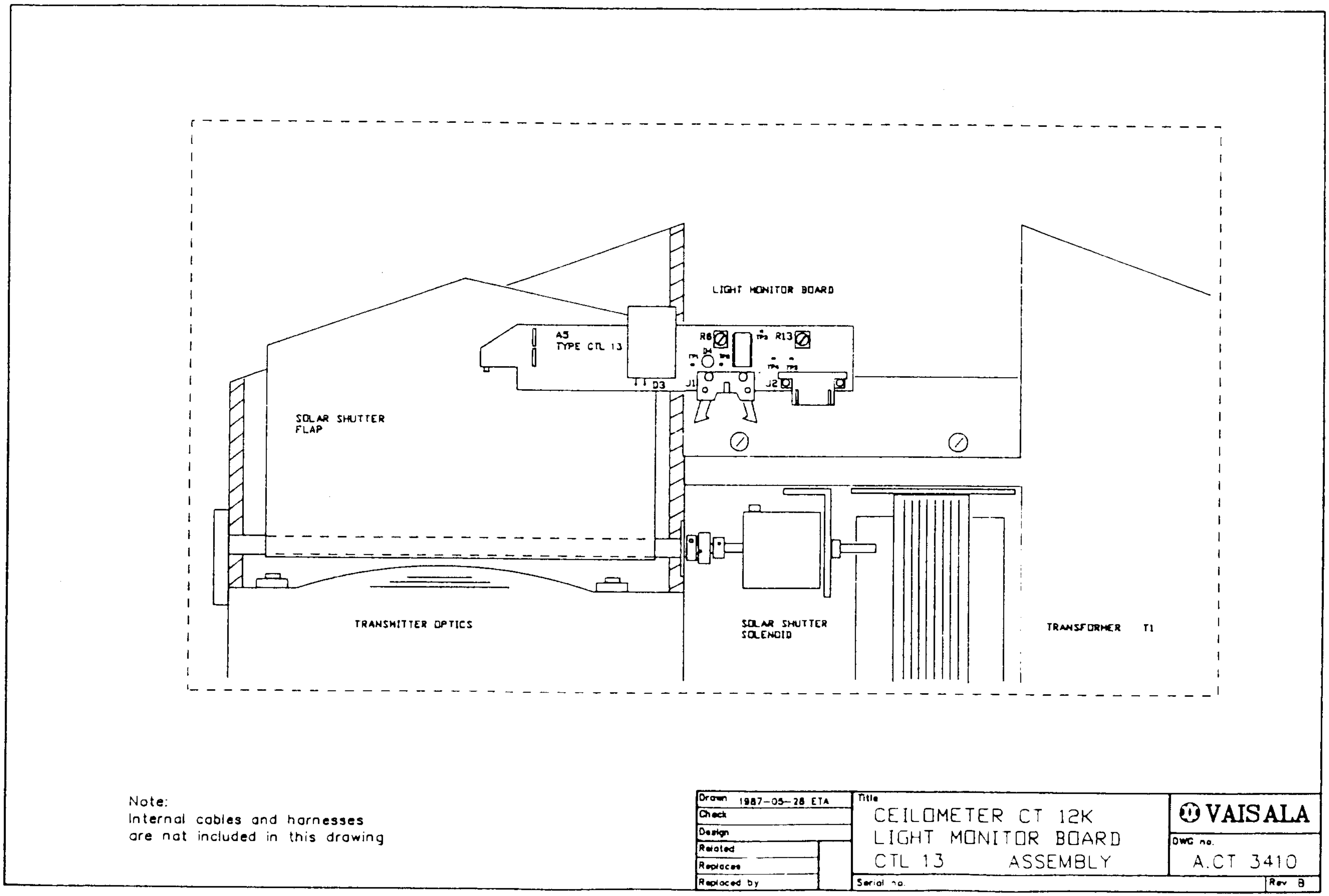


Title	CTL 13 LIGHT MONITOR COMPONENTS LAYOUT

VAISALA


LIGHT MONITOR BOARD
A5
TYPE CTL 13
R8
R13
D3
J1
J2
SOLAR SHUTTER
FLAP
TRANSMITTER OPTICS
SOLAR SHUTTER
SOLENOID
TRANSFORMER T1
Note:
Internal cables and harnesses
are not included in this drawing
Drawn 1987-05-28 ETA
Check
Design
Related
Replaces
Replaced by
Title
CEILOMETER CT 12K
LIGHT MONITOR BOARD
CTL 13 ASSEMBLY
VAISALA
DWG no.
A.CT 3410
Serial no.
Rev B

4.3.5 RECEIVER BOARD CTR 13

4.3.5.1 Introduction

The Receiver Board CTR 13 contains the photodiode that detects the reflections from any obstructions (normally clouds) in the path of the transmitted laser pulse.

The reflections are detected by the silicon avalanche photodiode located at the focal point of the receiver optics.

These focused reflections from the field-of-view of the receiver are converted to current in the reverse-biased photodiode.

The change of current is sensed and amplified by the onboard circuits to provide a suitable output for the Processor Board CTM 12 (Ref. Al).

The bias voltage of the photodiode is supplied from the High-Voltage Power Supply (Ref. PSl), regulated and temperature-compensated on the Receiver Board, and monitored by circuitry on the Processor Board.

The photodiode sensitivity is temperature-dependent. This is compensated for by a temperature-dependent control of the bias voltage.

The value of the bias voltage should be checked at maintenance or service of the Receiver. It is factory-adjusted to a value found on a sticker on the board at room temperature, giving the Receiver a nominal responsivity of 40 A/W. The actual bias voltage then varies by a factor of 1.3 V/°F (2.3 V/°C) depending on the actual temperature, giving it a constant responsivity.

The positioning of the photodiode and its mounting hardware on the receiver board is extremely critical and is held to tight manufacturing tolerances. This assumes field interchangeability of all receiver boards without the requirement of optical realignments.

4.3.5.2 Specifications

Type: Receiver Board CTR 13

Part Number: 20105

Designation: A6

Photodiode
Bias Voltage: 250 VDC - 425 VDC

Note: The bias voltage is individually adjusted for specified responsivity at room temperature and marked on a sticker on the board. Temperature dependency is 1.3V/°F (2.3V/°C).

Preamplifier
Supply
Voltage: 10 VDC ± 15%

Dimensions:	W	x	D	x	H	
	4.0	x	4.0	x	1.6	inches
	102	x	102	x	40	millimeters

Photodiode RCA C 30817
Type: Silicon Avalanche Photodiode (APD)

Note: For more specific information on photodiode, see manufacturer's data sheet.

Filter: Infrared interference filter 904 ± 25nm

Responsivity: 40 A/W at specific Bias Voltage and Temperature noted on board sticker.

4.3.5.3 Functional Description

Refer to Circuit Diagram CT 3593.

The + 10V DC supply voltage for the CTR 13 board is applied through connector Jl, pins 1 and 2. A low-pass filter formed by Ll, Cl and C2, blocks high-frequency interference from the input of regulator Ul.

The +5V output voltage of the regulator Ul is adjusted by resistors R7 and R8, and filtered by capacitors C3 and C4. The +5V output voltage for the board can be measured between test points TP3 and TPGND.

An unregulated high voltage bias supply is applied through connector J2. It is on-board regulated by transistor Q3, which is driven by differential amplifier 1/4U3, output pin 7.

The Avalanche Photodiode D2, which acts as the Ceilometer Receiver, has a responsivity which is both highly temperature dependent and highly bias voltage dependent. These are matched to maintain a constant responsivity by applying a linear bias voltage increase of 1.3 V for every 1°F temperature increase (2.3 V/°C).

Temperature Sensor U2 is in close thermal contact with D2. Its output is a zener-like shunt voltage of 10 mV/°K making it approx. 3 V at room temperature. This can be measured at TP4. For differential temperature changes °K equals °C and 1.8 x “F.

U4 is a zener-like voltage shunt. It is fed by a constant current source, 1/4U3 output pin 1 with surrounding resistors, creating a reference voltage of 4.90 . . . 5.10 V at TP5.

The bias voltage is adjusted at trimpot R19 to a value which gives a responsivity of 40 A/W, using a factory procedure. The resulting bias voltage along with the corresponding output of U2 are marked on a sticker on the board.

Qp-amp 1/4U3 (input pin 5) sensed the voltage at voltage divider R16/R20+ R21+ R22, connected between the bias voltage and U2, and via series-pass transistor Q3 which drives the bias voltage so that its input voltage difference is zero. This makes the bias voltage temperature dependence
(R20+R21+R22)/R16 x 10 mV/°C
= 2.33 V/°C = 1.3 V/°F.

The negative input at J2, pin 3, is connected through current measuring resistor R4 to the photodiode circuit forrned by D1, R5, R12 and the photodiode D2 itself. The photodiode DC-current can be measured as a voltage drop across R4 between test points TP1 and TP2.

Resistor R5 serves for current limiting. Capacitor C9 restores a low impedance level and filters interference.

Photodiode D2 transforms the light power incident upon it into a DC current proportional to the light power. Rapid current changes pass capacitor C8 to common-emitter preamplifier stage Ql and emitter-follower stage Q2. Ql and Q2 drive feedback resistor Rll and a voltage is produced (12.lk times Ql base input current).

Output is through capacitors C6 and C7 which block the DC-component. The output signal from connector J3 is connected to the amplifier of Processor Board Al.

Resistors Rl, R2, and R3, divide the bias voltage by one-hundred, which is then brought to connector Jl. This is further routed to the analog monitoring section of the Processor Board. Software reference is MRHV.

WARNING! Bias Voltage may reach 425V.

4.3.5.4 Parts List

Semiconductors

U1	1016	LM 317 LZ	Voltage Regulator
U2	1832	LM 335 AH	Temperature Sensor
u 3	2456	LM 124	Quad Op Amp
U4	20106	LM 236 H-5.0	Voltage Shunt 5.0 V
Q1,Q2	3591	2N918	Transistor NPN
Q 3	2970	TIP50	Transistor NPN
Dl	4336	lN4005	Diode
D2	1987	c30817	Avalanche Photodiode
D3	(not used)		
D4,D5	3884	lN4 148	Diode

Resistors

(all metal film resistors 1% 1/4W unless otherwise noted)

Rl	5169	20k5	
R2,R3,R21, R22	6627	1M	
R4,R16	5388	10k	
R5,R20	3191	332k	
R6	(not used)		
R7	0955	825R	
R8,Rl0	1732	274R	
R9	1297	3k83	
Rll	0165	12kl	
R12	5444	21k5	
R13	5118	332R	
R14	3186	48k7	
R15,R17	5156	2k74	
R18	6375	lk	
R19	0012	2k	Trimpot
RAl	0057	4 x 10k	SIL Resistor Array

Capacitors

Cl, Cl6	0610	22 µF	25 v
C2,C3,C5			
C6,C8,Cl0			
C11	0977	100 nF	63 V
c4	6920	10 nF	35 v
c7	10008	1 µF	50 v
C9,C14	10006	10 nF	630 V
C12,C13	4822	10 nF	100 v
Cl5	10007	68 nF	630 V

Inductors

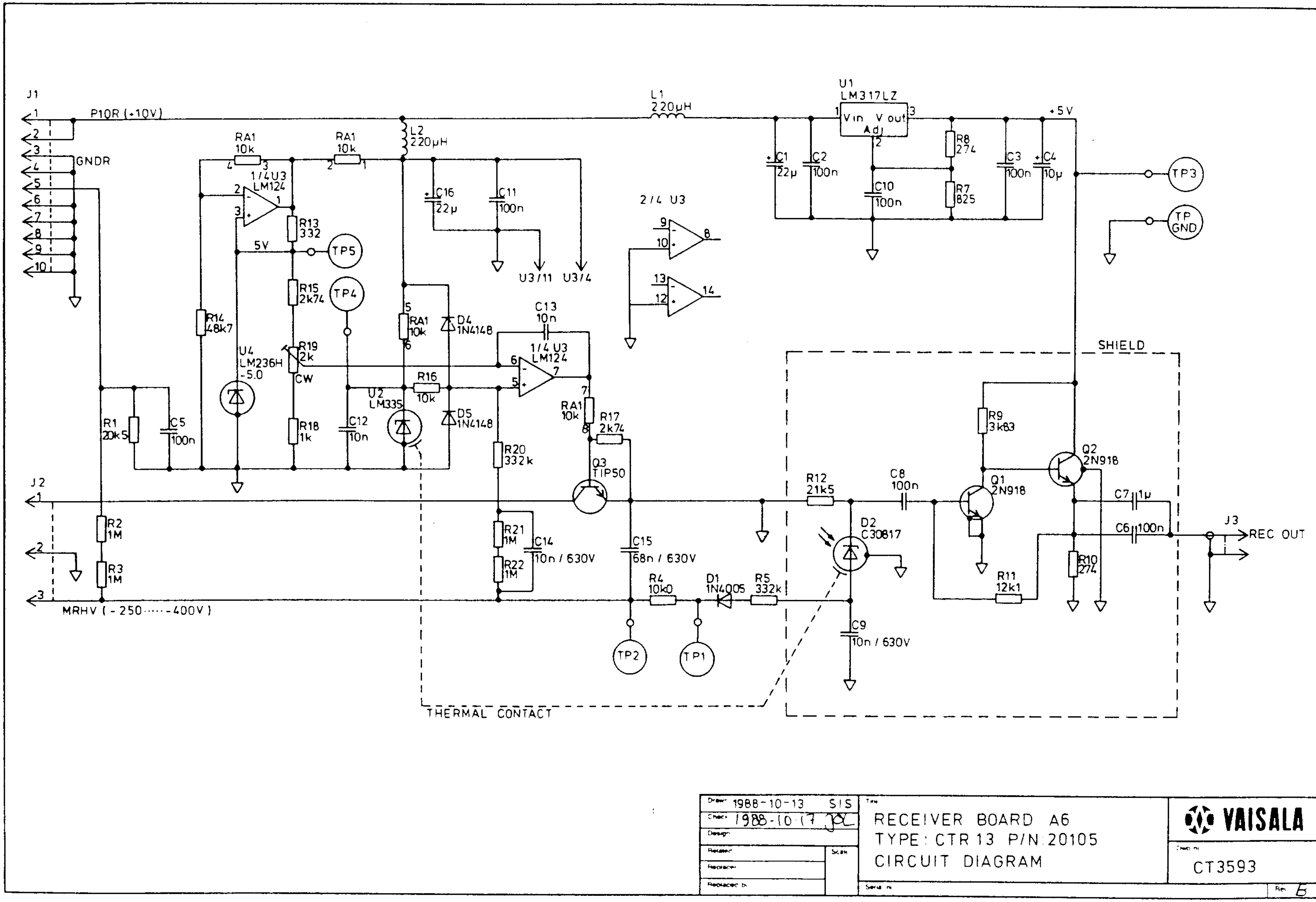
L1,L2	2321	220 µH

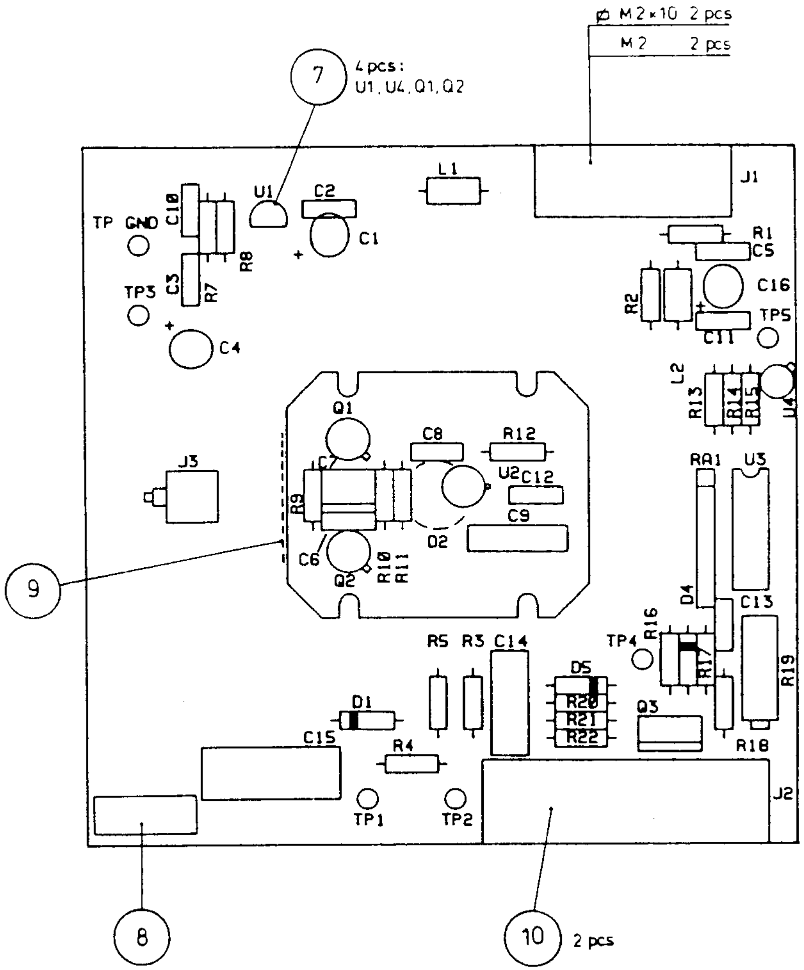
Connectors

Jl	2963	MIL-C-83503 10 pos., Male PCB, 90”
J2	2923	AMP Metrimate 3-pin, PCB, 90”
J3	1692	SMP Submini coaxial, PCB, 90”

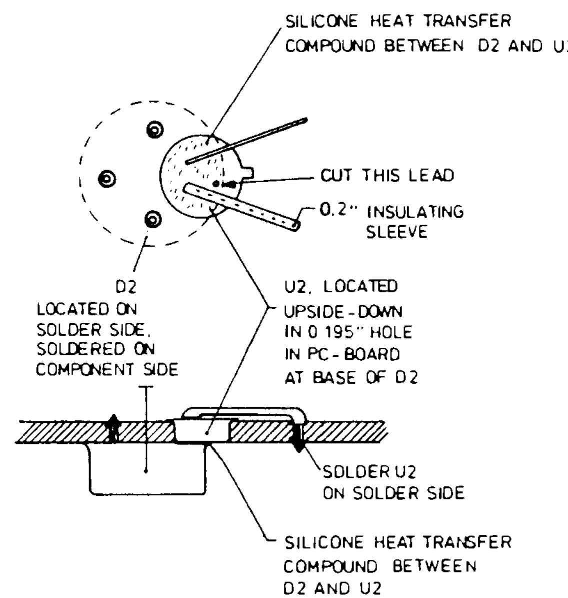
Optics

	1934	Infrared Interference Filter, 904 +25nm


J1
P10R (+10V)
GNDR
L1 220µH
U1 LM317LZ
Vin Vout
Adj
+5V
L2 220µH
RA1 10k
1/4 U3 LM124
5V
TP5
TP4
TP3
TP GND
2/4 U3
U3/11 U3/4
R13 332
R15 2k74
R14 48k7
U4 LM236H -5.0
R19 2k
CW
R18 1k
U2 LM335
R16 10k
D4 1N4148
D5 1N4148
C13 10n
C16 22µ
C11 100n
C12 10n
C1 22µ
C2 100n
C10 100n
C3 100n
C4 10µ
R8 274
R7 825
R1 20k5
C5 100n
R20 332k
R17 2k74
Q3 TIP50
SHIELD
R9 3k83
Q2 2N918
Q1 2N918
R12 21k5
C8 100n
C7 1µ
C6 100n
J3
REC OUT
D2 C30817
R11 12k1
R10 274
J2
R2 1M
R3 1M
R21 1M
R22 1M
C14 10n / 630V
C15 68n / 630V
R4 10k0
D1 1N4005
R5 332k
C9 10n / 630V
MRHV (-250·····-400V)
TP2
TP1
THERMAL CONTACT
Drawn 1988-10-13 SIS
Check 1988-10-17
RECEIVER BOARD A6
TYPE: CTR 13 P/N: 20105
CIRCUIT DIAGRAM
VAISALA
CT3593
Rev B



D2 - U2 DETAIL



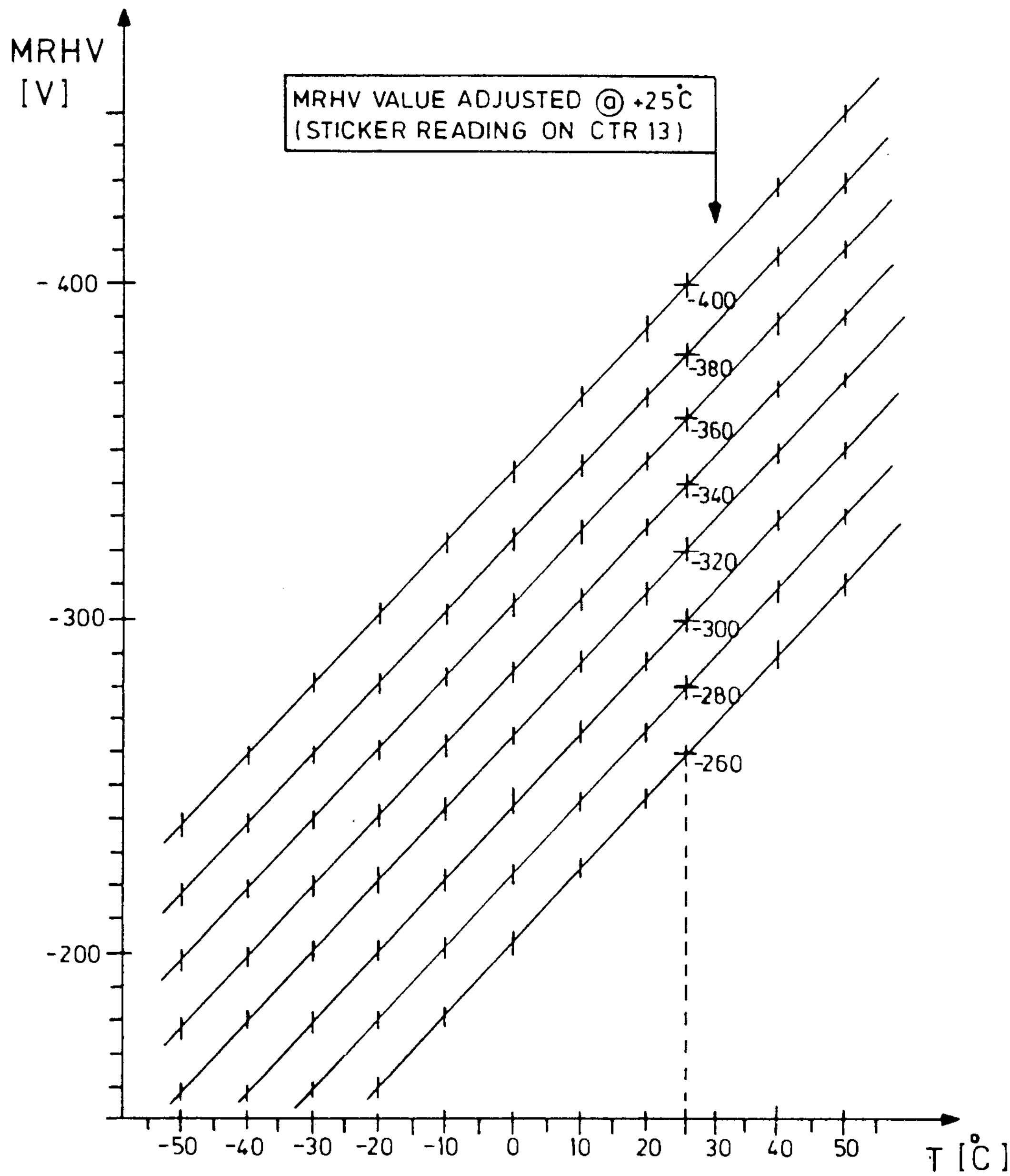
1988-11-04 AEN

RECEIVER BOARD A6
TYPE CTR13 P/N 20105
COMPONENTS PLACEMENT

VAISALA

CT3596

B



Drawn 88-11-01 HHA		Title	VAISALA
Check		TYPICAL TEMPERATURE DEPENDENCE OF MRHV AS A FUNCTION OF MRHV ADJUST VALUE @ + 25°C	
Design JOL			Dwg no. CT4594
Related CTR 13	Scale —		
Replaces			
Replaced by		Serial no	A

4.3.6 Laser Transmitter Board CTT 12 REF A7

4.3.6.1 Introduction

The Ceilometer CT 12K uses laser light pulses to obtain reflections from any particles in the path of the collimated laser light beam.

The Gallium Arsenide laser diode on the Transmitter board emits the laser light pulses under control of the processor board's "Laser Trigger" signal.

The operating voltage for the laser diode is supplied by the on-board high-voltage regulator and is switched to the laser diode through the laser diode supply circuits by the triggering circuitry.

The laser diode operating voltage and temperature monitoring signals are available for the processor and referred to as TL+, TL-(Laser Temperature) and PXHV (Positive Transmitter High Voltage).

The board requires two voltage supplies: + 10V DC for the triggering circuitry, and +260V DC for the high-voltage regulator.

The "Laser Trigger" signal activates triggering circuits to "switch on" the laser emission, providing one laser light pulse to traverse upward via the transmitter optics to the atmosphere.

The "Laser Trigger" signal is an active high and trailing edge sensitive pulse referred to as LTRG (Laser Trigger).

The positioning of the laser diode and its mounting hardware on the transmitter board is extremely critical and is held to tight manufacturing tolerances. This assures interchangeability of all transmitter boards without the requirement of optical realignments.

4.3.6.2 Specifications

Type:	Transmitter board CTT 12					
Part Number:	2687					
Designation:	A7					
Supply Voltage:	260V DC ± 15%, 25mA					
	10V DC ± 15%, 20mA					
Dimensions:	W	x	D	x	H	
	5.1	x	5.1	x	1.8	inches
	130	x	130	x	45	millimeters

Laser Diode:	LDL LD 224-8S	
Monitored Signals:	PXHV 1% of Laser Supply Voltage TL Laser Temperature	
Trigger Pulse: (LTRG)	50 ns	
Laser Pulse:	Peak Power	40 W
	Duration, 50 % level	135 ns (typical)
	Energy (Dia. = 118nm)	6.6 μWs
	Max. repetition rate	1120 Hz

4.3.6.3 Functional Description

Refer to Circuit Diagram CT 3120.

The CTT 12 Transmitter Board consists of the following circuits:

- High-Voltage Regulator
- Laser Diode Pulse Circuitry
- Laser Diode
- Laser Diode Triggering Circuitry

4.3.6.3.1 High-Voltage Regulator

The supply voltage of +260V DC is applied via connector J3, pin 1, from Power Supply CTP 12 (Ref. PSl). It can be measured between TP7 and GND.

The output current of the regulator is limited to 10mA and the output voltage is monitored via J2, pin 8, signal PXHV. The value of PXHV is determined by resistors R12 and R13, which divides the output voltage of the laser diode regulator.

The high-voltage regulator consists of the following subcircuits:

- Control Stage
- Error Amplifier

Control Stage

The output is regulated with Darlington-connected transistors Q8 and Q9.

The base voltage of transistor Q8 controls the output current of the regulator through transistor Q8 and Q9.

The output sink current of the error amplifier transistor Q7 determines the voltage drop over resistor R24 and, therefore, the base voltage of Q8. Zener diodes D8 and D9 limit its maximum value to 200V.

The regulator output current is limited to approximately l0mA. It is measured as a voltage drop over resistor R25. When the voltage between the base of Q8 and the output exceeds the forward bias of diodes Dll, D12, and D13, these will conduct and limit the base drive of Q8.

Error Amplifier

The differential error amplifier formed by transistors Q6 and Q7 measures the output voltage; then, through resistors, scales the feedback signal. The output voltage is adjusted with trimpot R21, changing the scale ratio of the feedback resistors for the error amplifier.

The base of Q6 is connected to reference voltage of D7 (+ 12V) via scaling network of resistors R16, R17, and R18. R17 is an NTC-type resistor sensing the operating temperature of the laser diode. Therefore, the scaling of the network (i.e., the base voltage of Q6) changes according to the sensed temperature. Refer to Figure 1.

When the reference voltage value of the error amplifier increases at the base of Q6, the output voltage of the regulator is increased. This temperature compensation is needed due to the operational characteristics of the laser diode.

The error (amplifier) adjusts the output voltage to such a value that the feedback voltage at the base of Q7 equals the reference voltage at the base of Q6. The Q7 collector current via R24 adjusts the base voltage of the control stage transistor Q8 and, therefore, the output voltage.

4.3.6.3.2 Laser Diode Pulse Circuit

Thyristors Q4 and Q5 are normally in a non-conducting state which allows the voltage regulator to charge the pulse energy capacitors C9, C12, and C14, to the regulated voltage. Resistors R10 and Rll assure that the voltage is divided evenly over the thyristors.

When the ultrafast thyristors Q4 and Q5 are triggered through transformer Tl, capacitors C9, C12, and C14, are discharged through the laser diode D6 in less than 200ns, peak current being in the order of 50A. This will cause D6 to lase. PC-board-implemented inductor Ll limits the peak current and shapes the pulse. Ll also causes the capacitors to be discharged to a slightly negative voltage which assures the "turn-off' of thyristors Q4 and Q5.

Diode D5 prevents the laser from being reverse-biased. The charge-discharge cycle can be measured at TP3. See Dwg 4417.

WARNING! Voltage in excess of I00V at TP3.

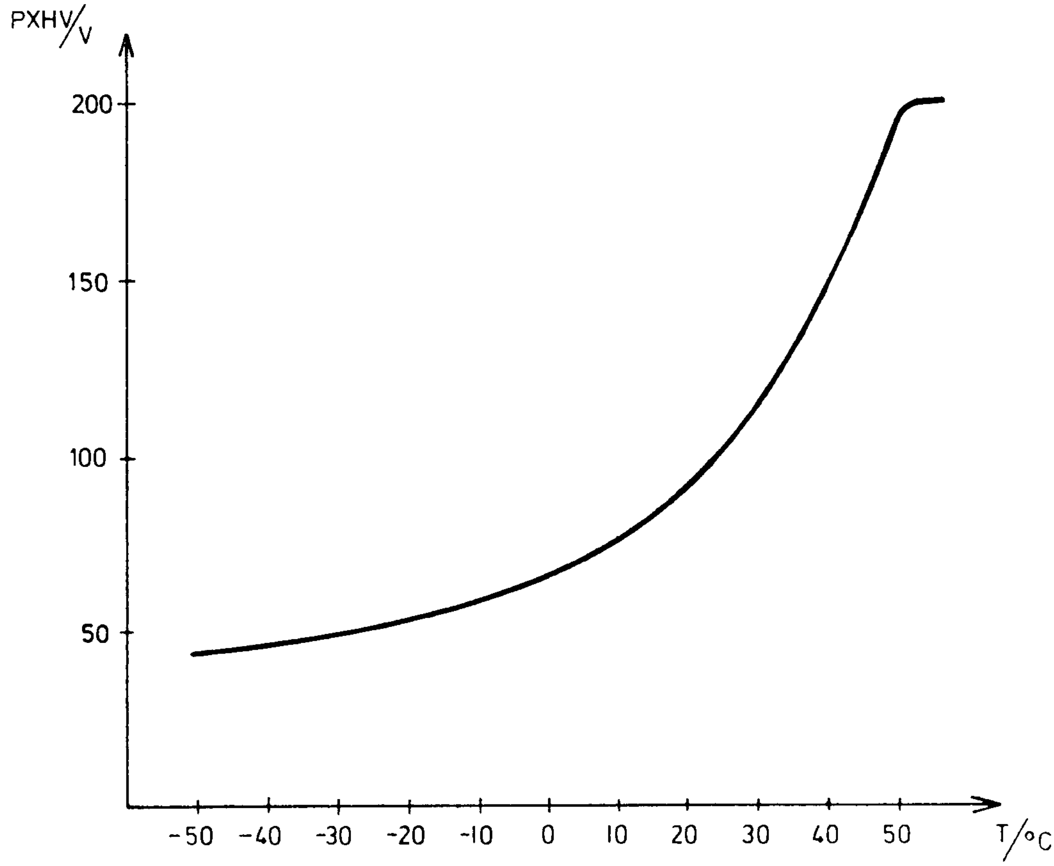


FIG. 1. LASER DIODE SUPPLY VOLTAGE TEMPERATURE DEPENDENCE

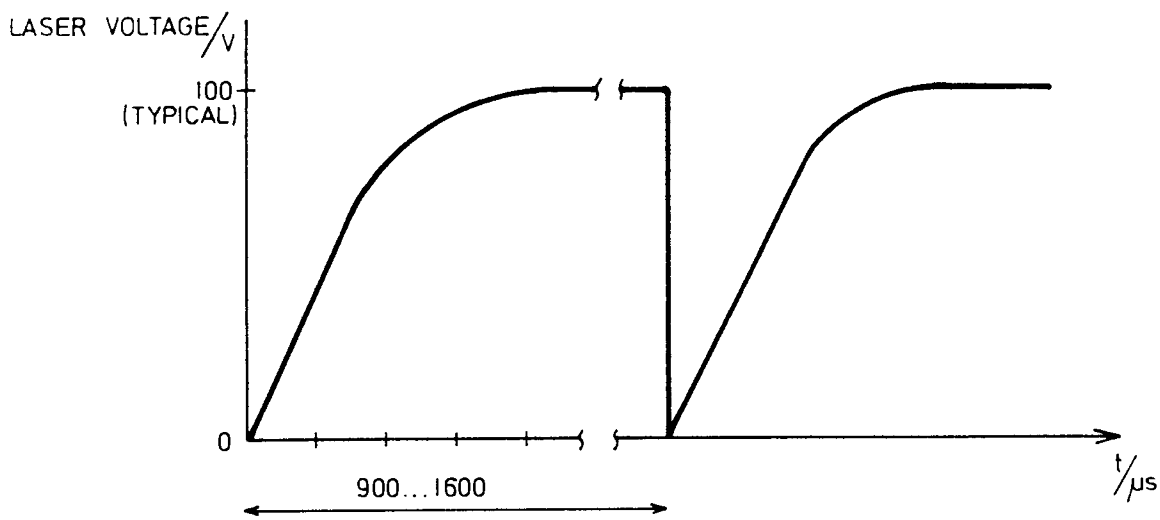


FIG. 2. TP3 - VOLTAGE CURVE FORM

CT4417

4.3.6.3.3 Laser Diode

The laser diode D6 emits the laser light when subjected to a current pulse in excess of 18A.

The operating temperature of the laser diode is monitored by a semiconductor sensor Ul (integrated circuit) and by NTC-type resistor R17.

Sensor Ul provides a temperature-monitoring signal for the processor referred to as TL; signals TL+ or TL- (Laser Temperature) and can be measured between test points TP5 and TP6.

R17 senses the laser temperature for the high-voltage-regulator-controlling circuits to provide a temperature compensation based on the operating temperature of the laser diode. The laser diode supply voltage is, therefore, increased as shown in Figure 1 when the laser diode temperature increases.

Maximum laser temperature allowed is 70°C (158°F). At this limit, the processor of CT 12K shuts down operation and gives an alarm.

4.3.6.3.4 Laser Diode Triggering Circuitry

The 'Laser Triggering" signal (LTRG) from the Processor Board controls the laser diode pulsing. The signal is active-high and trailing edge-sensitive, and is applied through connector Jl. Signal LTRG can be monitored at TPl.

The operating voltage of the circuitry is + 10V and is applied via connector J2, pins 1 and 2. It can be measured at TP4.

The 'Trigger Pulse" is generated by a single-shot formed by transistors Q2 and Q3. This, in turn, is triggered through Ql. Transistors Q2 and Q3 are normally "off' (i.e., no current is flowing). LTRG, when "high," turns Ql "off' and allows R4 to charge Cl. The trailing edge then pulls the emitter of Q2 down and current passes through Q2 to the base of Q3, causing its collector to rise "high" and keep Q2 conducting via C2 and R8 while at the same time driving current through transformer Tl primary. After approximately 20ns, capacitor C2 is charged and prevents Q2 from getting base current which leads to Q2 turning off and, consequently, to Q3 turning off.

D4 limits the kick-back of Tl. Tl secondaries turn the laser pulse thyristors Q4 and Q5 "on" in less than 20ns.

4.3.6.4 Parts List

Semiconductors

Q1,Q3	0285 1832	LM335H	Temperature Sensor
U1		2N2907	Transistor PNP
Q2	5416	2N2222	Transistor NPN
Q4,Q5	2369	GA201	Thyristor
Q6-Q9	2970	TIP50	Transistor NPN
Dl-D5, Dl0-D13	3384	lN4148	Diode
D6	1960	LD224-8S	Laser Diode
D7	4011	lN759	Zener Diode 12V
D8,D9	2972	lN985	Zener Diode 100V

Resistors

(all metal film resistors l%, 0.25W)
(unless otherwise stated)

Rl,R2,R6 R8,R28	6355	215R	
R3	5116	48R7	
R4	5453	487R	
R5	6373	100R	
R7	6375	lk0	
R9	3163	10R0	
Rl0,Rll,R13	1188	562k	
R12,R22	3176	5k62	
R4,R15,R24	4080	220k	Carbon Film, 5%, 0.5W
R16,R23	5467	33k2	
R17	2490	33k	NTC
R18	5444	21k5	
R19	5791	3k32	
R20	4247	150k	Carbon Film, 5%, 0.5W
R21	7464	10k	Trimpot, 15-turns, 3/4W
R25	5699	38R3	
R26	4242	1k0	Carbon Film 5%, 0.5W
R27,R29	5388	10k0	

Capacitors

	Cl	4782	220pF	100V
	C2	5734	100pF	63V
		4802	1nF	100V
C9,C12,C14	C4,C5,C8	4507	100nF	63V
			22µF	400V
	C6	10007	68nF	630V
	C7	10008	1µF	50V

Inductors

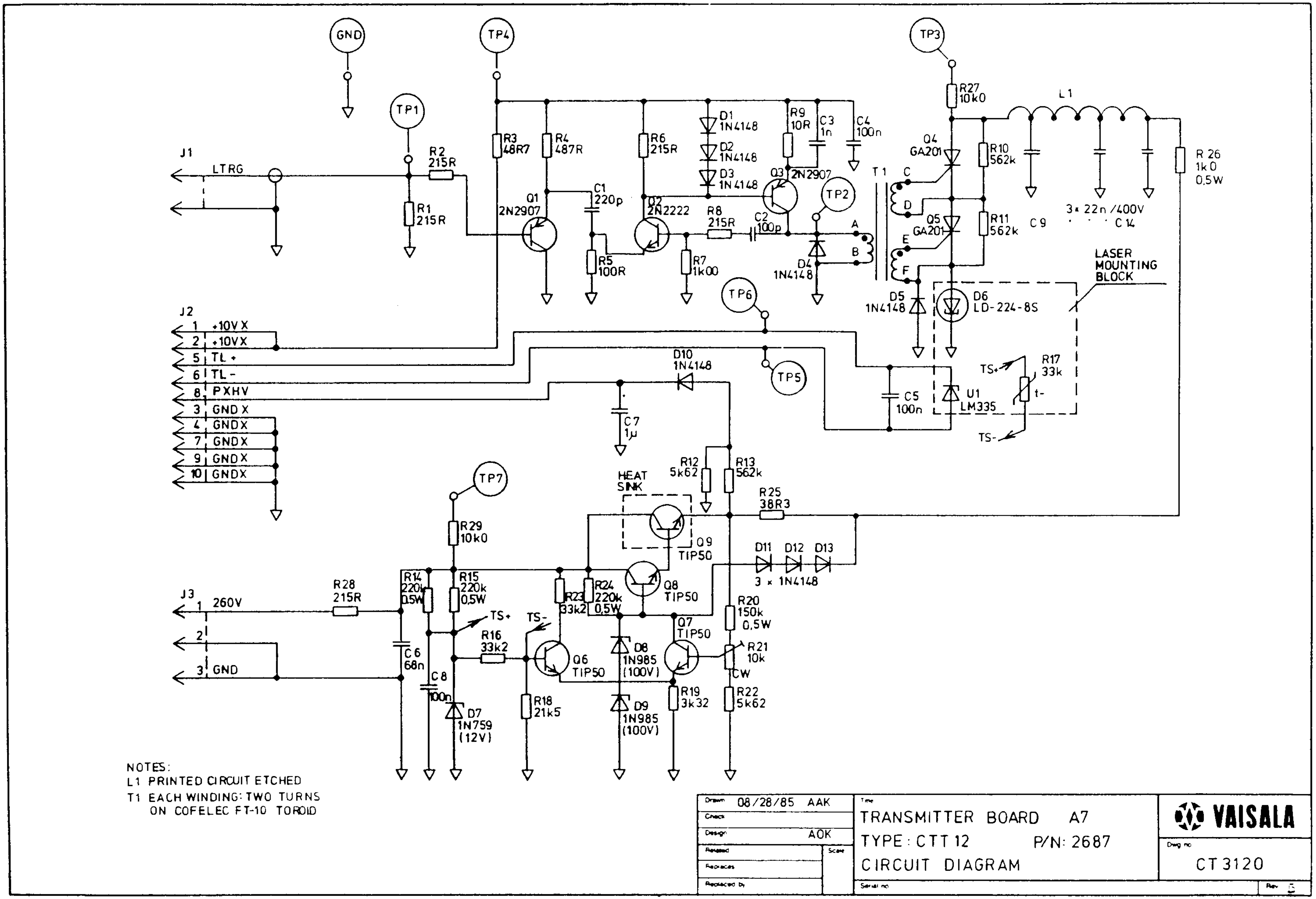
Ll	Part of PC-Board Layout
Tl	FACTORY-ASSEMBLED From P/N 1863

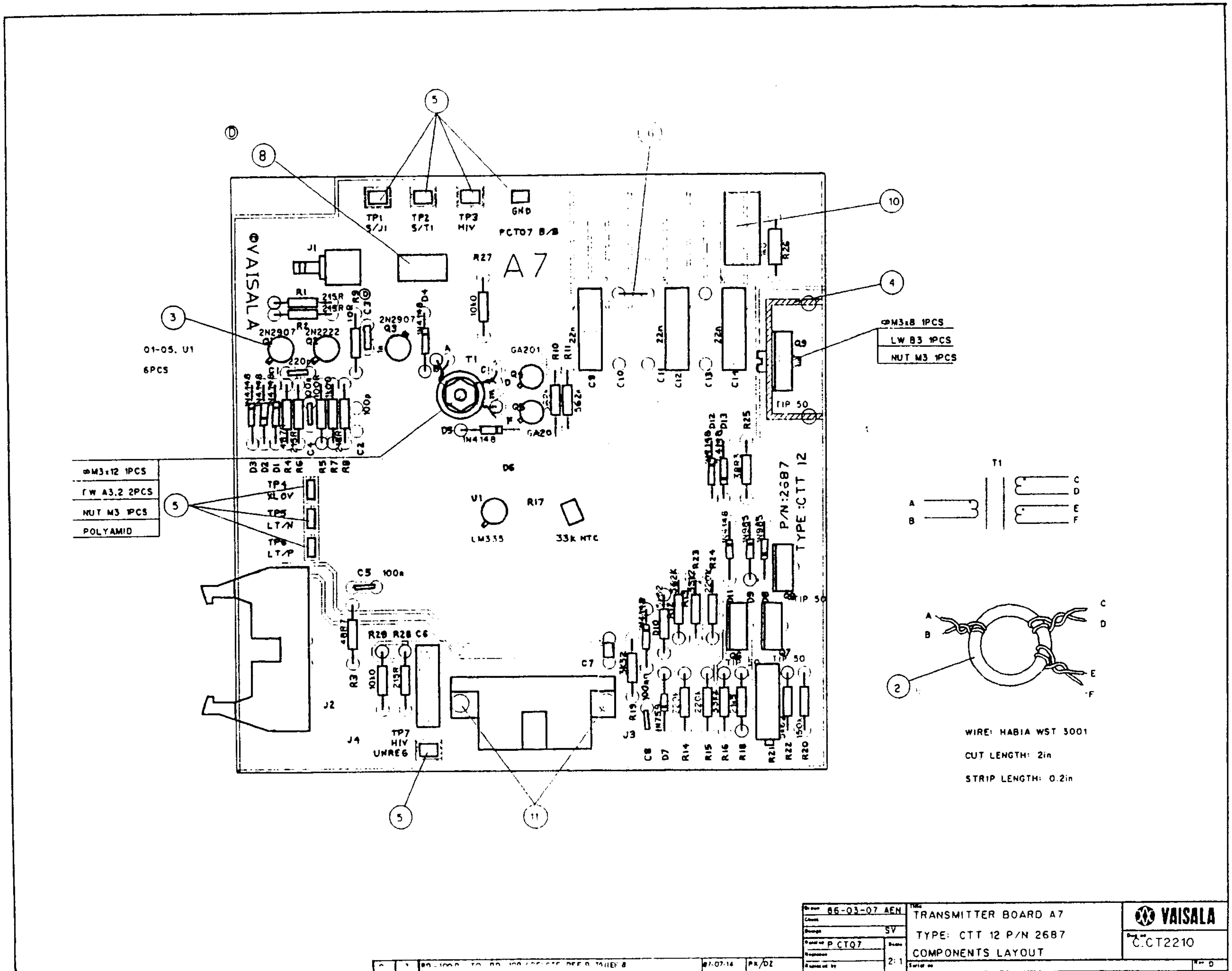
Miscellaneous

1863	Toriod dia. l0mm, Ref. Tl Assembly

Connectors

Jl	1692	SMB-Subminì Coaxial PCB 90°
J2	2963	MILC-83503, 10 pos Male, PCB 90°
J3	2923	AMP 207541-3, 3 pos Male, PCB 90°


GND
TP1
TP2
TP3
TP4
TP5
TP6
TP7
J1
LTRG
J2
1 +10V X
2 +10V X
5 TL +
6 TL -
8 PXHV
3 GND X
4 GND X
7 GND X
9 GND X
10 GND X
J3
1 260V
2
3 GND
R1 215R
R2 215R
R3 48R7
R4 487R
R5 100R
R6 215R
R7 1k00
R8 215R
R9 10R
R10 562k
R11 562k
R12 5k62
R13 562k
R14 220k 0,5W
R15 220k 0,5W
R16 33k2
R17 33k
R18 21k5
R19 3k32
R20 150k 0,5W
R21 10k
CW
R22 5k62
R23 33k2
R24 220k 0,5W
R25 38R3
R 26 1k 0 0,5W
R27 10k0
R28 215R
R29 10k0
C1 220p
C2 100p
C3 1n
C4 100n
C5 100n
C6 68n
C7 1µ
C8 100n
C 9
3 × 22n /400V
C 14
D1 1N4148
D2 1N4148
D3 1N4148
D4 1N4148
D5 1N4148
D6 LD-224-8S
D7 1N759 (12V)
D8 1N985 (100V)
D9 1N985 (100V)
D10 1N4148
D11 D12 D13
3 × 1N4148
Q1 2N2907
Q2 2N2222
Q3 2N2907
Q4 GA201
Q5 GA201
Q6 TIP50
Q7 TIP50
Q8 TIP50
Q9 TIP50
HEAT SINK
L1
T1
A B C D E F
U1 LM335
LASER MOUNTING BLOCK
TS+
TS-
t-
NOTES:
L1 PRINTED CIRCUIT ETCHED
T1 EACH WINDING: TWO TURNS ON COFELEC FT-10 TOROID
Drawn 08/28/85 AAK
Check
Design AOK
Released
Scale
Replaces
Replaced by
Title
TRANSMITTER BOARD A7
TYPE: CTT 12 P/N: 2687
CIRCUIT DIAGRAM
VAISALA
Dwg no
CT 3120
Serial no
Rev


TRANSMITTER BOARD A7
TYPE: CTT 12 P/N 2687
COMPONENTS LAYOUT
VAISALA
C.CT2210
86-03-07 AEN
SV
P CT07
2:1
A7
PCT07 B/B
P/N:2687
TYPE:CTT 12
©VAISALA
01-05, U1
6PCS
⌀M3x12 1PCS
FW A3.2 2PCS
NUT M3 1PCS
POLYAMID
⌀M3x8 1PCS
LW B3 1PCS
NUT M3 1PCS
WIRE: HABIA WST 3001
CUT LENGTH: 2in
STRIP LENGTH: 0.2in
TP1 S/J1
TP2 S/T1
TP3 HIV
GND
TP4 XL.0V
TP5 LT/N
TP6 LT/P
TP7 HIV UNREG
LM335
33k NTC
J1
J2
J3
J4
T1

4.3.7 High-Voltage Power Supply CTP 12 REF PSl

4.3.7.1 Introduction

The High-Voltage Power Supply CTP 12 is the 115V Line Input Voltage subunit of the Ceilometer CT 12K. It performs the following main functions:

- Transforms the line voltage to the low voltages needed by the electronics.
- Transforms the line voltage, and also rectifies, filters, and partly regulates, the high voltages needed by the transmitter laser diode and the receiver avalanche photodiode.
- Switches the line voltage by power relays to control the Ceilometer Window Conditioner.

4.3.7.2 Specifications

Type:	CTP 12						
Part Number:	2688						
Reference Designation;	PSl						
Dimensions:	W	x	D	x	H		
	7.1	x	11.8	x	5.8	in	
	180	x	300	x	148		mm
Weight:	10.1 lbs						
	4.6 kgs						
Line Input:	102V min. - 132V max.						
	45Hz - 65Hz						
	12A max. continuous						

outputs:

Electronics Supply: Primary Circuit Breaker CBl; Rating 2A Slow

Connector	Voltage	Current	Note
Pl	8VAC	0.7A	Unregulated
Pl	2 x 8VAC	0.lA	Unregulated
Pl	20VAC	0.7A	Unregulated
P1	2 xl5VAC	0.15A	Unregulated
(A1) J7	270VDC	30mA	Unregulated
(A1) J8	250VDC... 425VCD	1mA	Regulated Adjustable, Temperature-Dependent, 1.5V/°C
(All of the above outputs are floating)			
J3	Line Voltage		Temperature Control Transformer

Window Conditioner Control: Circuit Breaker CB2, Rating 10A Slow

Connector	Voltage	Note
J2	Line Voltage	Blower Supply
J2	Line Voltage	Heater Supply

Environmental Temperature: (Inside Ceilometer) -40°F... +140°F
-40°C... + 60°C

Humidity: Non-Condensing

4.3.7.3 Functional Description

Refer to Circuit Diagram CT 3289.

4.3.7.3.1 General

The Line Supply is brought in via connector Jl to Terminal Block J5 and, further, to Indicator Lamp DSl and Circuit Breakers CB1 and CB2. DSl is placed before the CB's to indicate whether power is applied regardless of the state of the breakers.

Circuit Breakers CBl and CB2 double as "ON/OFF" switches and circuit protectors. The dual pole configuration enables the use of a floating or non-specified line supply. CBl supplies the Ceilometer equipment and connects power to Terminal Block J5 where the over-voltage protectors Rl, R2, and R3, are located (i.e., Metal-Oxide Varistors). From J5, power is divided to internal transformers Tl and T2, and via J3, to the external Temperature Control Transformer. In 115V operation of all transformer primaries are connected in parallel.

4.3.7.3.2 Window Conditioner Control

Circuit Breaker CB2 supplies line power to the contacts of relays Kl and K2, and from these to the output connector J2, Kl and K2 are controlled by signals BLOWER ON (BON) and HEATER ON (HON) from connector P2. Kl and K2 are active when BON and HON are at ground potential, respectively. The relay contacts are so arranged that heating cannot be supplied unless the blower is ON.

The Window Conditioner-monitoring temperature sensor signals TB+ and TB- are connected via PSl from connector J2 to connector P2.

4.3.7.3.3 High-Voltage Outputs

The High-Voltage Transformer T2 secondaries are connected via fuses Fl and F2 to High-Voltage Power Supply Board PSl Al. Fuses Fl and F2 values shah be 60mA (1/16A) when using 0.25 x 1.25-inch fuses, and 50mA when using 5 x 20-millimeter fuses.

One secondary supplies the Avalanche Photodiode Receiver bias voltage regulating circuit while the other secondary is fullwave-rectified and filtered at J8, and connected to the Transmitter Board (A7) for onboard regulating.

The operation of the receiver bias voltage-regulating circuit is as follows:

The 200VAC from T2 is rectified, filtered, and doubled, in circuit Dl-Cl-C2-D2 to 550VDC. This biases a l0mV/°K temperature sensor Ul which, together with diode D3, creates a reference voltage of approximately 2.5V at room temperature with a temperature coefficient of 12mV/°K (22mV/°F) between diodes D3 and D4. D4 serves for temperature compensation of the transistor Q5 base-emitter voltage drop.

The output voltage is sensed with adjustable voltage divider R14-R12-R13-R15 and connected via Q5 to a difference amplifier Q3-A4 where the difference between reference and output controls the base of series-pass transistor Q2. The drive is supplied by R8-R9. Transistor Ql takes half of the regulation voltage drop which, in case of output short-circuit, may exceed that of a single series-pass transistor.

Current limiting is achieved when the voltage over R16 exceeds that of a diode junction (i.e., approximately 0.6V). The maximum output current with full voltage is approximately 1mA. When this occurs, diodes D6 and D7 will conduct excess Q2 base drive current to the output.

Zeners D8, D9, and Dl0, limit the output voltage to approximately 450V max while Zener D5 provides a collector voltage drop for Q4 and Q5 to within specifications of their breakdown voltage.

Resistors R17 and R18 provide protection for test points TPl and TP2.

Additional filtering is provided by C4,C5, and C6, and the final output voltage is from connector J7 to Receiver Board A6.

The actual bias voltage for the Receiver Photodiode is adjusted by R13. The voltage to be achieved at room temperature (22°C or 72°F) is found on a sticker mounted on the Receiver Board. For other temperatures, the adjustment value shall be corrected by applying the output voltage temperature coefficient 1.5V/°C or

If the Ceilometer is equipped with Receiver board CTR 13, which has it's own bias voltage compensation circuit, R13 has to be adjusted to it's maximum (fully clockwise).

4.3.7.4 Parts List

Reference	Part Number	Description
CBl	2956	Circuit Breaker 2A Slow Airpax T21-2-2.0-01-00
CB2	2958	Circuit Breaker 10A Slow Airpax T21-2-10.0-01-00
Kl,K2	10021	Relay 24VDC/DPDT 16A Sigma 68R24-24DC-SCO
32	2952	Fuseholder Littlefuse 345603-010
33	2954	Fuse Knob - 0.25 x 1.25 inch Littlefuse 345603-020
Fl,F2	10179	Fuse 62mA Slow - 0.25 x 1.25 inch
10	10011	Terminal Weidmuller AKZ 4SS PA
DSl	10231	Indicator Lamp - 125V, 00.5-inch 1D1 1030 Dl
Rl	0956	Metal Oxide Varistor - 275V, 15A GE V275 LA 15
R2,R3	10002	Metal Oxide Varistor - 150V, 10A GE V150 LA 10

10274 Main Transformer Subassembly

Tl	2722	Transformer Vaisala CT 3113
Pl	2931	Header. 18-pos. AMP 207442-l
	2936	Socket AMP 163k084-2

10275 Line Input Harness Subassembly

Jl	2929	Receptacle 6-pos., AMP 207153-l
	2934	Pin AMP 163082-2

10276 Blower Control Harness Subassembly

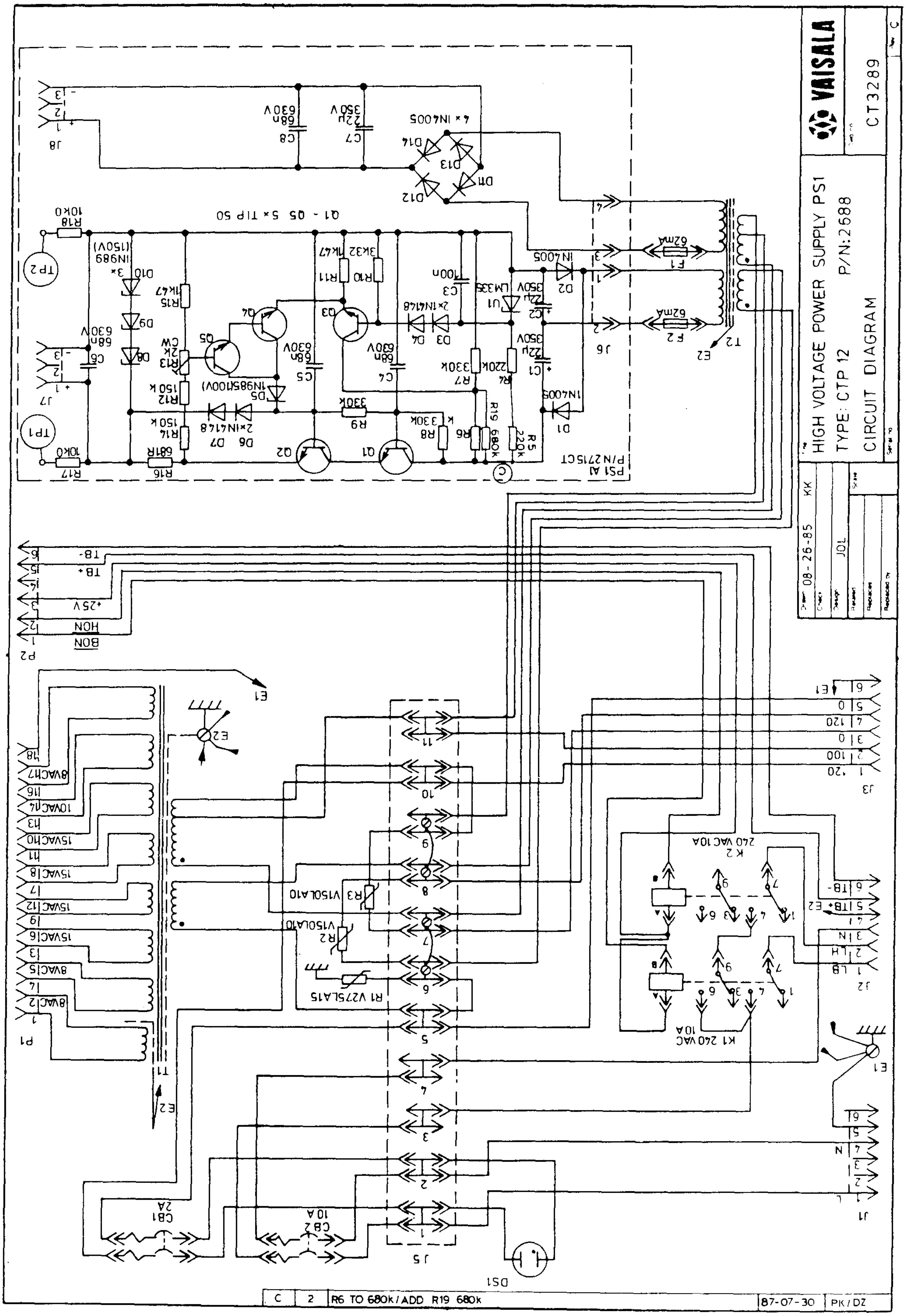
P2	2929	Receptacle 6-pos. AMP 207153-l
J2	2928	Header 6-pos, AMP 207152-l
	2934	Pin AMP 163082-2
	2936	Socket AMP 163084-2

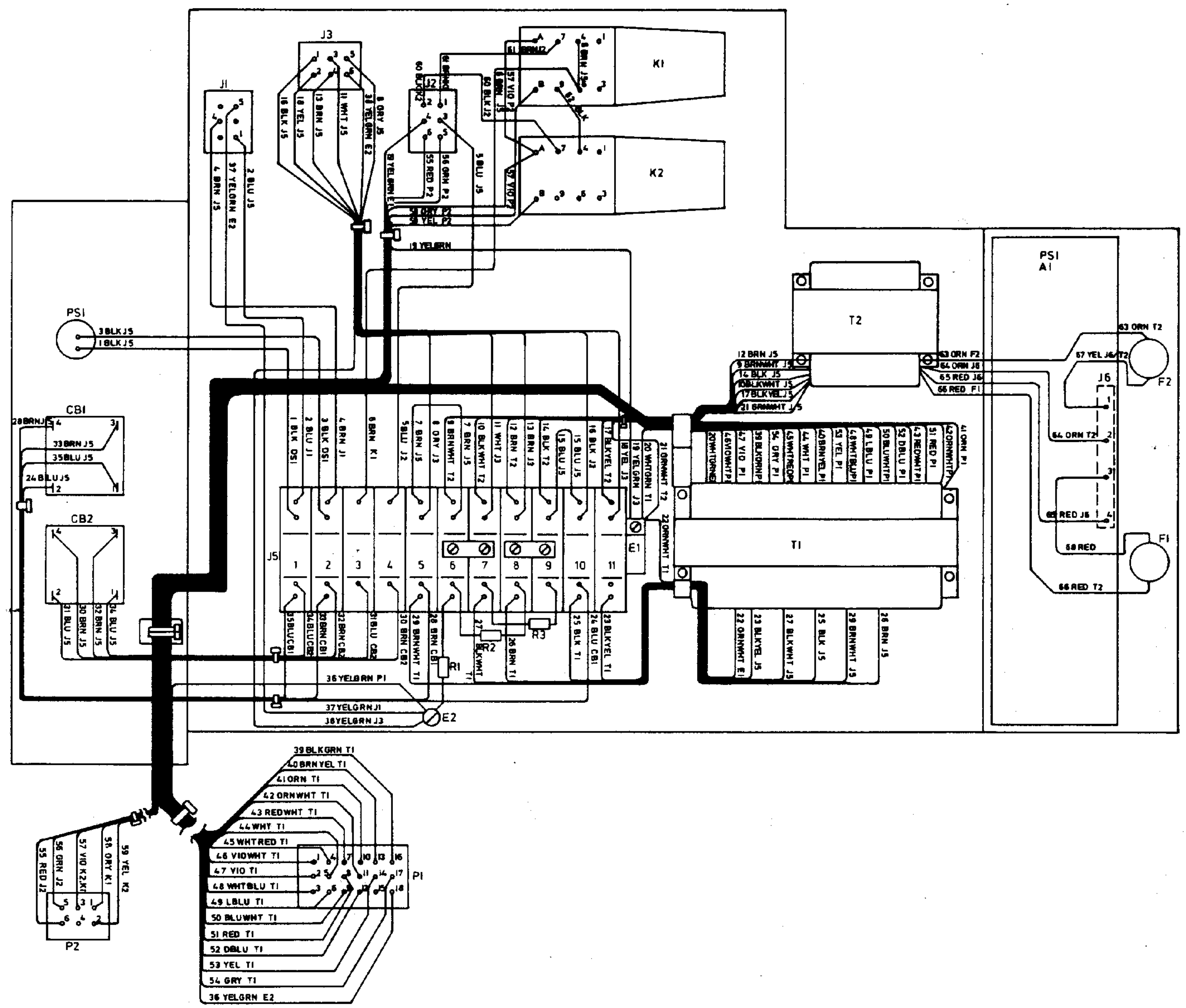
10277 Temperature Control Transformer Harness Subassembly

J3	2928	Header 6-pos, AMP 207152-l
	2936	Socket AMP 163084-2
	2934	Pin AMP 163082-2
T2	2723	Transformer Vaisala CT 3114

Al 2715 High Voltage Power Supply Board

Ul	1832	Temperature Sensor NS LM335
Ql-Q5	2970	Transistor NPN 400V TI TIP50
D1,D2, Dll-D14	1336	Diode 600V 1A lN4005
D3,D4,D6, D7	3884	Diode 75V 0.2A lN4148
D5	2972	Zener 100V 0.4W lN985
D8,D9,Dl0	2971	Zener 150V 0.4W lN989
R4,R5	4080	Resistor Carbon Film 220k 5% 0.5W
R6-R9	4248	Resistor Carbon Film 330k 5% 0.5W
R10	5791	Resistor Metal Film 3k32 1% 0.25W
Rll,R15	7481	Resistor Metal Film lk47 1% 0.25W
R12,R14	4247	Resistor Carbon Film 150k 5% 0.5W
R13	0012	Trimpot 2k 0.75W, 15 Turns
R16	5153	Resistor Metal Film 681R 1% 0.25W
R17,R18	5388	Resistor Metal Film 10k 1% 0.25W
Cl,C2,C7	10003	Capacitor Alum El 22µ 350v
c3	4507	Capacitor Ceramic loon 63V
C4-C6,C8	10007	Capacitor Polyest 68n 630V
J7,J8	2924	Connector 3-pos. AMP 207608-3

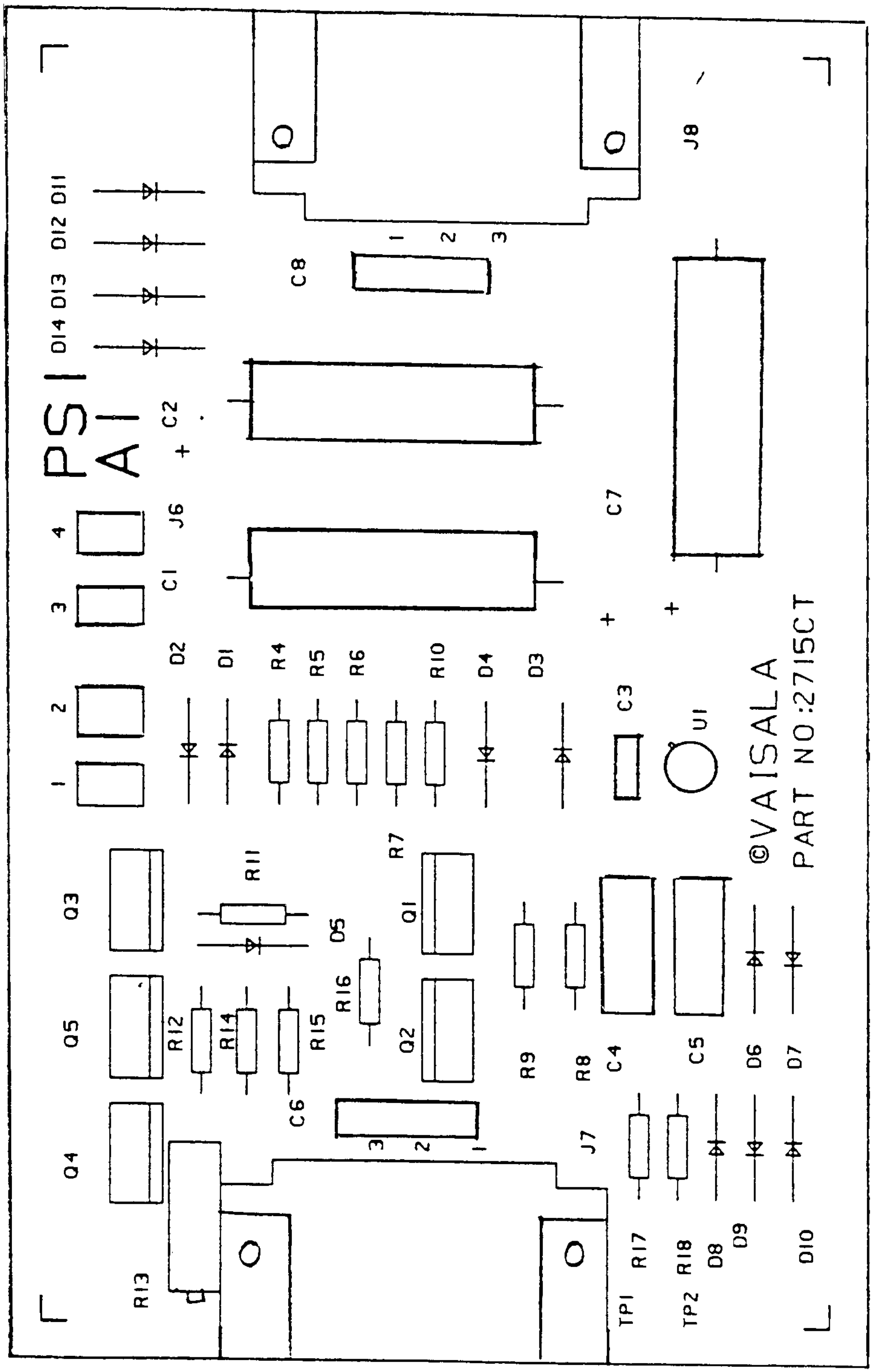

HIGH VOLTAGE POWER SUPPLY PS1
TYPE: CTP 12
P/N:2688
CIRCUIT DIAGRAM
VAISALA
CT3289
08-26-85
KK
JOL
C
2
R6 TO 680K/ADD R19 680k
87-07-30
PK/DZ



NO	TYPE	COLOR	FROM	TO	LENGTH
1	AWG 22	BLK	J5/1	DS1	4.5
2	AWG 18	BLU	J5/1	J1/1	5
3	AWG 22	BLK	J5/2	DS1	4.5
4	AWG 18	BRN	J5/2	J1/4	5
5	AWG 18	BLU	J5/4	J2/3	5
6	AWG 18	BRN	J5/3	K1/4.6	5+2
7	AWG 18	BRN	J5/5	J5/6	2
8	AWG 18	GRY	J5/5	J3/5	5
9	AWG 20	BRNWHT	J5/6	T2/PRI	7
10	AWG 20	BLKWHT	J5/7	T2/PRI	7
11	AWG 18	WHT	J5/7	J3/3	5
12	AWG 20	BRN	J5/8	T2/PRI	7
13	AWG 18	BRN	J5/8	J3/4	5
14	AWG 20	BLK	J5/9	T2/PRI	7
15	AWG 18	BLU	J5/9	J5/10	2
16	AWG 18	BLK	J5/10	J3/1	5
17	AWG 20	BLKYEL	J5/11	T2/PRI	7
18	AWG 18	YEL	J5/11	J3/2	5
19	AWG 18	YELGRN	E1	J2/4	5
20	AWG 20	WHTGRN	E1	T1/SCREEN	6
21	AWG 20	GRNWHT	E1	T2/SCREEN	6
22	AWG 20	GRNWHT	E1	T1/SCREEN	6
23	AWG 20	BLKYEL	J5/11	T1/PRI	7
24	AWG 18	BLU	J5/10	CB1/2	6
25	AWG 20	BLK	J5/10	T1/PRI	7
26	AWG 20	BRN	J5/8	T1/PRI	7
27	AWG 20	BLKWHT	J5/7	T1/PRI	7
28	AWG 18	BRN	J5/5	CB1/4	6
29	AWG 20	BRNWHT	J5/5	T1/PRI	7
30	AWG 18	BRN	J5/4	CB2/4	6
31	AWG 18	BLU	J5/3	CB2/2	6
32	AWG 18	BRN	J5/2	CB2/3	6
33	AWG 18	BRN	J5/2	CB1/3	6
34	AWG 18	BLU	J5/1	CB2/1	6
35	AWG 18	BLU	J5/1	CB1/1	6
36	AWG 18	YELGRN	E2	P1/18	13
37	AWG 18	YELGRN	E2	J1/5	8
38	AWG 18	YELGRN	E2	J3/6	8
39	AWG 20	BLKGRN	P1/16	T1/SEC	18
40	AWG 20	BRNYEL	P1/13	T1/SEC	18
41	AWG 20	ORN	P1/10	T1/SEC	18
42	AWG 20	ORNWHT	P1/11	T1/SEC	18
43	AWG 20	REDWHT	P1/7	T1/SEC	18
44	AWG 20	WHT	P1/5	T1/SEC	18
45	AWG 20	WHTRED	P1/4	T1/SEC	18
46	AWG 20	VIOWHT	P1/1	T1/SEC	18
47	AWG 20	VIO	P1/2	T1/SEC	18
48	AWG 20	WHTBLU	P1/3	T1/SEC	18
49	AWG 20	LBLU	P1/6	T1/SEC	18
50	AWG 20	BLUWHT	P1/9	T1/SEC	18
51	AWG 20	RED	P1/8	T1/SEC	18
52	AWG 20	DBLU	P1/12	T1/SEC	18
53	AWG 20	YEL	P1/14	T1/SEC	18
54	AWG 20	GRY	P1/17	T1/SEC	18
55	AWG 18	RED	P2/6	J2/6	19
56	AWG 18	GRN	P2/5	J2/5	19
57	AWG 18	VIO	P2/3	K2/A, K1/A	19+3
58	AWG 18	GRY	P2/1	K1/B	19
59	AWG 18	YEL	P2/2	K2/8	19
60	AWG 18	BLK	J2/2	K2/7	3
61	AWG 18	BRN	J2/1	K1/7	3
62	AWG 18	BLK	K1/9	K2/4	3
63	AWG 20	ORN	T2/SEC	F2	6
64	AWG 20	ORN	T2/SEC	J6/2	6
65	AWG 20	RED	T2/SEC	J6/4	6
66	AWG 20	RED	T2/SEC	F1	6
67	AWG 18	YEL	F2	J6/1	2
68	AWG 18	RED	F1	J6/3	2

NOTE: ALL THE DIMENSION IN INCHES

85-10-22 LeHu
AOK
HI-VOLTAGE POWER SUPPLY PS1
TYPE: CTP12 P/N 2688
WIRING DIAGRAM
VAISALA
U.CT 1200



Title
HIGH VOLTAGE SUPPLY BOARD PS1A1
TYPE: CTP12 P/N: 2715CT

COMPONENTS LAYOUT

VAISALA

Drawn
Check
Design
Related
Replaces
Replaced by
Scale
Dwg no.
Serial no.
Rev

4.3.8 Window Conditioner Bl

4.3.8.1 Introduction

The Window Conditioner of the CT 12K Ceilometer serves for keeping the windows on top of the instrument free from precipitation and dust. In addition, it is used for regulating the temperature of the Ceilometer. It is controlled by the processor of the Ceilometer via two power relays in the High-Voltage Power Supply PS 1.

4.3.8.2 Specifications

Part Number:2736
Designation: B 1

Dimensions:	W		D		H
	22.8	x	16.5	x	13.4 inches
	580	x	420	x	340 millimeters

Weight: 21 lbs
9.5 kg

Blower Fan: Single-Phase 1 15VAC, 75W, Capacitor Coupled

Air Volume: $410m^3/h$
$14450ft^3/h$

Ball Bearings: Maintenance-Free

Life Expectancy: 4.5 Years at 20°C (68°F) in Continuous Operation

Heater: Silicon Insulated Foil
Power 600W Nominal
Resistance 44 ohm + 44 ohm,
Parallel-Connected at 115V

Safety Thermostat: Open at 256°F (124°C), Increasing
Close at 202°F (94°C), Decreasing
Rating: 100,000 Cycles at ll5VAC, 15A

Temperature Sensor: Semiconductor-Type,
Voltage Drop 10mV x T/°K

Air Speed Over Window Pane: 33ft/s (l0m/s)

Air Temperature Rise: 13°F (7°C) Typical

4.3.8.3 Functional Description

Reference	Circuit Diagram
Window Conditioner Bl	CT 4290
Processor Board Al	CT 3386 (2/4)
Unregulated Power Supply Board A2 . . .	CT 3196
High-Voltage Power Supply PSl	CT 3289
Ceilometer Wiring Diagram	CT 1104

The Processor Board Al outputs, HON and BON, are routed via Unregulated Power Supply Board A2 to its connector, Jll, where they connect to High-Voltage Power Supply PSl and drive relays Kl and K2.

Line power is supplied via a dedicated circuit breaker, CB2 in PSl, to relays Kl and K2 contacts. These are connected so that heating is not possible unless the blower is on. The Line Supply signals, LB (Blower) and LH (Heater), are then routed from PSl through harness W2 and Ceilometer connector J2 to the Window Conditioner.

Heating Resistor HRl foils are parallel-connected for 115V operation. Its heat is transferred to the Radiator (part 7) upon which the Safety Thermostate Sl and the temperature Sensor TS2 are mounted.

The Blower housing is designed to create an even, efficient airflow over the radiator, picking up approximately 13°F of heat before sweeping over the windows of the Ceilometer.

Operation is monitored with Temperature Sensor TS2 which is connected via PSl and A2 to Processor Board Al Monitor A/D converter channel 11 (software reference TB).

Monitoring criteria are:

When both Heater and Blower are “ON,” the temperature shall be less than 72°F (40°C) above ambient as measured with TSl (Ref. TE). If Blower only is “ON,” then the difference limit is 54°F (30°C).

If heater has been ON (and subsequently the blower) for more than 10 minutes, then TB shall exceed TE by 3°C or more.

If temperature TB exceeds external temperature TE by 72°F (40°C), more heating is cut off by software control and a hardware alarm is given.

The temperature measurement circuit is monitored against the alarm limit TB (ALIM TB; default value 176°F = 80°C) to insure proper operation.

Four (4) minutes time-filtering is used.

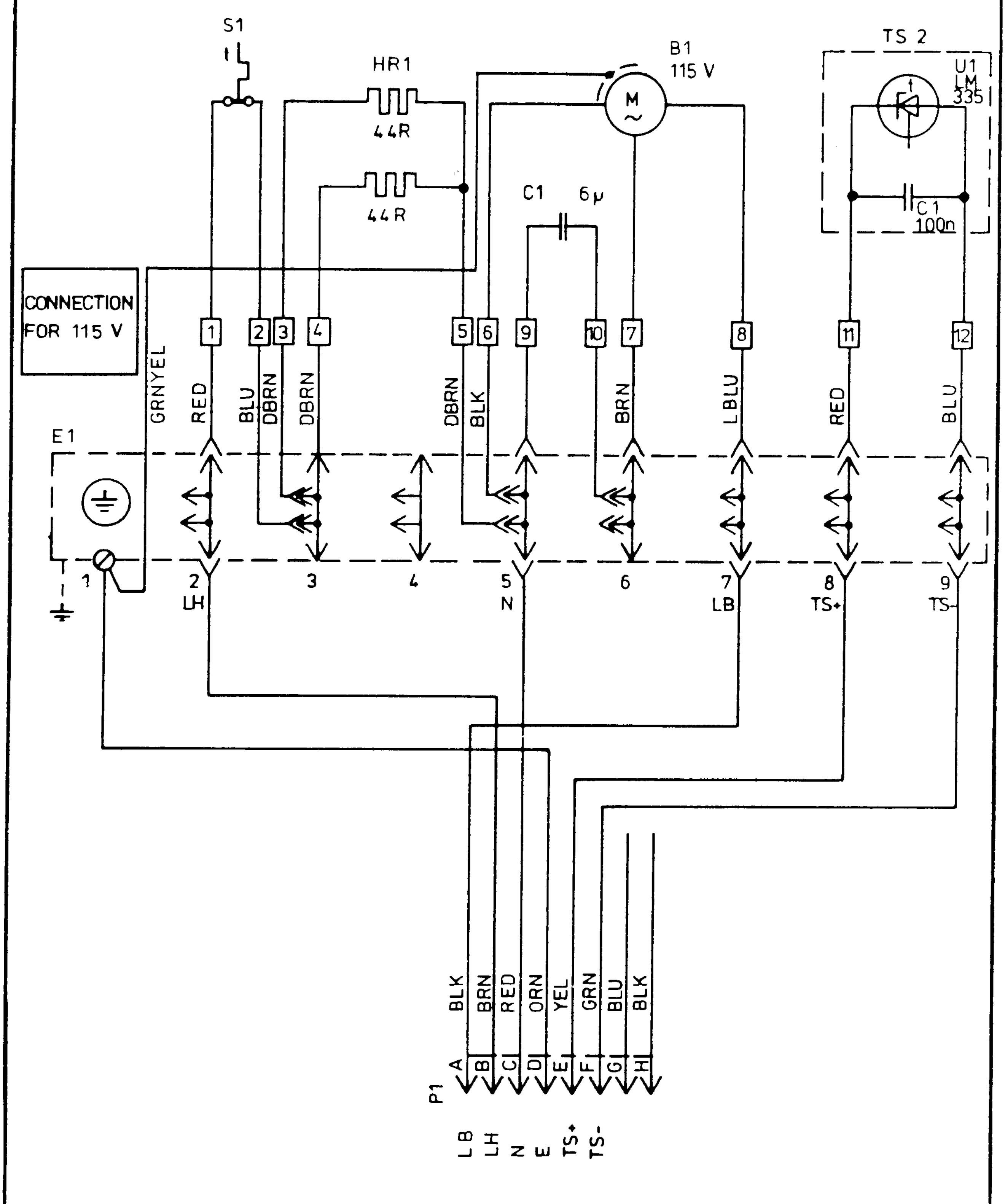
As a final safeguard against overheating, the Safety Thermostat Sl cuts off heating supply at 256°F ± 6°F (124°C ± 3°C). The processor gets no information of its operation, however.

The heat and the airflow are also used for stabilizing the immediate environmental conditions of the Ceilometer. In cold weather, (T + 14°F = -10°C) the heating is always “ON” (together with blowing); and, in hot weather (T> + 86°F = +30°C), the blowing is always “ON” and heating “OFF’ to keep heating by solar radiation at a minimum.

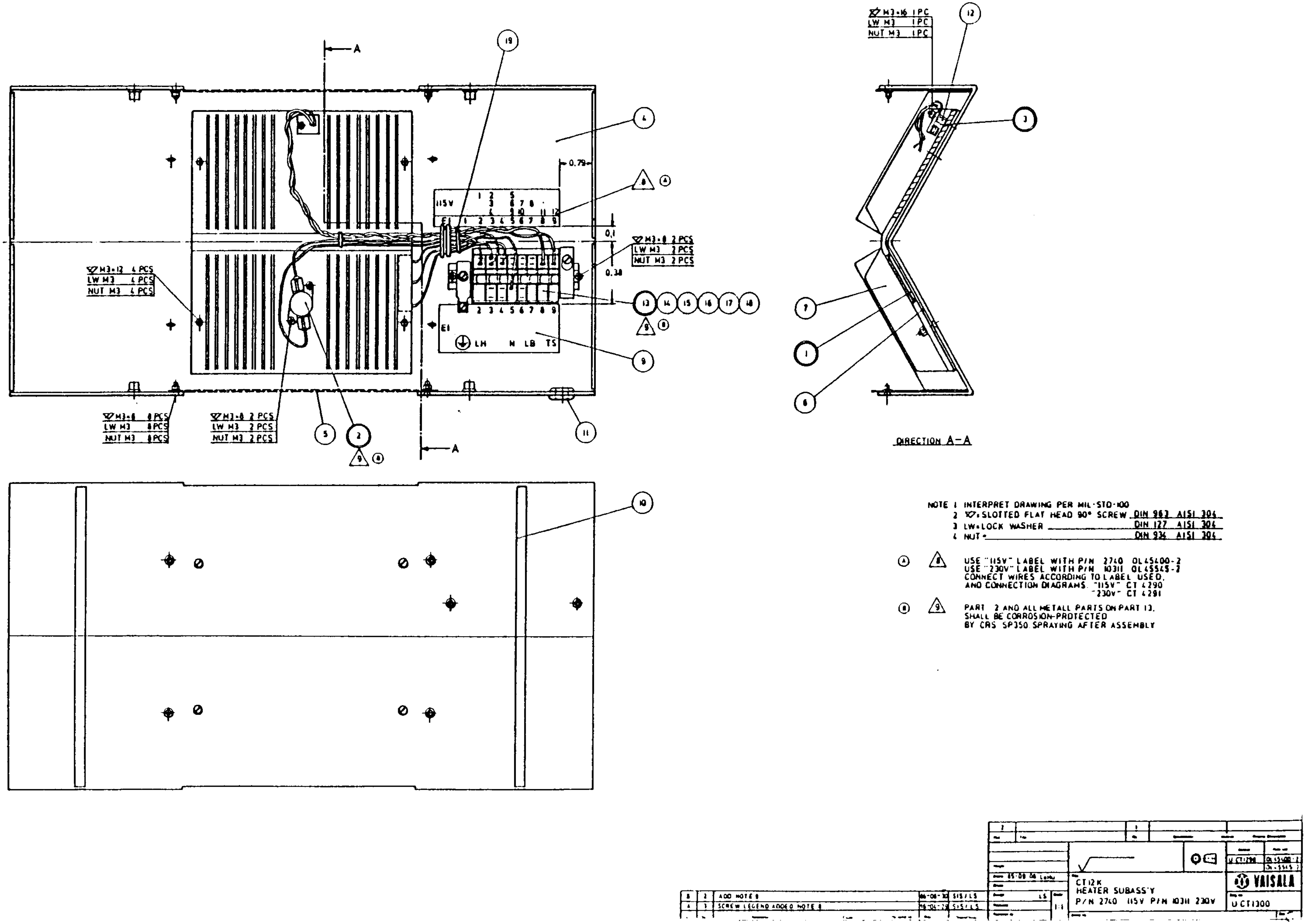
In intermediate temperatures, the operation is software-controlled to keep both heating and blowing “ON” always when there are clouds being detected in low visibility conditions; and, in 5- minute periods every 60 minutes to insure recovery in all situations and to keep dust contamination at a minimum.

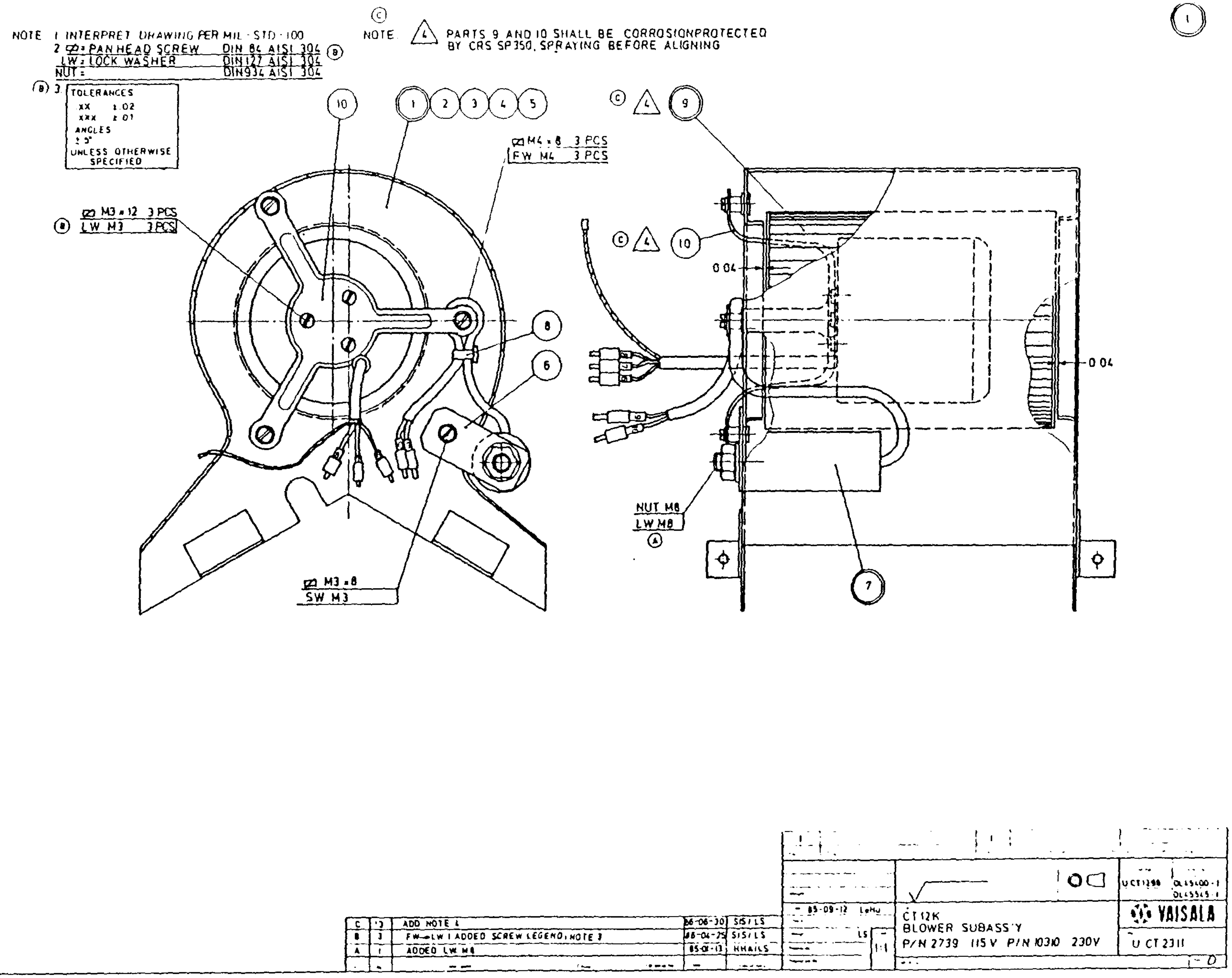
4.3.8.4 Parts List

Bl	10250	Blower Motor and Fan
Cl	10251	Motor Capacitor
HR1	2744	Heater
TS2	2746	Temperature Sensor
Sl	2745	Thermostat Subassembly
E l	10011	Terminal, 4-pin, 0.11 inch
	1923	Wire Terminal, 0.11 inch in Female, AWG 18
	273 1	Connection Cable Subassembly
	10045	Cable Alpha 45068
Pl	2944	Connector MS 3 116F16-8P



Drawn 08/14/85 KK		Title	VAISALA
Check		WINDOW CONDITIONER B1	
Design JOL		P/N2736(115 V)	Dwg no CT4290
Related	Scale	CONNECTION DIAGRAM	
Replaces			
Replaced by		Serial no	Rev A


M3×16 1PC
LW M3 1PC
NUT M3 1PC
M3×12 4 PCS
LW M3 4 PCS
NUT M3 4 PCS
M3×8 2 PCS
LW M3 2 PCS
NUT M3 2 PCS
M3×6 8 PCS
LW M3 8 PCS
NUT M3 8 PCS
M3×8 2 PCS
LW M3 2 PCS
NUT M3 2 PCS
0.79
0,1
0,38
115V
E1
LH N LB TS
A
A
DIRECTION A–A
NOTE 1 INTERPRET DRAWING PER MIL-STD-100
2 ▽=SLOTTED FLAT HEAD 90° SCREW DIN 963 AISI 304
3 LW=LOCK WASHER DIN 127 AISI 304
4 NUT= DIN 934 AISI 304
(A) 8 USE "115V" LABEL WITH P/N 2740 0L45400-2
USE "230V" LABEL WITH P/N 10311 0L45545-2
CONNECT WIRES ACCORDING TO LABEL USED,
AND CONNECTION DIAGRAMS "115V" CT 4290
"230V" CT 4291
(B) 9 PART 2 AND ALL METALL PARTS ON PART 13,
SHALL BE CORROSION-PROTECTED
BY CRS SP350 SPRAYING AFTER ASSEMBLY
B 2 ADD NOTE B
A 1 SCREW LEGEND ADDED NOTE 8
85-08-06
1:1
CT12K
HEATER SUBASS'Y
P/N 2740 115V P/N 10311 230V
VAISALA
U CT1300


NOTE 1 INTERPRET DRAWING PER MIL-STD-100
2 PAN HEAD SCREW DIN 84 AISI 304
LW = LOCK WASHER DIN 127 AISI 304
NUT = DIN 934 AISI 304
3 TOLERANCES XX ±.02 XXX ±.01 ANGLES ±.5° UNLESS OTHERWISE SPECIFIED
NOTE 4 PARTS 9 AND 10 SHALL BE CORROSIONPROTECTED BY CRS SP350, SPRAYING BEFORE ALIGNING
M3 x 12 3 PCS
LW M3 3 PCS
M4 x 8 3 PCS
FW M4 3 PCS
M3 x 8
SW M3
NUT M8
LW M8
0.04
0.04
ADD NOTE 4
FW→LW / ADDED SCREW LEGEND, NOTE 3
ADDED LW M8
CT12K
BLOWER SUBASS'Y
P/N 2739 115 V P/N 10310 230V
VAISALA
U CT 2311

4.3.9 Maintenance Terminal CTH 12

4.3.9.1 Introduction

Maintenance Terminal CTH 12 is designed for service and maintenance of Ceilometer CT 12K.

It is a portable, near-pocket-size, hand-held terminal operating over a wide temperature range. It is built into a plastic case, with a lid covering the display and the keyboard when not in use.

It operates with standard RS-232C signals. The operating power, + 12V, is supplied from the Ceilometer.

The terminal contains a 16-character LCD display that supports the full ASCII character set. It also contains an electro-luminence light for night readability and a heater element for low temperature operation, both controlled automatically by built-in sensors.

The keyboard is a 16-character hexadecimal pad.

4.3.9.2 Specifications

Type:	CTH 12
Part Number:	2690
Supply Voltage:	12V DC ±20%
Current consumption:	50mA; with heater on: 250mA
Operating Temperature Range:	-40°C... +50°C -40°F... +120°F

Mechanical Dimensions:	W	x	D	x	H	
	5.0	x	7.7	x	2.0	inches
	127	x	196	x	51	millimeters

Cable:	1.2m 4 ft
Interface:	RS-232C level RXD, TXD
Baud Rate:	300 Baud (Standard)
Data Frame: (Standard)	1 Start Bit 8 Data Bits (Polarity of Unused 8th Bit (MSB) Same as Stop Bit) 1 Stop Bit No Parity

Display:	16-Character, Alphanumeric LCD, 5 x 7 Dot Matrix
Night Readability:	Electro-Luminence Light Backlighting
Heating:	Foil Resistor Temperature Sensor-Controlled Heating "ON" Temperature: -12°C (+ 10°F) Heating "OFF' Temperature: -2°C (+ 28°F) Heating Power: 2.5 W
Keyboard:	16-Key Hexadecimal Keyboard Module with Symbols 0...9 and A...F

4.3.9.3 Functional Description

4.3.9.3.1 Operation

4.3.9.3.1.1 Keyboard

A 16-key, matrix-coded, hexadecimal keyboard is used with the keys 0...9 and A...F as follows:

		Column			
		H	G	F	E
Line	M	0	1	2	3
	L	4	5	6	7
	K	8	9	A	B
	J	C	D	E	F

The keyboard module is wired so that when a key is depressed, the key switch shorts a certain line to a certain column. For example, when the key “0” is pressed, line “M” connects to column “H.” Designations of the columns “H” to “E” and lines “M” to “J” refer to pin designations of keyboard module connector. The connector pins are arranged as follows (seen from the left to the right when viewing the keyboard from the normal operating direction): M L K J H G F E

4.3.9.3.1.2 Keyboard Control Circuit

Keyboard reading is controlled by a 16-key encoder (74C922) designated U9. The circuit is provided with internal pull-up resistors and a contact debounce circuit. The Data Ready (DA) signal goes “HIGH” when the key is pressed and returns "LOW" when the key is released. The speed of the scanning circuit is approximately 600 Hz and the operating time of the debounce circuit is about 10ms.

The circuit operates as follows:

The circuit clock feeds a two-bit counter which pulls down one column, output Cl...C4, at a time through the decoder while the other column outputs are in high-impedance state. When no key is being pressed, all line inputs are “ones” (l’s), this being affected by the internal pull-up resistors.

Thus, for example, when key "0" is pressed and while scanning proceeds, column Cl state goes LOW, and closure of the switch pulls down the line output signal state. This interrupts the scanning, activates the contact debounce circuit, and locks up the other line output states. The key code transmitted is a combination of the counter's stopping value and the decoded line's input value. When the operating time of the debounce circuit is used up, the data ready pin state goes HIGH.

In the presence of contact bounce, key scanning goes ON and the debounce circuit is reset. Only when the contact has been closed over a set period of time, it is recognized as a key depression and the data is locked.

4.3.9.3.1.3 Keyboard Codes

Codes corresponding to the keyboard keys are shown in Table 1. The codes have been selected so as to correspond to ASCII codes as regards the keys from 0...9.

Table 1. Key Codes

KEY	HEX	ASCII
0	30	0
1		1
2	31 32	2
3	33	3
4.	34	4
5	35	5
6	36	6
7	37	7
8	38	8
9	39	9
A	3A	:
B	3B	;
C	3c	<
D	3D	=
E		>
F	3E	?

Table 1. Key Codes

4.3.9.3.1.4 UART Circuit

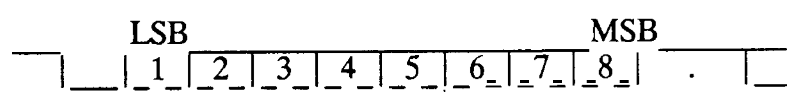
The universal, asynchronous Receiver-Transmitter circuit designated U4 is of type IM 6402. The circuit is used to convert the parallel keyboard entry data into serial form, and the incoming serial data into a suitable parallel form, to be used by the display module.

The Receiver of the circuit converts the serial data into parallei form, checks for correct form of transmission, parity, and location of the stop bits. The Transmitter of the circuit converts the parallel-form data into serial-form data and adds it to the start bits, parity, and stop bits. The meanings of these bits and the number of data bits can be changed by means of the control input signals of the circuit. The inputs have been fixed as follows:

Figure 1. Serial Data Format

Pin	Symbol	Meaning
35	PI = 1	Parity Not Used
39	EPE = 1	Don't Care
38	CLSl = 1	Number of Data Bits = 8
37	**CLS2** = 1	Number of Data Bits = 8
36	SBS = 1	2 Stop Bits

The serial data thus takes the form illustrated below:



One (1) start Bit

Eight (8) Data Bits

Two (2) stop Bits

Figure 1. Serial Data Format

Note: This format applies to transmission only. Ceilometer uses one stop bit. Due to interchange being asynchronous, only one stop bit is mandatory. Additional stop bits cause no errors.

4.3.9.3.1.4.1 UART Transmitter

The serial data transmitter receives the information keyed in (TBRl...TRR8) and transmits it serially via pin TRO. When the key has been depressed over a period determined by the contact debounce logic, the state of signal DA in the keyboard controller goes HIGH (state 1 at test point J10/5). Signal TBRL state then falls LOW, if it was HIGH, and data is loaded to the buffer register of the Transmitter. When the key is released, DA state goes LOW and TBRL state goes HIGH. The states of the data lines TBRl...TBR4 from the keyboard circuit and hardwired data lines TBR5...TRR8 are then locked in the Transmitter buffer register.

Signal TBRE is reset by the rising edge of the I3 =TBRL pulse which prevents keying-in of further data until the contents of the buffer register, 0...1 baud clock cycle later, is transferred to the Transmitter buffer register, transmission has started, and signal TBRE has returned back to HIGH state.

If the previous data transmission was still unfinished, signal TBRE does not return to state 1 until the previous data transmission has been concluded. Only after this, is data transferred from the Transmitter buffer register to the Transmitter register and TBRE state returned.

4.3.9.3.1.4.2 UART Receiver

Incoming data is received at input RI, test connector J10, pin 9. When data is not sent, input RI is normally HIGH. Incoming data is clocked by the RRC clock obtained from the baud generator. RRC frequency is 16 times the baud frequency. The receiver timing is shown in Figure 2 below:

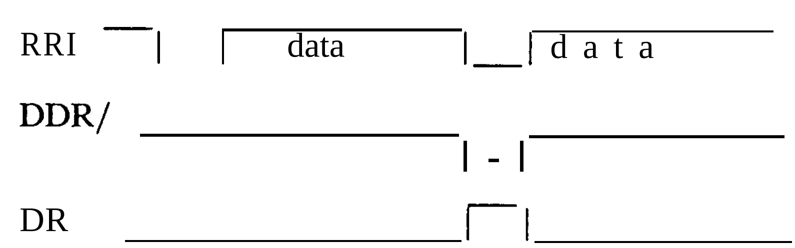


Figure 2. UART Receiver Timing Diagram

During the first stop bit, data is transferred from the Receiving register into the Receiver's buffer register, RBR. One clock cycle later, the data ready signal, DR, goes HIGH. After approximately 3µs (created by resistor RA1/3-4, and capacitor C4) the state at pin 3 of circuit U5 goes LOW. This is connected to the UART's input DRR which resets the output DR. After another 3µs, the state at U5, pin 3, and the input signal DRR goes HIGH and the circuit is ready to receive a new character.

4.3.9.3.1.5 RS-232C Transmitter

The RS-232C Transmitter is comprised of operational amplifier U3 (LM 124). The serial data signal, TRO, coming from the UART Transmitter is brought to the inverting input of the op. amplifier. A ref. voltage of approximately 1.7V is obtained by resistors RA3/1-2 and RA2/9-10. Here, U3 has the function of an inverting comparator which, at the same time, converts the TTL-level voltage into an RS-232C-compatible voltage. The operational amplifier is protected against overvoltages and short circuits by diode bridge Dl and resistor R6. Outgoing RS-232C data is brought to terminal strip El, pin 3.

4.3.9.3.1.6 RS-232C Receiver

Incoming RS-232C data is brought to terminal strip El, pin 2. R5 and D3 protect the input against overvoltages beyond + 15V. RA3/3-4 provides a load resistance of 10 k ohm for the input and insures that the unconnected input is kept at state 0. RA3/5-6 and C7 form a low-pass filter (time constant: 10 µs) preventing further passage of RF interference.

Jumper J5 enables selection of two distinct inputs. When using the RS-232C interface, jumper J5 must be in position l-2. The level change from RS-232C (+ 12V) is effected by NAND gate 5. Diodes in series at the input of the circuit limit incoming voltage to between OV and +5V and, at the same time, the circuit inverts the signal so that it can be fed directly into the UART receiver. The signal for the UART is taken to test connector J10, pin 9.

4.3.9.3.1.7 Baud Clock

The baud clock of the terminal is a crystal oscillator providing the fundamental frequency, 2.4576 MHz. By dividing this in an asynchronous counter, the required baud frequencies for the UART are obtained. The baud clock frequency corresponding to a certain baud frequency is 16 times that baud frequency. Jumper J6 is used to select the frequency taken to the UART's clock inputs. Selection can be made between the data transfer rates of 300 baud, 1200 baud, and 2400 baud. Frequencies of the baud clock corresponding to these rates are given in Table 2.

Table 2. Baud Clock Freauencv Settings

Data Transfer Rate	Baud Clock Frequency	J6 Setting
330 bd	4800 Hz	4-5
1200 bd	19200 Hz	2-3 or 3-4
2400 bd	38400 Hz	l-2

Table 2. Baud Clock Frequency Settings

Frequencies available from the baud generator are also employed to provide the voltage -9V (153.6 kHz, see Section 4.3.9.3.1.8.9) and the AC voltage 160V (600 Hz, see Section 4.3.9.3.1.8.5).

The oscillator circuit consists of crystal Zl, capacitors Cl7 and C18, resistors R24 and RA4/1-2, as well as HCMOS circuit U8 (74HC4060). The latter contains an inverting oscillator circuit which can be used to form a crystal oscillator of the parallel-resonance type. Capacitors Cl7 and Cl8 provide the load capacitance for the crystal. Resistor R24 biases the inverter into the active range. Circuit U8 contains an asynchronous counter dividing the fundamental frequency down by 214. In order to obtain the transfer rate frequencies from these division results, frequencies divided by 64, 128, and 512, have been used.

4.3.9.3.1.8 Display

4.3.9.3.1.8.1 Operation of the Display Module

The display of the CTH 12 is a 16-character, alphanumeric LCD module. The module is comprised of the display control circuits, a processor, and the required storage devices. There are three (3) types of memory:

- 80-Character RAM to Hold Display Data
- 8-Character Characters Memory to retain eight (8) characters of the User's Choice
- 192-Character ROM for a permanent retention of the following (See Table 3):
- 96 Alphanumeric Characters
- 64 Katakana Characters
- 32 Symbols

The characters are formed by means of a 5 x 7 dot matrix. Display control is via the eight-bit bus. An electro-luminescent light behind the display provides lighting as required.

4.3.9.3.1.8.2 Operation of the Display Initialization Circuit

The display module is automatically initialized when power is turned ON. The following commands are carried out during initialization:

1. Memories Cleared
2. Operating Mode Set as Follows:

DL = 1: O-bit bus
N = 0: Single-Line Display
F = 0: 5 x 7 Display Mode

3. Display ON/OFF:

   D = 0: Display OFF
   C = 0: Cursor Not Visible
   B = 0: No Flashing

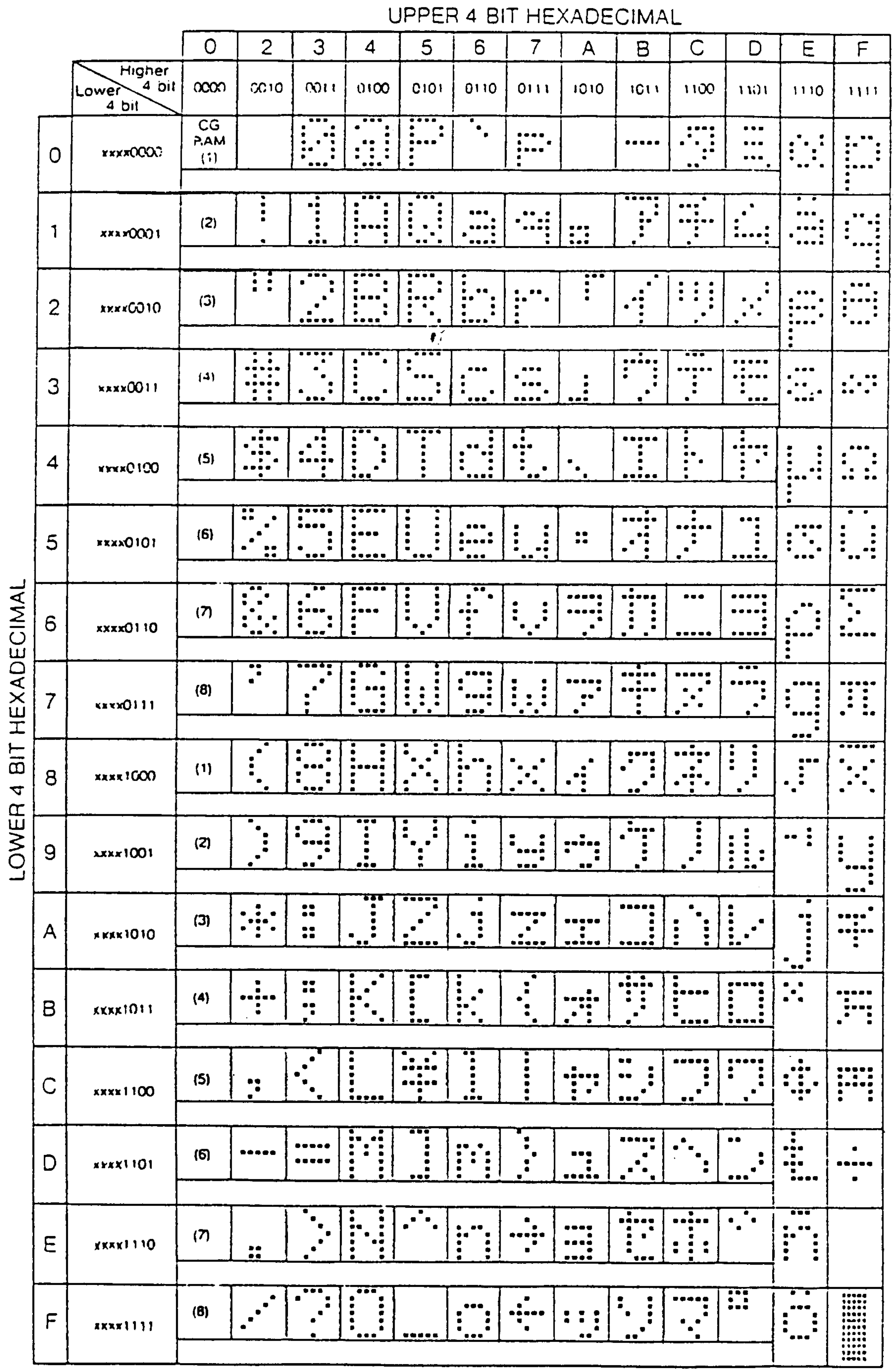
4. Selecting Input Mode:

   I/O = 1: Address Incrementation
   S = 0: No Transfer

5. DD RAM Addressing Selected

Note: If power for the system is connected incorrectly as far as the display is concerned, it is possible that the display is not initialized.

Repeat the connection if necessary.



Contents of Character ROM

CT4577

4.3.9.3.1.8.3 Display Control

The 8-bit parallel data received from the UART receiver is taken to the display module as follows: The seven (7) lowermost bits are brough directly to the 8-bit bus of the display; whereas the upper-most data bit RBR8 is used to control the RS input of the display. The RS input signal determines whether the information received from the data bus is interpreted as a control command or as character data:

RS = 0: Control Command
RS = 1: Character Data

The uppermost data bit DB7 of the display bus is controlled by a separate register, U7, provided with separate set and reset control commands. See Section 4.3.9.3.1.8.4.

The data read timing signal E is derived from signal DR of the UART received via circuit U6/12. The signal is also taken to test connector J10, pin 4. In its normal state, signal E is the same as signal DRR inverted. In addition to inverting the signal DR, OR gate 6 provides two safeguards: Further passage of an extra DR signal generated during power-up is prevented by holding, by means of signal MR, signal E LOW for the duration of the initial reset function. Also, if a character received from the serial data path is faulty and an FE fault is created (i.e., the stop bit is not found at the correct point), this character is not sent to the display because the DR pulse is prevented by signal FE from reaching E.

In principle, it is‘ possible to read the contents of the memories of the display module. This feature, however, cannot be used to advantage in the CTH 12. Also, the R/W control input is permanently connected to position W so that only data writing into the display module memories is possible.

4.3.9.3.1.8.4 DB7 Control Logic

The most significant data bit RBR8 of the UART receiver is used to control the RS input of the display. Separate set and reset commands are, therefore, needed for controlling the most significant bit, DB7, of the display data bus.

DB7 is controlled by the register circuit U7 output. The register can be set or reset by setting the least significant data bit coming from the UART at 1 or 0. The register is clocked by circuits U5 and U6 which decode incoming control commands so that U7 will receive a clock pulse only when a control command of the following format is issued to the display:

D7	6	5	4	3	2	1	0	
0		01	(DL)(N)		(F)	0	0	= DB7 Reset
0		01	(DL)(N)		(F)	0	1	= DB7 Set

4.3.9.3.1.8.5 Display Illumination

To enable display reading in conditions of insufficient lighting, an electroluminescent light set beneath the display module provides a greenish illumination for the display.

The electroluminscent light requires a high-voltage AC supply. The 600 Hz rectangular wave from the baud generator is used for this purpose. Because of lifetime limitations, a light-dependent resistor (LDR) is used in the El supply circuit. This turns OFF the illumination when there is sufficient light for reading. Transistor Q5 forms a level converter, 5V to 12V, and the power stage consisting of transistors Q3 and Q4 feeds a 12Vpp rectangular wave to the transformer via capacitor C8. Transformer Tl raises the voltage to approximately 160Vpp for the El light.

4.3.9.3.1.8.6 Display Heating

Because the lowest operating temperature of the LCD display is -20°C, a display-heating arrangement is necessary in conditions of extreme cold.

The heater element is attached to the steel frame of the display by self-adhesive tape for immediate conduction of heat to the LCD module. The method avoids heating the terminal itself and a sufficient temperature rise (about +40°C) is obtained using a power of approximately 2.5 W. This keeps the display operating down to an ambient temperature of about -60°C. On the other hand, display temperature must not be allowed to rise above +60°C. A temperature sensor (Ul) in the heater control circuit has been provided to measure the temperature inside the case. Ul is a semiconductor sensor giving an output voltage proportional to temperature (10mV/°K).

Circuit U3 forms a comparator connecting base current to the Darlington transistor, Ql, when the voltage over the temperature sensor Ul is less than the voltage produced by the voltage divider, R15 and R16. A hysteresis of approximately 100mV at the comparator, brought about by resistor R14, corresponds to a temperature of approximately 10°C. The nominal heater switch-on and switch-off temperatures are:

- Switch-on: -12°C (10°F)
- Switch-off: - 2°C (28°F)

Ql base current is determined by resistor R10 and the base-emitter junction of Ql is protected against negative voltages by diode D2. Heating power is adjusted by resistor R3. The heater element resistance is 50 ohms. With the R3 value of 8.2 ohms, heating current is 205mA and power is 2.5 W.

4.3.9.3.1.8.7 Initial Reset Circuit

The initial reset circuit is comprised of D-register, U7, resistor RAl/l-2, and capacitor C14. When power is turned ON and the 5V supply goes up, Cl4 is charged via resistor RAl/l-2. The clock input of the D-register is connected to ground; likewise, input R. When input S is also zero, the register is set into state 1. As voltage at Cl4 goes up, input W/ is turned into state 1, whereupon the register is reset by input R/. The duration of the reset pulse is determined by the RC time constant of approximately 50ms.

The reset pulse functions are:

- Reset DB7 Bit
- Inhibit Key-In Display
- Inhibit DB7 Bit Setting
- Reset UART Circuit
- Reset Baud Clock Counter

The voltage of the initial reset circuit is also brought to test connector J10, pin 10.

4.3.9.3.1.8.8 + 5V Supply

The supply voltage of the terminal is + 12V. From this voltage, the logic supply voltage is produced by an adjustable linear regulator (U2). The voltage is determined by resistors R12 and R13 which also perform the function of minimum-load for the circuit. Capacitors Cl, C2, C3, C12, C13, C15, and C16, are filter capacitors for the logic circuits. The +5V operating voltage is brought to test connector J10, pin 3.

4.3.9.3.1.8.9 -9V Supply

A negative voltage is generated for display biasing and the RS-232C interface. The -9V supply voltage is produced from the + 12V DC supply by first creating a 153.6 kHz AC voltage (transistors Q6 and Q7) and rectifying it (diodes D10 and Dll).

The voltage passed on to the display is formed by first limiting the negative voltage to -5V by means of a zener diode. The trirmner, R22, enables adjustment of the display biasing voltage within the range -5.lV to +5.lV.

4.3.9.3.2 Connection Signals

Connector El terminals, interface signals, colors, and the MS-connector pins, of the standard interface cable of CTH 12 are:

Table 4. Signals of CTH 12

El Terminal	Signal	Color	MS Pin	Explanation
1	(Not Used)	-----	---	-------------------
2	TXD	Brown	B	Data In (To Terminal)
3	RXD	Red	C	Data Out (From Terminal)
4	(Not Used)	-----	---	-------------------
5	(Not Used)	-----	---	-------------------
6	FLAG	Blue	G	Signalling of Maintenance Terminal Presence
7	GND	Green	F	Common Ground
8	+ 12V	White	H	Power Supply
9	(Not Used)	-----	---	-------------------
10	(Not Used)	-----	---	-------------------

Table 4. Signals of CTH 12

4.3.9.3.3 Jumper Settings

The following Table presents the internal jumpers of CTH 12:

Table 5. Setting of the CTH 12 Jumpers

Symbol	Connection	Function
J4	None	RS-232C Levels (Standard)
	1-2	Not Used
J5	l-2	RS-232C Levels (Standard)
	2-3	Not Used
J6	1-2	2400 Bd Baud Rate
	2-3, 3-4	1200 Bd Baud Rate
	4-5	300 Bd Baud Rate (Standard)
J7	l-2, 4-5	Normal Operation (Standard)
		Others Reference "Operation Testing"
J9	None	Normal Operation (Standard)
	1-2	Reference "Operation Testing"

Table 5. Setting of the CTH 12 Jumpers

4.3.9.3.4 Operation Testing

The operation of the CTH 12 Maintenance Terminal is easily tested with the internal on-board jumper settings.

Test connector J10 provides most of the major operational signals for the testing. These signals are listed in Table 6.

Jumper J9 internally connects the TXD and RXD signals for testing purposes.

Test connector J7 provides access to the character coding at the input pins TBR5, TBR6, and TBR8, of the UART.

The self-contained functional test of the CTH 12 is performed as follows:

- Connect J9 — Signals TXD and RXD are connected together. No external RS-232C I/O source shall be connected to the CTH 12.
- Connect J7 Pins: **2-3, 4-5**
- Press Symbol: “F’ on Keyboard
- Connect J7 Pins: 1-2, 5-6
- Press Symbols: **"0...9"** and "A...F"

The display of CTH 12 shall now contain the following characters:

0 1 2 3 4 5 6 7 8 9 : ; < = > ?

If such a string does not appear in the display, the operational test has failed, and the CTH 12 needs service.

Table 6. Test Connector J10 Signals

J10 Pin	Signal
1	GND
(removed)	(none)
3	+5
4	E-Signal (Enable) for the Display Subassembly
5	DA-Signal (Data Acknowledgement) of Keyboard Encoder
6	**-9V**
7	TRO (Transmitter Register Output) from UART
8	Baud Generator Frequency (16 x Baud Rate)
9	RRI (Receiver Register Input) to UART
10	Reset-Signal from Reset Logic

Table 6. Test Connector J10 Signals

4.3.9.4 Parts List

Reference	Number	Description
	10022	Box Vero 75-3019J, - Hole Dwg. CT 4269
	2729	Front Panel
	2730	Instructions Label
	5612	Keyboard, Grayhill 88BB2-062

2725 Component Board Subassembly

Ul	1832	Integrated Circuit NS LM335H
U 2	1016	Integrated Circuit NS LM317LZ
U 3	2456	Integrated Circuit NS LM124
U 4	3216	Integrated Circuit, Intersil IM64021PL
U5	1056	Integrated Circuit 74HC132
U6	2983	Integrated Circuit 74HC27
U 7	1910	Integrated Circuit 74HC74
U8	2977	Integrated Circuit 74HC4060
U 9	5411	Integrated Circuit NS 74C922N
Ql	1384	Transistor,TIP120 Darl. NPN 60V 5A
Q3,Q5-Q7	5416	Transistor 2N2222A NPN 40V 800mA
Q4	0285	Transistor 2N2907A PNP 40V 5OOmA
Q2	----	(Unused)
Dl	0555	Diode Bridge Varo VM28 140V 1A
D2,D9-D11	3884	Diode lN4148 75V 200mA
D5	1237	Transient Zener, Thomson BZW-06-15 15V 0.6 Ws
D12	4171	Zener Diode lN751A 5.1V 5% 0.4W
D3,D4	----	(Unused)
D6...D8	----	(Unused)
Zl	3846	crystal 2.4576 MHz HC-6/U

Rl, R15, R23	5791	Resistor Metal Film, 3k32 1% 50ppm 0.25W
R2	3853	Resistor, Light-Dependent (LDR), Silonex NSL493 1
R3	1902	Resistor, Wirewound 8R2 5% 5W
R4	----	(Unused)
R5, R9, R21	3163	Resistor Metal Film, 10R 1% 50ppM 0.25W
R6, R13	5118	Resistor Metal Film, 332R 1% 50ppM 0.25W
R7, R8	----	(Unused)
R10, R12, R19	6375	Resistor Metal Film, lk 1% 50ppM 0.25W
Rll	----	(Unused)
R14	3191	Resistor Metal Film, 332k 1% 50ppM 0.25W
R16	1297	Resistor Metal Film, 3k83 1% 50ppM 0.25W
R17, R18	----	(Unused)
R20	5388	Resistor Metal Film, 10k 1% 50ppM 0.25W
R22	6372	Trimpot, 10k 0.5W l-turn CE Beckman 72P
R24	5434	Resistor Metal, Film 5M6 1% 50ppM 0.25W
RAl, RA3	0057	Resistor Array, 4xl0k 2% Separ. SIL 8 pin, Bourns 4608X-102-103
RA2	0965	Resistor Array 5x4k7 2% Separ. SIL 10 pin, Bourns 4610X-102-472
RA4	4989	Resistor Array, 4xlk 2% Separ. SIL 8 pin Bourns 4608X-102-102
Cl,C8 C10, Cl1 and Cl4	6920	Capacitor, Tantalum, 10µ 20% 35V ITT TAG,
C2, C3, C12, C13, C15, C16, and Cl9	0977	Capacitor, Polyest, 100n 10% 63V EVOX MMK05
C4, C5, and C7	4802	Capacitor, Polycarb., 1n 10% 100V EVOX CMK5
C6	1287	Capacitor, Al. El., 100µ 25V, Siemens B41326-A5707-V
C9, C20	10008	Capacitor, Polyest., 1µ 10% 50V EVOX MMK05
C17, Cl8	5726	Capacitor, Ceramic, 22p 2% NPO 63V, Phillips 2222-681-10229

T1	10013	Transformer, 220V/8V 0.2VA Spitznagel SPK 2202
E1	6377	Terminal Block, 3-pole, Lumberg KRE 3
J1, J2, and J5...J10	5498	Connector Pin Strip, 0.1"/0.025" square, Au, Phillips F095 (32-pin stock)
J3	1399	Connector 2 pos., AMP 5203152, Foil Receptacle
J4	----	(Unused)
P5, P6, and P7A, P7B	5143	Jumper, 2 pos, 0.1"/0.025" square, Au, Phillips F088

2726 Cable Subassembly

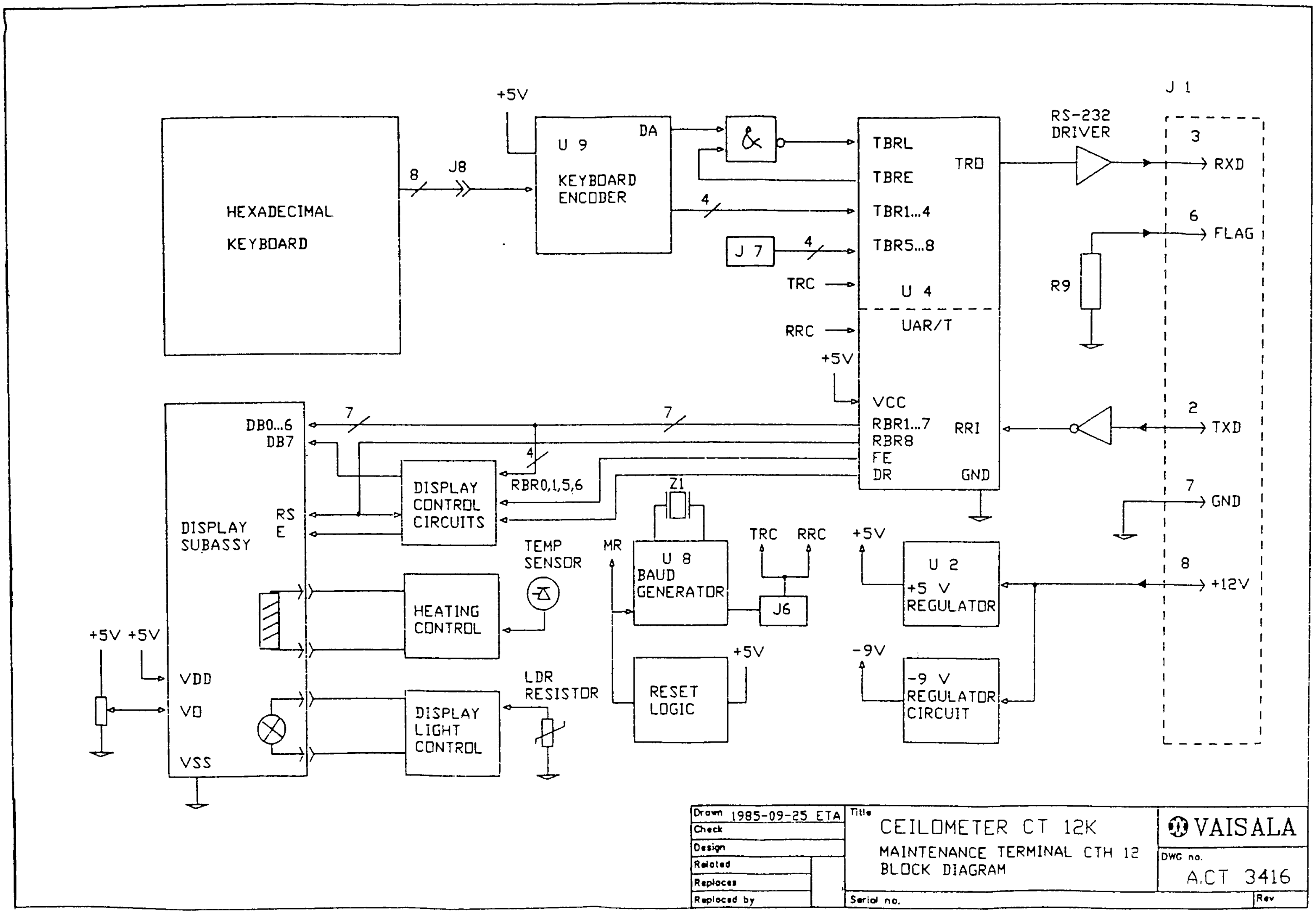
2924	Connector	MS3116F12-8P
2946	Connector, Cap	MIL-C-26482 size 12, Cable Side
100045	Cable	8xAWG 18, Alpha 45068
4014	Terminal Bush	AWG 18, Abiko 7575

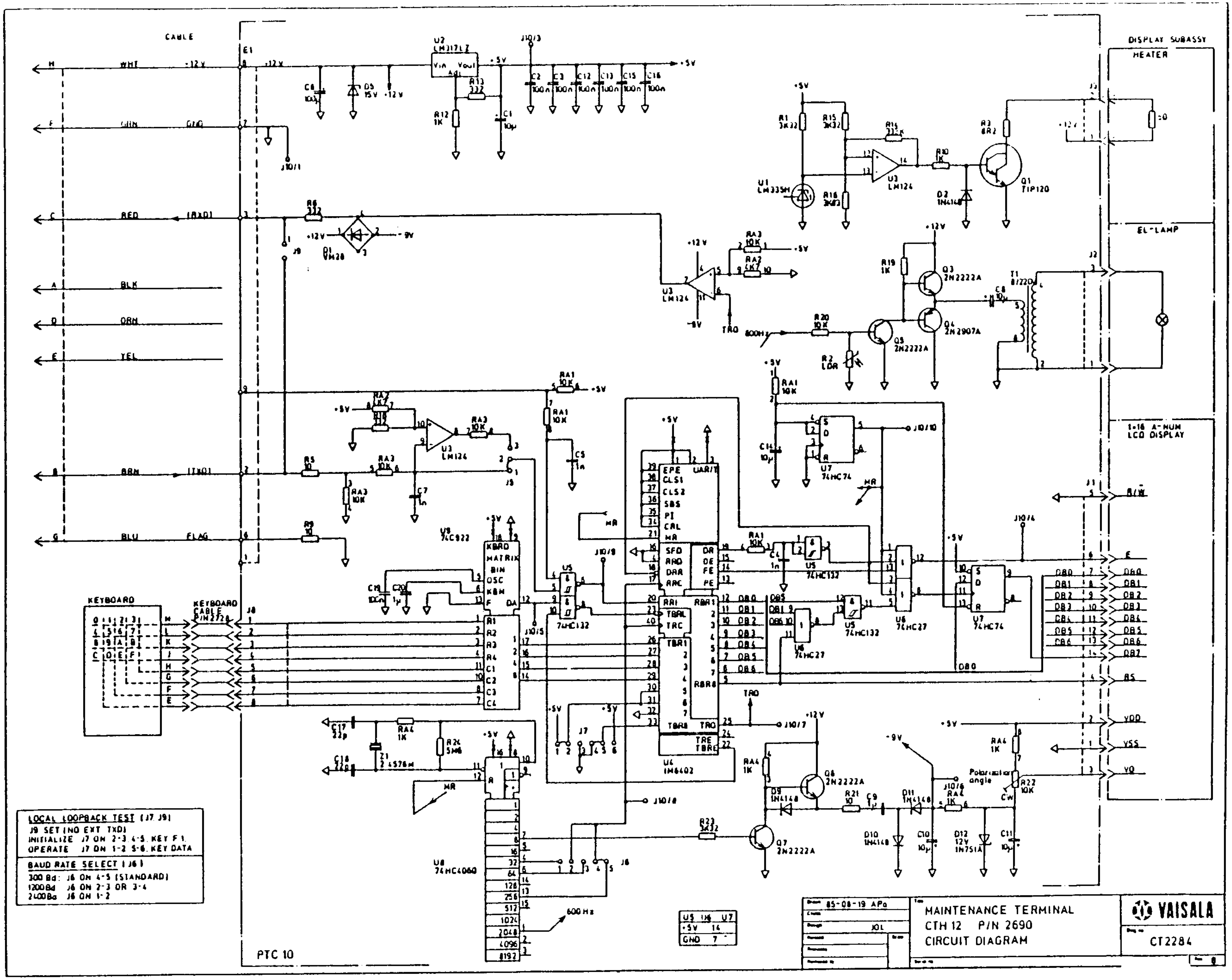
2727 Display Subassembly

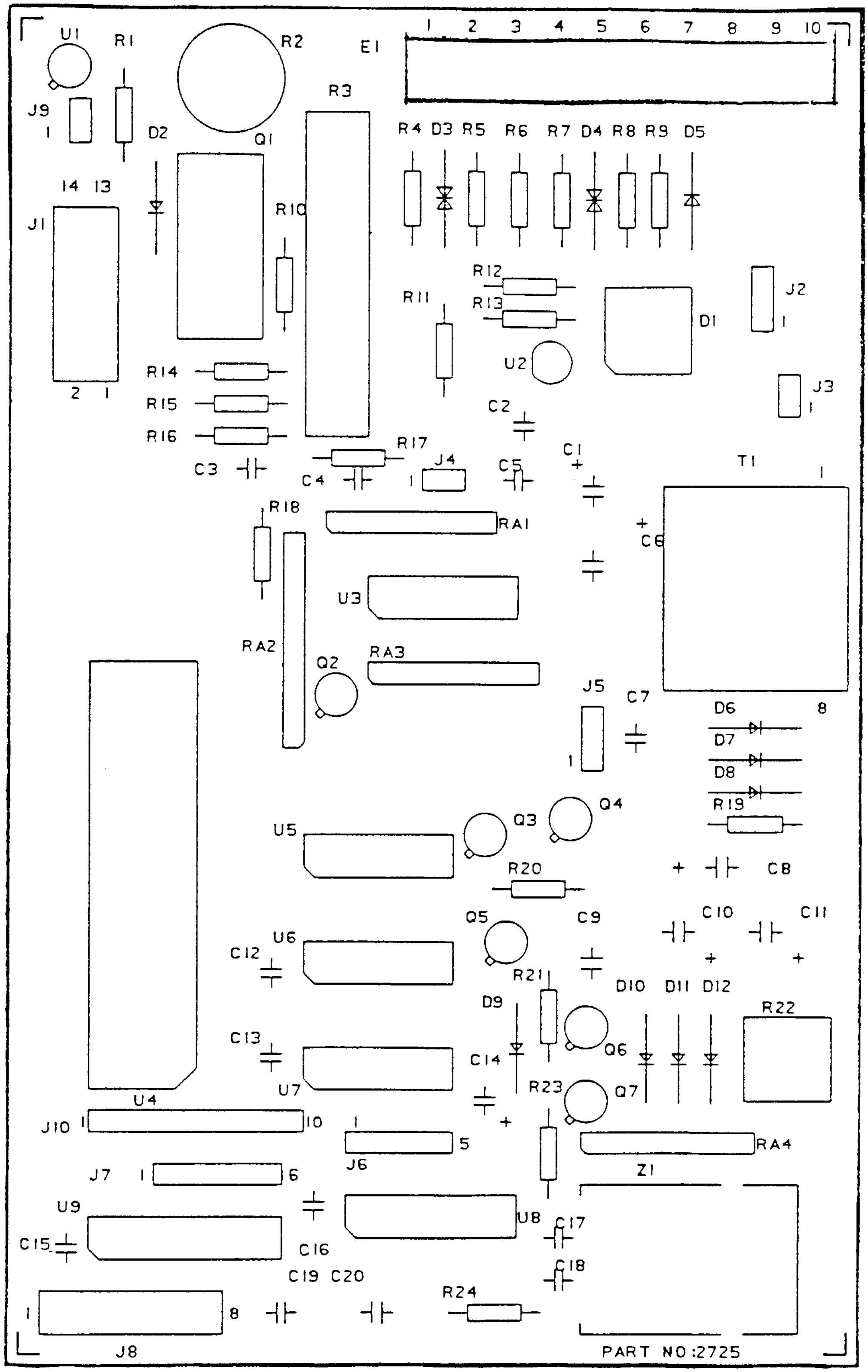
2871	LCD Display Module, Densitron LM12B1C16CB(H)
2718	Heating Foil
2964	Connector, 1x3 pos. 0.1", Berg 76308-103
2965	Connector, 2x7 pos. 0.1", Berg 76314-107

2728 Keyboard Cable Subassembly

Pl, P2	6433	Connector, 16 pos., Ribbon Cable Header, Yamaichi FAS-1601-2101-OAF
	10044	Polarizing Pin, Yamaichi No. 2/FAS
	0571	Ribbon Cable, 16xAWG28, Spectrastrip 455-044-16


HEXADECIMAL
KEYBOARD
8
J8
+5V
U 9
DA
KEYBOARD
ENCODER
4
&
J 7
4
TBRL
TBRE
TBR1...4
TBR5...8
TRD
TRC
U 4
UAR/T
RRC
+5V
VCC
RBR1...7
RBR8
FE
DR
RRI
GND
RS-232
DRIVER
J 1
3
RXD
6
FLAG
R9
2
TXD
7
GND
8
+12V
DB0...6
DB7
7
7
4
RBR0,1,5,6
DISPLAY
CONTROL
CIRCUITS
RS
E
DISPLAY
SUBASSY
HEATING
CONTROL
TEMP
SENSOR
DISPLAY
LIGHT
CONTROL
LDR
RESISTOR
+5V +5V
VDD
VO
VSS
MR
Z1
U 8
BAUD
GENERATOR
TRC
RRC
J6
RESET
LOGIC
+5V
+5V
U 2
+5 V
REGULATOR
-9V
-9 V
REGULATOR
CIRCUIT
Drawn 1985-09-25 ETA
Check
Design
Related
Replaces
Replaced by
Title
CEILOMETER CT 12K
MAINTENANCE TERMINAL CTH 12
BLOCK DIAGRAM
VAISALA
DWG no.
A.CT 3416
Serial no.
Rev


CABLE
DISPLAY SUBASSY
HEATER
EL-LAMP
1x16 A-NUM LCD DISPLAY
KEYBOARD
KEYBOARD CABLE P/N 2726
PTC 10
LOCAL LOOPBACK TEST (J7, J9)
J9 SET (NO EXT TXD)
INITIALIZE J7 ON 2-3, 4-5, KEY F 1.
OPERATE J7 ON 1-2 5-6, KEY DATA
BAUD RATE SELECT (J6)
300 Bd: J6 ON 4-5 (STANDARD)
1200 Bd J6 ON 2-3 OR 3-4
2400 Bd J6 ON 1-2
85-08-19 APa
JOL
MAINTENANCE TERMINAL
CTH 12 P/N 2690
CIRCUIT DIAGRAM
VAISALA
CT2284



Drawn	Title	CTH 12/COMPONENT BOARD P/N: 2725 COMPONENTS LAYOUT	VAISALA
Check			Dwg no.
Design			
Related	Scale		
Replaces			
Replaced by		Serial no.	Rev

CHAPTER 5. PERIODIC MAINTENANCE
TABLE OF CONTENTS

5.1 MONTHLY CHECK OF MESSAGE ALARMS

Check that the data message contains no alarms; see paragraph 6.1.1. If there are alarms, proceed to troubleshoot following section 6.

5.2 90 DAY CHECK OF WINDOW CLEANLINESS AND CLEANING PROCEDURE

WARNING! *DO NOT LOOK INTO CEILOMETER OPTICS WTH MAGNIFYING GLASS, BINOCULARS OR OTHER MAGNIFYING OPTICS DURING THE COURSE OF PERFORMING THE PROCEDURE BELOW*

Inspect the cleanliness of the ceilometer windows. If they are definitely unclean (e.g. film, streaks, or particles), perform cleaning as detailed below. Otherwise, do not.

A Unplug Window Conditioner connector J2; loosen four (4) knurled screws holding Window Conditioner to Equipment Cover, and remove Window Conditioner.

B. Gently dust off all loose particles from the windows with dry cleaning cloth of Field Spares Kit, or preferrably with soft brush.

C. Soak the window surfaces in cleaning alcohol included in the Field Spares Kit. Let soak for a few minutes.

D. Gently wipe off liquid with cleaning cloth. Do not rub. Avoid scratching the surface. Turn cloth and gently wipe until dry.

E. Replace Window Conditioner. Be sure to tighten all four (4) knurled screws well. Reconnect connector to J2.

F. Wash cleaning cloth,

5.3 MONTHLY CHECK OF WINDOW CONDITIONER BLOWER

In connection with Window cleanliness check, observe the performance of the Window Conditioner Blower by listening to its sound and feeling the air flow to detect signs of wear. If necessary, use the following commands:

AUTO OFF
BLOW ON
- -
AUTO ON
CLOS

to control the blower.

If heating is ON, observe that the temperature difference between Blower (TB) and Ambient (TE) is approximately 7°C (=OK). A significantly higher difference is a sign of reduced blower efficiency.

CHAPTER 6. TROUBLESHOOTING AND REPAIR
TABLE OF CONTENTS

THE TROUBLESHOOTING AND REPAIR SHOULD BE DONE AS FOLLOWS:

A. Identify the symptoms of a fault from the alternatives of Chapter 6.1, "Diagnosis," listed in the manual's Table of Contents.

B. Go to the Paragraph in question and determine the suspect LRU.

C. Go to the Paragraph in Chapter 6.2, "Verification and Replacement," which covers the suspect **LRU.** Verify that it is faulty and replace it.

6.1 DIAGNOSIS

6.1.1 DATA MESSAGE CONTAINS AN ALARM

The first line of the Data Message is Status Line 1. The general format is as follows:

$NSB\_H_1H_1H_1H_1H_1\_T_1T_1T_1T_1T_1\_H_2H_2H_2H_2H_2\_T_2T_2T_2T_2T_2\_S_1S_2S_3S_4S_5S_6S_7S_8S_9S_{10}$(CRLF)

For full interpretation, turn to Section 3.2. The "S" bits and the "B" indicator are the instrument status indicators of the unit. Their interpretation is as follows:

S = 0 No Status Bit Sl...S4 ON for more than 5 minutes

S = 1 At least one Status Bit S1...S4 ON for more than 5 minutes

B = Space if S = 0

B = "Bel" character if S = 1. Because "bel" is an invisible character, the alarming line appears one character shorter than normal in a printout.

Status Indicators:

S_1 =	Hardware Alarm
S_2 =	Supply Voltage Alarm
S_3 =	Laser Power Low
S_4 =	Temperature Alarm
S_5 =	Solar Shutter ON
S_6 =	Blower ON
S_7 =	Heater ON
S_8 =	0 = Unit is Feet 1 = Unit is Meters
S_9 =	0 = Data of internal Table 2 is Height-Square Normalized Only 1 = Data of internal Table 2 is Height-Square and Extinction Normalized
S_{10} =	Fast Heater Off is active

Identify the alarm from the following alternatives and proceed to the Paragraph in question:

6.1.1.1 if Status bit S_1 is "1" signalling General Hardware Alarm

6.1.1.2 if Status bit S_2 is "1" signalling Voltage Alarm

6.1.1.3 if Status bit S_3 is "1" signalling Laser Power Low Alarm

6.1.1.4 if Status bit S_4 is "1" signalling Temperature Alarm

The fault in question may cause two or more bits to be "1." The order of troubleshooting is arbitrary. After each single repair action, operation shall be checked. When all Status bits S_1 to S_4 are "0" proceed to observe operation as a whole.

6.1.1.1 Status Bit S_1 is "1" signalling General Hardware Alarm

Connect a terminal to the Ceilometer. Open line for dialogue and request Status (STA). The Status will contain one or more of the following messages. Identify it and proceed to check the corresponding LRU:

Message	Suspect LRU
SKY MONITOR SUSPECTED	A5, A6, or Al
AD MONITOR ERROR	Al
SEQUENCE ERROR	Al
INTERNAL HEATING SUSPECTED	Tl, Rl, R2, Al, or A2
BLOWER/HEATER ERROR	B1, PS1, TS1, or Al
SHUTTER CONTROL SUSPECTED	Kl, A5

In case none of these applies, command **RESET** or toggle switch AlSl or turn power off/on by PSl CBl for a moment. Wait, and observe one of the following messages. Identify it and proceed to check the corresponding LRU:

Message	Suspect **LRU**
EX XXXXX XX XX 1)	Al
OFFSET ERROR	Al
AMPLIFIER ERROR	Al
NOISE ERROR	Al, A6 or W8
SEQ RAM NOT CLEARED	Al
SEQ PULSE COUNTER ERROR	Al
ANALOG MONITOR ERROR	Al
LASER POWER LOW	A7, A5, Kl, or PSl
SEQUENCE HALT	Al
MODEM ERROR	A3, Al
EEPROM ERROR	Al

If no error message is obtained, the fault may be intermittent. Reset Ceilometer and observe for proper operation.

Note 1: X's may be any hex character O...F.

6.1.1.2 Status bit S_2 is "1" signalling Supply Voltage Alarm

Connect a terminal to the Ceilometer. Open line for dialogue and request Status (STA). The Status will contain one or more voltages being below the alarm limit (refer to ALIM command), pinpointed by an asterisk ("*") after the voltage value.

If voltage is within boundaries of table below, check Alarm Limits (ALIM). If these are okay, suspect (e.g.) temporary Line Voltage dip or intermittent connector fault.

Voltage Reference	Nominal Value	Alarm Limit (Low)	Acceptable High Value
P20I	+ 20V	+ 15 V	+ 24V
P10X	+ 10V	+ 7.5V	+ 12V
M20A	- 20V	-15 V	- 24V
P10R	+ 10V	+ 7 V	+ 13V
MRHV	-300V (1)	-150 V	-450V
P12M	+ 12V	+ 8 V	+ 15V
P10D	+ 10V	+ 6.5V	+ 12V
P25V	+ 25V	+ 20 V	+ 30V
PXHV	+ 130V (1)	+ 52 V	+ 200V
P20A	+ 20V	+ 15 V	+ 24V
M20I	- 20V	-15 V	- 24V

Note 1: These voltages are individually adjusted at 72°F (22°C) to values found on the respective boards.

If voltage is out of limits, proceed to check the following:

Voltage low	CHECK FUSE(S)	VOLTAGE AT TEST POINT	AC INPUT AT A2	LOADING BY
Pl0D	A2, F3	A2TP4	D 8: 3-4; 8 UAC	Al
P20I	A2, F6, or F7	A2TP3	Dll: 3-4;30 VAC	Al, or A3
M20I	A2, F6, or F7	A2TP2	Dll: 3-4;30 UAC	Al, or A3
P25V	A2, Fl	A2TPl	D 2: 3-4;20 VAC	R1, R2, Al, A5, or PSl (SUPPLY: Tl)
M20A	A2, F4 or F5	A2TP5	Dl0: 3-4;30 VAC	Al
P20A	A2, F4 or F5	A2TP6	Dl0: 3-4; 8 VAC	Al
P12M	A2 F8	A2TP7	D12: 3-4;10 VAC	Al or A3 MAINTENANCE TERMINAL
Pl0X	A2 F9	A2TP9	D13: 3-4; 8 VAC	Al or A7
PXHV	PSl Fl	PSlAlJ8:1-3	----------	A7
Pl0R	A2 F2	A2TP8	D 8: 3-4; 8 VAC	Al or A6
MRHV	PSl F2 and PSl:TPl-TP2	A6:TPI-TPGND	----------	A6

General Troubleshooting Guide:

1. Replace fuse, if blown.

2. Remove loading, if fuse repeatedly blows.

3. Suspect A2, if fuse blows without load; except for PXHV and MRHV, suspect PSl.

4. Replace subassembly in question, if identified as cause of fuse blowing.

5. Suspect A2, if voltage at test point is low and AC input is okay; except for PXHV and MRHV, suspect PSl.

6. Suspect PSl, if single or a few AC inputs are low and line input is above 103 VAC; except for P25V, suspect Tl.

7. If PXHV at PSlJ8 is above the limit but alarm persists, check GND connection through W9 and replace W9 or part with bad connector.

8. If MRHV at PSlAl, TPl-TP2 is above limit but alarm persists, check GND connection through W8 and replace W8 or part with bad connector.

9. If all voltages are okay but alarm persists, suspect Al.

10. If line voltage is below 103V, a problem may exist with the line voltage. Check the line for proper operation.

6.1.1.3 Laser Power Low Alarm

6.1.1.3.1 Laser Power (LLAS) is close to zero

Check to see that:

- Supply Voltages are Okay
- Nothing prevents the Light Monitor Board A5 photodiode Dl from seeing the lens (e.g., solar shutter)
- The laser normal (LNOR) parameter value has been entered properly and is the same as the factory-calibrated value marked on the Transmitter Board. Verify LNOR with commands LNOR or PAR. See Section 3.3.
- Voltages and waveforms of transmitter board A7 are correct. See Section 6.2.7. If not, recheck supply voltages and check trigger pulse from Al via W9. If voltages and trigger pulse are okay, suspect A7.

If above checks do not indicate a fault, tilt the Ceilometer toward an obstruction within a few thousand feet.

WARNING!, *MAKE SURE THAT NOBODY VIEWS CEILOMETER FROM CLOSE DISTANCE WITH BINOCULARS OR MAGNIFYING OPTICS.*

If a distance reading is obtained, proceed to check A5 according to 6.2.4 and its signal path to Al through A2. Replace faulty board.

Note: If a solar shutter is in place, tilt the Ceilometer so that the shutter does not cover the transmitter lens by its own weight.

6.1.1.3.2 Laser Power (LLAS) is Below Alarm Limit But Not Close to Zero

Note that processor uses maximum pulse frequency (i.e., FREQ is 7).

Note the Laser Temperature, TL. It should be below +60°C (+ 140°F). If not, allow the laser to cool by interrupting operation for a period (AUTO OFF). Check temperature and laser power again.

If temperature is well below +60°C (+ 140°F), readjust the Laser Supply voltage according to Paragraph 6.1.1.3.3 If the alarm remains on, replace A7.

6.1.1.3.3 Laser Power Adjustment

Perform this adjustment only at an ambient temperature + 60°F... + 80°F (15°C...27°C).

Remove equipment covers. Remove transmitter board A7 cover.

WARNING! HIGH VOLTAGE!

Check PAR output message for LNOR value.

Connect voltmeter between TP3 and GND. Increase voltage by adjusting R2 1.

Ceilometer in Maintenance Mode, Frequency 3, Laser on, Sequence on.

Increase voltage towards a maximum of 160V until the LLAS value in status message equals LNOR-5.

A typical procedure would be as follows:

1) Increase voltage with R21;
2) Open line, command AUTO ON, close line;
3) Allow time to stabilize;
4) Check LLAS = LNOR-5
5) Repeat, if necessary.

6.1.1.4 Temperature Alarm

Temperatures are expressed in degrees Centigrade (= Celsius). Equivalent degrees Fahrenheit is:

$$T(°F) = 1.8 \times T(°C) + 32$$

or inversely:

$$T(°C) = \frac{T(°F) - 32}{1.8}$$

A Temperature Alarm occurs if the reading EXCEEDS the preset alarm limit. An open circuit will cause a HIGH temperature reading, approximately 200°C equalling a voltage of 5V.

The output of an operational temperature sensor will be:

$$V = T(°K) \times 10mV, \quad \text{where } T(°K) = T(°C) + 273$$

equalling

$$V = \left(\frac{T(°F) - 32}{1.8} + 273\right) \times 10mV$$

Typical values are:

T/°F	T/°C	Sensor Voltage/V
140	60	3.33
104	40	3.13
68	20	2.93
32	0	2.73
-4	-20	2.53
-40	-40	2.33

6.1.1.4.1 Troubleshooting

Connect a terminal to the Ceilometer, open the line for dialogue by requesting status (STA). This will contain one or more temperatures above the alarm limit (see ALIM command) pinpointed by an asterisk ("*") after the temperature value (e.g., too large a difference between ambient temperature and blower temperatures (TE, TB) - see Section 3.5.2.2).

If temperature is within the limits of Table below, check Alarm Limits (ALIM). If these are okay, suspect an intermittent connector fault.

Temperature Reference	Normal Range After Stabilization	Alarm Limit (High)
TE	Ambient -0°C... + 5°C (32°F...41°F)	100°C (212°F)
TI	Ambient + 5°C... + 15°C above 0°C (41°F...59°F)	100°C (212°F)
	Ambient + l0°C... + 30°C below 0°C (50°F...86°F)	
TL	TI -5°C... + 5°C (23°F...41°F)	70°C (158°F)
TB	TE +0°C... +20°C in sunshine (32°F...68°F) with Blower off, Heater off	80°C (176°F)
	TE +0°C...+5°C (32°F...41°F) with Blower on, Heater off	
	TE + 5°C.. + 10°C (41°F...50°F) with Blower on, Heater on	

Stabilization times are in the order of minutes for TE and TB; and, in the order of hours for TI and TL.

If, after sufficient stabilization, the temperature is out of range, identify the type of error from the following alternatives and proceed to the Paragraph in question:

6.1.1.4.2 Temperature Close to +200°C (392°F) Indicating Open Circuit

6.1.1.4.3 Temperature AIarm with Credible Values

6.1.1.4.2 Temperature Close to +200°C (392°F) Indicating Open Circuit:

CHECK

TL
A7 TP6-TP5
A2 Jl:A13-Cl3
Al U15:12
Connectors A7J2, A2J8, A2J1, AlJl
Cable W7

TE
TSl Ul
A2 J9:1-2
A2 Jl:a14-cl4
Al U15:13
Connectors TSlPl, A2J9, A2J1 AlJl

TI
Al U16, Al U15:15

TB
Bl E1:8-9
A2 Jl:a15-cl5
Al U15:14
Connectors BlE1:8-9; BlPl; W2J2; W2Pl;
PSlJ2; PSlP2; A2Jll; A2Jl; AlJl
Cables W2; BlWl

REPLACE NON-CONDUCTING PART.

IF NO FAULT IS FOUND BUT ALARM PERSISTS: SUSPECT Al.

6.1.1.4.3 Temperature Alarm with Credible Values

n exceeds 70°C (158°F)	If ambient temperature is close to 120°F (49°C) and solar radiation is intense, check that the Window Conditioner Blower (Bl) operates and heating is OFF. If not so, then proceed to check the Window Conditioner.
TB exceeds 80°C (176°F)	Probable Cause: Window Conditioner Blower does not operate; Heater does. Proceed to check Window Conditioner.

or

TB-TE exceeds 40°C (72°F)	Probable Cause: Window Conditioner Blower does not operate; Heater does. Proceed to check Window Conditioner.

6.1.1.4.4 Gifft RBC Recorder Signals Alarm

If the PROJ lamp of the Gifft RBC Recorder signals an alarm by blinking or not being lit at all, connect a terminal to the Ceilometer and proceed according to Paragraph 6.1.1.

6.1.1.4.5 Gifft RBC Recorder Operation Improper or Missing

First check that Ceilometer is in mode AUTO ON. If yes, then proceed.

At Recorder site:

Command Ceilometer to output Recorder test pattern commands:

AUTO OFF

RECT

Observe Recorder and Voltmeter or Oscilloscope connected to the Trigger Break and Cloud Signal (inscription) to determine which, if any, of the circuits are faulty. Trigger Breaks should open for 80ms every 12s permitting the line voltage to raise to approximately 90V for 80ms. The Cloud Signal should be intermittently 120Hz, typically 0.5 VAC to 1.5 VAC, 160ms ON/160ms OFF, for 3 seconds after the Trigger Break, starting with an ON period.

If operation was faultless and a missing Cloud Signal caused the initial concern, proceed to Paragraph 6.1.4, "Cloud Detection Missing."

If one or both of the circuits failed to operate, abort Recorder Test by pressing the ESC (ESCape) key.

6.1.2 FSK INTERFACE OPERATION IMPROPER OR MISSING

6.1.2.1 No Message

Check at Remote (Receiving) end:

- With Receiving circuitry disconnected, check presence of carrier with AC voltmeter. Voltage should be in the 0.1V...1.0V range.

- If voltage is close to zero, measure loop resistivity with an ohmmeter. Resistance should be approximately:

  50 ohms with short line

  1600 ohms with 10-mile line (AWG 22)

  If not, proceed to check the line.

  Note: If a terminal is connected, ohmmeter may not give credible values.

- With terminal connected, attempt to open line with RETURN character. If successful, check that AUTOMATIC MODE is ON (AUTO command). If not, set AUTO ON and CLOSE line. If unsuccessful at any stage or messages are still missing, proceed to check the Ceilometer.

At the Ceilometer:

- Connect a Maintenance Terminal and observe if messages are sent. Observe TXD LED on A3 if lighting conditions permit.

- If messages are not being sent, check that Ceilometer is in AUTOMATIC MODE. If not, set AUTO ON. If unsuccessful or if messages are still missing, suspect A1.

- If messages appear on Maintenance Terminal, check A3 according to Section 6.2.3. Replace, if faulty.
- If A3 is okay, check connection through W3 and external connections.
- If fault cannot be localized at Ceilometer, check Receiving end connections and equipment.

6.1.2.2 Message Improper

- Check line resistivity as in Section 6.1.2.1.
- Check for abnormal interference in line.
- At the Ceilometer, observe with Maintenance Terminal that message is proper. If not, suspect Al.
- Raise Transmit Level of A3 to maximum. If messages remain improper, suspect A3.
- If still not successful, proceed to check line and receiving equipment.

6.1.2.3 Remote Dialogue Not Operating

- Check with Maintenance Terminal at Ceilometer. If dialogue operates, proceed to check A3 according to Section 6.2.3. Replace, if faulty. If dialogue does not operate, suspect Al.

6.1.3 LOCAL RS-232C INTERFACE OPERATION IMPROPER OR MISSING

- If the FSK (Modem) interface is operational, check the RXD, TXD and GND connections via connector J4, harness W4, and board A2. If Maintenance Terminal CTH 12 is used, check further the + 12V supply (P12M) and the FLAG signal. The latter shall be +5V without terminal through A2 and Al, and OV with terminal connected. Use repeated RETURN characters. These should produce a “LINE OPENED...” message followed by one “prompt” arrowhead for every RETURN. Observe RXD and TXD voltages by oscilloscope to swing from below -3V to above +3V.
- If an FSK interface is not available, check in addition to the above that the Output Interface Board A3 does not short a signal (unplug A3 card temporarily) and extend the signal levels tracing to Processor Board Al. Observe Paragraph 6.2.1.

- Replace board or harness, if found faulty.

- Note that a message being transmitted cannot be interrupted (i.e., dialogue commencement may be delayed for this reason).

6.1.4 CLOUD DETECTION MISSING

If both Gifft RBC Recorder and FSK or RS-232C data messages are available, check that they agree. If not, proceed to the corresponding Paragraphs.

If clouds are present and within range without a doubt, check that:

- Message contains no alarms. If yes, go to Paragraph 6.1.1.

- Parameter settings are intact. If not, restore them.

- LLAS value is not significantly lower than LNOR value, nor significantly higher. If so, proceed to check A7, A5, and Al.

- Ceilometer lenses or windows are not obstructed by anything. If so, clear obstructions.

- Noise values and gain selection are credible (i.e., during bright daytime and clouds present, gain is 0 and noise is 4...10; and, in darkness and twilight with no clouds, gain is 2 and noise is 1...4. If not, proceed to check A6, and Al.

- Status message after start-up, due to local or remote RESET, contains no alarms. If yes, go to Paragraph 6.1.1.

Above noise numbers are read with command NOIS (see Section 3.4) as difference between middle-value and low-value columns. A reliable performance check can be done by tilting the Ceilometer on its pedestal toward a nearby horizontal obstruction.

WARNING! MAKE ABSOLUTELY SURE THAT THE LASER BEAM IS NOT VIEWED DIRECTLY WITH BINOCULARS OR ANY OTHER MAGNIFYING OPTICS!

If the above checks do not reveal cause of malfunction, arrange for full performance check at authorized Depot or Ceilometer manufacturer.

6.1.5 SUPERFLUOUS DETECTION

If repeated mis-hits are experienced without any apparent cause, check that all parameter values are intact.

Perform offset calibration (see Section 6.4).

If problem persists, return Ceilometer to Depot or Manufacturerer for full performance check.

6.2 VERIFICATION AND REPLACEMENT

6.2.1 PROCESSOR BOARD CTM 12 REFERENCE Al

Verification

In many of the failure cases, the malfunction may be caused by temporary interference, confusing the Processor software. To clear abnormal conditions, actuate the RESET switch on Al prior to proceeding with verification. RESET is also achieved by temporarily off/on switching PSlCBl or by RESET command, provided that the device is able to receive commands.

Operating Voltages

Check that the following voltages are inside limits:

J6/8:	+ 5.0V ±0.25V	(+ 5V, Logic Supply)
J5/10:	+ 12.2V ± 0.8 V	(+ 12V, Interface Supply)
J5/9:	-12.2V ±0.8 V	(-12V, Interface Supply)
J9/5:	+ 9.0V ±0.5V	(+ 9V, Flash ADC Supply)
J14/2:	+ 12.7V ±0.8 V	(+ 13V, An. HI Supply)
J19/6:	-12.7V ±0.8 V	(-13V, An. HI Supply)
J19/3:	+ 6.1V ±0.3 V	(+ 6V, An. LO Supply)
J19/4:	- 6.1V ±0.3 V	(- 6V, An. LO Supply)
J6/7:	+ 5.0V ±0.05V	(V5, Mon. ADC Ref.)
J9/4:	+ 8.3V ±0.1V	(RP, Flash ADC HI Ref.)
J9/3:	+ 1.7V ±0.05V	(RC, Flash ADC LO Ref.)
J9/2:	+ 0.9V ±0.1 V	(IN, Flash ADC Input)
J16/10:	+ 7.1V ±0.3 V	(+ 7.1, Level Shifter Source)
J16/9:	+ 1.9V ±0.3V	(+ 1.9, Level Shifter Return)
J19/7:	- 4.3V ± 0.3 V	(AT2, Amp. Test Point 2)
J19/5:	+ 3.0V ±0.5 V	(ATl, Amp. Test Point 1)

All the op. voltages are on-board regulated. Their source supplies can be checked from the STATUS message. Al may also be unplugged to verify the source supplies on A2. +5V and + 12V are fed via A2 to A3 which may overload them. Unplug A3 to detect this.

CPU Status:

Observe the LED indicators on Al. Green LED should be blinking once a second and Red LED should be dark. If not so, check that +5V and its source supply, + l0VD, are inside limits. If they are, replace Al.

Error Messages Concerning Al Internal Onerations:

Reset the Processor and observe one of the following messages:

AD MONITOR ERROR
ANALOG MONITOR ERROR
EX XXXXX XX XX (any hex number 0...F for x)
OFFSET ERROR
AMPLIFIER ERROR
NOISE ERROR
SEQUENCE ERROR
SEQUENCE RAM NOT CLEARED
SEQUENCE PULSE COUNTER ERROR
SEQUENCE HALT
EEPROM ERROR

If any one of these appears, check that the jumpers on Al are installed according to the Technical Description. If they are, and if the source supply voltages are okay, replace Al.

Supplv Voltage Alarm:

First check other units according to Paragraph 6.1.1.2. If all the voltages are correct, replace Al. Notice, however, that if cables W8 and W9 are disconnected or faulty, Pl0X, Pl0R, PXHV, and MRHV, are unmeasureable by Al thus causing an alarm. Even after reconnecting W9, the PXHV reading may be invalid for some time.

Temnerature Alarm:

Check that the negative voltage levels MTE, MTL, MTB, and MTI, correspond to existing temperature (for reference, see Paragraph 6.1.1.4). If they do, but the alarm persists, replace Al. If they don’t, check that sensor source voltage on D2 anode is inside -4.4V to -5.lV. If not, replace Al. Otherwise, suspect the sensor subassemblies and their cables and/or connectors.

Other Alarms:

LASER POWER LOW, with Automatic Mode ON, check the Laser Trigger LTRG (J21/9). This should be high for 60ns approximately every lms. To measure the pulse, use SQO (J21/3) trigger for oscilloscope. LTRG pulse should appear right after the rising edge of SQO. If no pulse seen, unplug W9 from 526. If still not, replace Al; otherwise, suspect W9 or A7. If LTRG is okay, proceed to check LLAS input level. If it is not in conformance with the Laser Power reading, suspect other subassemblies. Otherwise, replace Al.

SKY MONITOR SUSPECTED; check for LSKY input level, that it is in conformance with its corresponding Status reading. If not, replace Al. Otherwise, suspect A5 or interconnections.

SHUTTER CONTROL SUSPECTED; check that signal SSON is low. If not, even after Reset, unplug A5, as it may overload SSON. If still high, replace Al; otherwise, suspect A5 and/or Kl.

BLOWER/HEATER ERROR; enter Maintenance Mode by commanding AUTO OFF. Set Blower ON and OFF by respective commands and check that signal BON is low while ON and open circuit while OFF. Similar check can be used for Heater control signal HON, but it should be noted that Heater shall not be activated by the Processor if the Blower is OFF. When the signals are inactive (open-circuit), +25V should be present at control lines, supplied through the relay coils in PSl.

Communication Lines:

Actuate the RESET switch. The Processor should start sending Status Data onto serial line. Check that voltage level at TXD (A3/5) swings from below + 1V to above +3V. If no data or incorrect levels, replace Al. If okay, proceed to check TXD (Alc22). The level should swing from below -5V to above +5V. If not, unplug A3 and/or Maintenance Terminal, as they overload the line. If correct now, suspect the unplugged LRU. Otherwise, check for shorts on A2 and data cables/connectors. If no shorts found, replace Al.

For data input, check that IRXD (Alc21) and MRXD (Ala21) swing from below zero to above +5V, when commands are transmitted to the Ceilometer. IRXD is supplied by A3 and MRXD by Maintenance Terminal (or equivalent). Note that the lines cannot be used simultaneously; one must be low when the other is active. If the levels are not good, suspect A3 or Maintenance Terminal. Otherwise, proceed to check for levels from below + 1V to above +3V at RXD (A3/6). If incorrect, replace Al.

Modem Control:

Check that both ALB and SQT on Al are logic low (< 1.5 Volts), thus enabling the Modem. If not, unplug A3. If still not, replace Al; otherwise, suspect A3.

Gifft RBC Recorder Control:

Activate Recorder Test according to Paragraph 6.1.7. RBCT should now be activated (high) for 80 ms every 12 seconds and RBCE alternate for 3 seconds thereafter. Check that levels are from below + 1V to above +4V. If not, unplug A3 and repeat the test. If still not, replace Al; otherwise, suspect A3.

Signal Amnlifier:

With cloud detection missing or repeated mis-hits or high offset data base, ‘first check that parameter values are intact and perform Offset Calibration, Section 6.4. If the problem still exists, do the Amplifier test as follows (for reference, see Dwg CT 3536 in the Technical Description):

- Unplug W8 at 522.
- Select Single-Pulse/430ns/AMSl by jumper sets J15/J18/J23, respectively.

Simulated Cloud Base should now be detected at ca. 6500 ft. When Double-Pulse is selected by J15, two ranges of signal should be detected: one at 3300 ft; the other at 9700 ft, the latter qualifying as a cloud base. With a terminal connected, open line for dialogue. Enter Maintenance Mode (AUTO OFF) and command the following:

GAIN 0

MEAS (Device is Busy for 1 Second After This)

TAB 0

Now the signal response will be output to the terminal showing bit numbers for each range gate level. Check that the output is approximately stable 14...17 for the whole range excluding the simulated base level(s). For reference, see the top figure in CT 3536/ TP Response in Sample RAM. If the output numbers are within ±20% of those in the figure (AMSl), proceed to check with the higher gain; commands:

GAIN 2

MEAS

TAB 0

If the readings are okay also for GAIN 2 (figure below the top one), the Amplifier/Converter and Sequence Control most probably are in order, and LRUs other than Al should be suspected.

When returning back to normal operation, set jumpers in J15, J18, and 523, to their original positions, replug W8 to 522, and command AUTO ON.

Replacement of Al

Unplug W8 at J22 and W9 at 526. Unplug Al and replace by spare. Replace W8 and W9. Check that jumpers are set according to specifications in the Technical Description. Switch Power ON and check that Green LED starts blinking. Set LNOR as described in Paragraph 6.2.6. Perform Offset Calibration according to Section 6.4. Check parameters according to 3.3.

6.2.2 UNREGULATED POWER SUPPLY BOARD CTS 12 REFERENCE A2

Verification

Supply Voltages

Check suspect supply voltage AC input from PSl or TSl. Check suspect voltage (DC) at A2 test points and connectors according to 6.1.1.2. Check voltage with and without loading. If loading causes significant reduction, check waveform with oscilloscope. If full or half-wave rectified form is observed, replace A2

Signal Connections

Trace signal connections from connector to connector with an ohmmeter and/or oscilloscope to determine possible break.

Temperature Control Reiavs

- Check that switch Sl on A2 is in position ON.

- Apply temperature differences between l0°F...80°F (-l0°C...-+30°C) with cold spray and fingers to Processor Board Al, temperature sensor U16. Signals RELl and REL2 swing from approximately + 12V to -12V when chilling from 80°F to 10°F; first RELl, then REL2.

If relays operate, the sound can be heard.

- Feel the heat at Temperature Control Heaters Rl and R2. The heating can barely be felt at simulated temperatures between 30°F...70°F (0°C...20°C) but can be felt very well below simulated temperature 30°F (0°C).

If relay drive signals are okay and heaters Rl and R2 have the specified resistivity (see Section 6.2.10), then replace A2.

Replacement

Unplug Al and A3, disconnect all connectors, and unscrew the four (4) screws holding the board to the board frame. Unplug the board from the two (2) plastic standoffs, and use pliers to press plastic springs. Replace in reverse order. Check that the switch positions are: Sl ON, S2 NORMAL.

Perform offset calibration as per Section 6.4.

6.2.3 OUTPUT INTERFACE BOARD CTI 12 REFERENCE A3

Verification

Check supply voltages at test points. Only -5V is on-board regulated from -20V; others are supplied via A2. A3 may be unplugged to verify the external supply.

Do a processor RESET and observe the results of the modem self-test.

With a remote modem on, check the carrier detect LED, "CD." This should be ON = LIT.

Check the Gifft RBC Recorder interface with command RECT (in AUTO OFF = MAINTENANCE MODE). The Trigger Break should be visible at the "RBCT' LED, and audible as a relay click-click. If this is not the case, check the input at test point J6/7; this should be HIGH for 80ms every 12s. If not, the fault is external. During the break, if a recorder is connected, the voltage between test points J9-Jl0 shall rise to 90V (approximately).

The cloud signal can further be checked by observing LED "RBCE," test point J5/9 (120Hz intermittent), and test point J5/7 (HIGH for active signal). If the latter toggles at about 3Hz, but one or both of the others deviate, then replace A3; otherwise, proceed to check the external circuits. Suspect Al and/or A2.

Replacement

Unplug W3 at J2. Unplug A3 from A2. Replace with spare board in reverse order. Check that jumper settings are according to specifications in Technical Description.

6.2.4 LIGHT MONITOR BOARD CTL 13 REFERENCE A5 AND SOLAR SHUTTER CTD 12 REFERENCE Kl

Verification

Check that nothing obstructs monitor photodiodes Dl and D3 from seeing their respective light sources.

Check supply voltage between TP3 (+ 17V ± 1V) and TP5 (GND) If not in range, check +25V at cathode of D7. If not present, suspect W5, A2, or Tl.

Laser Power Monitor

If an out-of-range Laser Power Monitor signal, LLAS, has been observed but positive cloud or hard-target detection has verified laser operation, check linearity with OV equalling LLAS 0, and 5V equalling LLAS 255 (=max). If this is not the case, suspect W5, A2, or Al.

If V(TP1) is less than 1.5V or greater than 4V with laser ON and positive cloud or hard-target detection, replace A5.

Skv Light Monitor

Check the voltage at TP2 to be close to OV when no strong light source is right above Ceilometer and photodiode D3 is pointed upward; and, check with high-intensity focused light brought right above D3 that the voltage increases to a value exceeding 2V. If this is not the case, replace A5. If the sun is shining, then a suitably-positioned mirror can be used instead of the lamp.

Solar Shutter Driver

With D3 covered, check that voltage at TP4 is 2V ±0.lV. Adjust at R13 if necessary. Check that driver Q2 is fully conducting (i.e., solenoid is energized and flap is open). If not, check that force on signal SSON is LOW. If it is, replace A5; otherwise, suspect Al, A2, or W5. Check that processor control status is SHUTTER OFF.

Place an intense focused light above D3. Observe V(TP2) to exceed 2V. Observe V(TP4) to decrease to approximately 1V. Observe the shutter to turn ON (i.e., de-energize and release the flap to cover the transmitter lens). If not, check Solar Shutter Kl, and replace faulty part.

Remove light. Shutter should open.

Command SHUT ON and SHUT OFF in Maintenance Mode (AUTO OFF). Shutter shall follow. If not, check signal SSON. If not HIGH (+4V or more) after SHUT ON command, check Al, A2, or W5.

Solar Shutter CTD 12 Reference Kl

Solenoid resistivity should be approximately 40 ohms; check. Check mechanical parts. Adjust or replace if necessary.

Replacement of A5

Turn Ceilometer power OFF. Release connectors. Unscrew the two (2) screws holding board mounting block to Optics Frame. Replace new board in reverse order. Turn Ceilometer ON. Observe commencement of normal operation.

Replacement of Kl

Follow installation procedure found with the kit. Remove faulty shutter in reverse order.

6.2.5 RECEIVER BOARD CTR 13 REFERENCE A6

WARNING! HIGH VOLTAGE IS ACCESSIBLE WHEN THE RECEIVER BOARD COVER IS REMOVED!

- Check Ceilometer Receiver noise behavior according to Paragraph 6.1.4.

- Check voltages:

- V(TP3) - GND should be 5V +0.5V, provided V(L1, either lead) - GND is 10V +2V; otherwise, replace A6. If V(L1) is out of limits, suspect A2 or A6.

- Voltage at TP2 should be at value found on sticker on the board at 25°C (77°F) with a temperature dependency of 1.3V/°F (2.3V/°C) for other temperatures. If not, suspect PSl or Wl0.

- Check photodiode current by measuring voltage across R4 (10k0) at TPl-TP2. When the receiver lens is covered, this should be less than 1mV. In bright daylight, with bright clouds above, this may be as much as 0.5V but not significantly more. Artificial light may be used as a substitute.

- Check preamplifier Ql and Q2 operation by placing concave shield above Ceilometer and measuring the resulting pulse with laser on, either by connecting an oscilloscope directly to A6J3 after unplugging W8 or at the corresponding Al test point. Oscilloscope bandwidth shall be 10MHz minimum. Observe positive pulses in the order of l00mV, length 135ns, repetition rate 620Hz... 1100Hz.

If above conditions are not met, replace A6; otherwise, suspect Al or W8.

Replacement

- Disconnect all connectors. Unscrew hex spacer nuts holding board to optics assembly. Pull board down to clear long screws. Place into bag or box immediately to protect mirror-like infrared-interference-filter. ESPECIALLY AVOID TOUCHING FILTER WITH FINGERS.

- Replace with new Receiver Board. Observe the same filter protection precautions! Tighten spacer nuts to approximately same tightness felt when loosening them.

- Connect cables, turn Ceilometer ON.

- Replace all covers and perform offset calibration as per Section 6.4. Observe performance with real clouds and no fog or precipitation. Check current signal sum by TOTAL command. Check several, and note average.

- If cloud detection reliability appears significantly reduced and the CURRENT SIGNAL SUM obtained is out of range 20...40 (See Section 3.3, 'Total") in specified conditions, then return Ceilometer to Depot or Manufacturer for thorough performance check.

6.2.6 TRANSMITTER BOARD CTT 12 REFERENCE A7

Verification

The absence of laser power can be verified by cloud hits missing, monitored laser 'power (reference LLAS) being very low--which should give a "Laser Power Low" alarm, status bit S_3 = l--and by using an external infrared detecting device.

WARNING! *DO NOTATTEMPT TO LOOK AT TRANSMITTER OPTICS WITH MAGNIFYING GLASSES, BINOCULARS, ETC.*

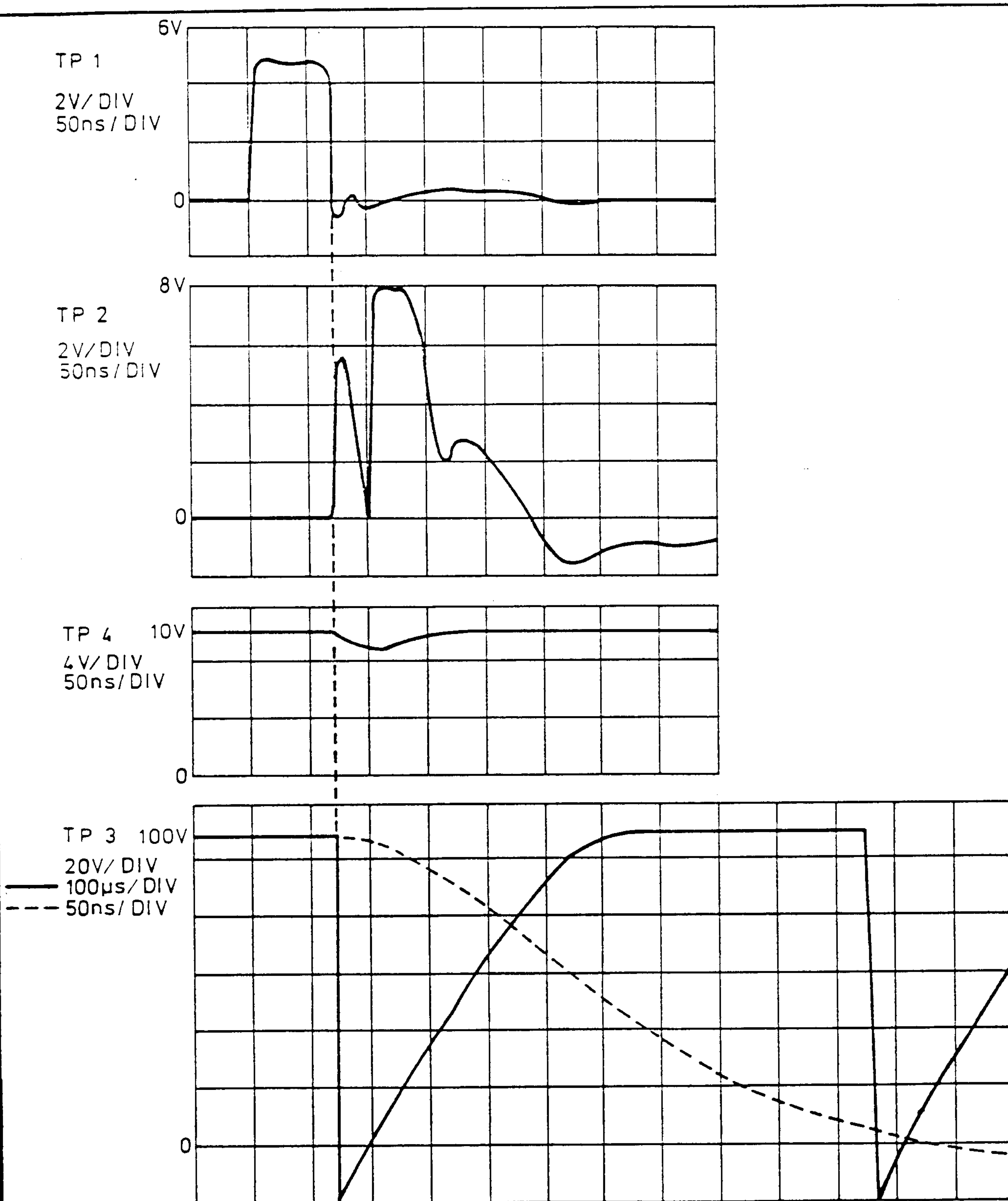
WARNING! *HIGH VOLTAGES ARE ACCESSIBLE WHEN THE TRANSMITTER BOARD IS REMOVED!*

Measure the DC voltages:

- TP4-GND +10V ± 1.5V (Low Voltage Supply)
- TP7-GND +260V ± 40V (High Voltage Supply)
- TP3-GNDDC-voltage marked on sticker on board, measured with laser off (Maintenance Mode) and correcting for ambient temperature deviation from 70°F temperature coefficient approximately lV/°F (1.8V/°C).
- TP6-GND +2.94VDC at 70°F; temperature coefficient 5.5mV/°F (l0mV/°C) (laser temperature sensor)

Command AUTO ON and observe the following waveforms with oscilloscope. Note that these are typical forms measured with 60MHz or faster Oscilloscope. Lower bandwidth will round off steep changes (Dwg No. CT 4535).

- If the Trigger pulse input at TP1 is missing or severely deformed, suspect Al or W9.
- If the input voltage at TP7 is too low, suspect PSl or W7.
- If the temperature sensor voltage TP6-TP5 is too low, suspect Al, A2, or W7.
- If the low voltage supply at TP4 is too low, suspect A2 or W7.
- If voltage at TP7 is okay but TP3 is close to zero, turn Ceilometer power OFF, then ON, and check again. If operation is restored, observe it for a period; if the situation is repeated, replace A7.
- In all other cases, and in cases mentioned above, in which a check of the suspect part has yielded no fault, replace A7.



Drawn 86-04-23 SIS	Title		VAISALA
Check	CTT12 TEST POINT WAVEFORMS		
Design JOL			Dwg no. CT 4535
Related	Scale		
Replaces			
Replaced by		Serial no.	Rev A

Replacement

CAUTION: Never look direct& into laser beam coming from transmitter optics when laser is enabled (Red LED on Light Monitor Board is lit when laser is enabled).

Remove all connectors. Unscrew the three (3) spacer nuts holding board to optics assembly. Pull board down clear of long screws. Insert new board. Tighten spacer nuts to approximately same tightness as with the removed board. Plug connectors.

Place diffuser over transmitter lens such that the three notches in the diffuser ring are lined up with the three pairs of support screws located on the lens plate. (Diffuser ring must rest flat on lens plate).

Turn power to the ceilometer on using switch on front panel of power supply. Now allow unit to “warm up” for at least l/2 hour with the external covers replaced on unit.

Connect maintenance terminal to base of unit at connector J4.

Using maintenance terminal command the following:

AUTO OFF (Maintenance Mode)
FREQ 3
SEQ ON
LASE ON
AN LLAS

Watch the values now displayed on the maintenance terminal. If the average of these values is not equal to the value listed on the diffuser then terminate the output and do the following:

If Average is less than the diffuser value (after ±3 tolerance) then command:

FREQ 4
SEQ ON
LASE ON
AN LLAS

If Average is more than the diffuser value (after ± 3 tolerance) then command:

FREQ 2
SEQ ON
LASE ON
AN LLAS

Again monitor the values displayed. Repeat the previous step as many times as it takes (incrementing or decrementing “FREQ” by 1 each time) until the average “LLAS” value is equal to the diffuser value (±3). Do not terminate the output when this average value is achieved.

Remove external covers from the unit.

Remove diffuser from lens plate being careful not to scratch lens or hit the light monitor board.

Notice the “LLAS” values now being displayed on the maintenance terminal. Visually estimate the average of these values and then terminate the output.

Add 5 to this average, which will be the value for LNOR.

Using the maintenance terminal, command the following (Example):

LNOR 150

NOTE: *The actual ‘LNOR” value inputted will be that calculated in the previous step.*

Command: LNOR: The response seen on the maintenance terminal should be:

LNOR XXX

(where XXX signifies the value inputted in the previous step). If this is not the case, repeat the previous step and check to make sure the information is transferred correctly.

Command: AUTO ON

Disconnect maintenance terminal from unit.

Replace transmitter optics assembly cover and unit cover. Return used transmitter board to depot for repair.

Perform offset calibration according to Section 6.4. Set unit into Automatic Mode:

AUTO ON

CLOS

Observe operation with real clouds. Observe value of CURRENT SIGNAL SUM with command TOTAL. If cloud detection shows clear signs of uncertainty and value of above SUM is out of range 20...40 (See Section 3.3, "Total") in specified conditions, return unit to Depot or Manufacturer for thorough performance check.

6.2.7 HIGH-VOLTAGE POWER SUPPLY CTP 12
REFERENCE PSl

WARNING! HIGH VOLTAGES!

Verification

Check that the line input voltage is within specified limits. Indicator lamp DSl should be lit regardless of circuit breakers CBl or CB2 positions.

With CBl or CB2 ON, check that all output voltages are present and within specifications. Check Window Conditioner Controls Blower ON (Line voltage PSlJ2:l signal LB) and Heater ON (PSlJ2:2 signal LH) with commands:

AUTO OFF
BLOW ON
HEAT ON

If not okay, check PSl relays Kl and K2, drives BON and HON (active Low), and supply +25V at A2Jll. Suspect Al or A2 if not okay; otherwise, replace PSl.

Replacement

Unplug all connectors of PSl. Unscrew four (4) screws at front and two (2) at rear using the Allen (hex) key found in the Field Spares Kit. Slide entire power supply out from the front. Replace in reverse order.
If the Ceilometer is equipped with receiver CTR 13, R13 has to be adjusted to it's maximum (fully clockwise). If the old receiver CTR 12 is being used, adjust Receiver High-Voltage at TPl-TP2 with R13 to initial value found on sticker on Receiver Board A6 and Quality Assurance documents. Observe temperature co-efficient 0.83V/°F (1.4V/°C) at temperatures outside 60°F...80°F range (15°C...27°C). Perform offset calibration as per Section 6.4.

6.2.8 TEMPERATURE CONTROL TRANSFORMER REFERENCE Tl

WARNING! HIGH VOLTAGES!

Verification

Check output voltage of transformer, 20VAC ±3V, found on A2 (e.g., at diode bridge D2, pins 3-4). Cool down U16 of Al with cold spray to obtain maximum loading. Check voltage with Tl disconnected from A2(J3).

Check line supply voltage outputs at PSlJ3.

Replace faulty part.

Renlacement

- Disconnect connectors from A2J3;PSlJ3. Open up cable clamp holding secondary wires to top of Optics Frame. Remove Receiver Cover. Cut bundle ties holding primary wires to Optics Frame lower part.

- Lift plastic feed-through bushing guiding secondary wires through Optics Frame top. Remove wires through slot. Unscrew two (2) screws holding Tl to Optics Frame top. Remove, Tl. Replace in reverse order. Replace cut bundle ties with new ones.

6.2.9 TEMPERATURE CONTROL HEATERS REFERENCES Rl AND R2

Verification

Disconnect from A2 connector J2 or J4, respectively, and measure resistance to be 10 ohms ±5%. Replace if not within limits; otherwise, suspect A2, Al or Tl.

Renlacement

- Disconnect from A2. Pull out feed-through bushing from hole in Optics Frame wall. Unscrew two (2) screws holding resistor to wall.

- Transfer as much as possible of heat-conducting silicon compound from replaced resistor to new resistor. Assemble in reverse order.

6.2.10 TEMPERATURE SENSOR REFERENCE TSl

Verification

Check circuit voltage at A2 to be approximately 2.94V at 70°F (21°C), temperature coefficient 5.5mV/°F (l0mV/°C). If not, disconnect TSl at A2J9 and measure an open circuit voltage of approximately 5V at A2J9, pins 1 and 2. Short it and measure a current of approximately 2mA. If the latter measurements are not okay, suspect Al or A2. Otherwise, replace TSl.

Replacement

- Disconnect from A2J9. Cut bundle ties. Remove air filter from vent. Lift TSl from vent. Replace in reverse order. Replace cut bundle ties with new ones.

6.2.11 WINDOW CONDITIONER (1l5V) REFERENCE Bl

WARNING! HIGH VOLTAGES!

Verification

Using maintenance commands, check temperature sensor TB to give credible values. Command BLOW ON, HEAT ON (in Maintenance Mode, AUTO OFF), and observe TB to rise approximately 12°F (7°C) above ambient (TE) in a few minutes. If temperature rises considerably more, suspect blower operation; if not at all, suspect heater operation.

- Disconnect the Window Conditioner at J2 and measure resistivities:

- Blower circuit, approximately 60 ohms;

- Heater Circuit, 22 ohms.

If these are okay, suspect PSl, Al, or A2; otherwise, replace Bl.

- If the temperature TB is not correct, check the supply circuit as with TSl (Section 6.2.11) and replace Bl if this is correct. Otherwise, suspect PSl, Al or A2.

Replacement

- Disconnect at J2, Loosen four (4) knurled screws holding Window Conditioner to Equipment Cover. Lift off. Remove cable from guiding clamp at inside. Unscrew four (4) screws holding Heater-Blower to the housing. Pull down Heater-Blower. Replace in reverse order.

6.2.12 MAINTENANCE TERMINAL CTH 12

A self-test can be performed on the Maintenance Terminal to verify operation. See Section 4.3.9.3.4.

6.3 REMOVAL OF CEILOMETER COVERS

WARNING! *WHENEVER WORKING CLOSE TO A CEILOMETER, DO NOT UNDER ANY CIRCUMSTANCES LOOK INTO IT'S OPTICS WITH MAGNIFYING GLASSES, BINOCULARS OR OTHER MAGNIFYING OPTICS, NOR ALLOW ANYBODY ELSE TO DO SO. IT MAY BE HARMFUL TO THE EYES.*

1. Disconnect Window Conditioner Connector J2.
2. Loosen four (4) Window Conditioner knurled screws on wide sides of Ceilometer.
3. Raise Window Conditioner and place on ground.
4. Open latches of Equipment Cover at lower edge of wide sides of Ceilometer.
5. Carefully raise the Equipment Cover over the equipment and place on ground.

IN ALL MAINTENANCE OPERATIONS, PREVENT DUST, PRECIPITATION, ETC., FROM COLLECTING ON THE LENSES! Use temporary covers, if necessary. Especially avoid touching the lenses with bare hands. Clean lenses, if necessary, with alcohol and a clean, lint-free cloth according to Paragraph 5.2. Cover the Ceilometer by following steps l-5 in a reverse order. Be sure to remove temporary lens covers, and to leave circuit breakers CBI and CB2 ON.

6.4 OFFSET CALIBRATION

The instrument offset has been factory-calibrated and in normal conditions no need for field recalibration exists.

If, however, a part is replaced that has an influence on internal noise behavior, a recalibration shall be performed after restoration of operation. Parts influencing noise behavior are:

Al Processor Board
A2 Unregulated Power Supply Board
A6 Receiver Board
A7 Transmitter Board
PS 1 High-Voltage Power Supply
W6 Receiver Low-Voltage Cable
W7 Transmitter Low-Voltage Cable
W8 Receiver Signal Cable
W9 Transmitter Control Cable

If, for some reason, noise hits are more frequent in some ranges than in others--excluding the self-evident higher probability for high-range noise hits than for low-range ones due to lower signal-to-noise ratio--a recalibration is to be performed.

Procedure for Offset Calibration

A. Check that noise conditions are such that difference between two smallest numbers (average and minimum) seen with command NOIS are 8 or higher with GAIN 2 and 2 or higher with GAIN 0. Use artificial light pointed into Receiver, if necessary.

B. With equipment in normal operating configuration (i.e., equipment cover and window conditioner ON), cover the transmitter side aperture of the Window Conditioner with dark, non-reflecting cloth. If done indoors, use a desk lamp positioned over the receiver as the constant light source. If done outdoors, make sure that ambient light conditions are stable. For example wait for a long break in the clouds if there is a broken cloud cover.

C. Perform command sequence:

AUTO OFF (Output: MAINTENANCE MODE)
GAIN 0
LASE ON
SEQ ON
CAL 240

D. After 4 minutes, the unit has recorded its offset signature and responds with:

OFFSET TO EEPROM

and starts listing the offset values obtained. This can be interrupted by hitting the ESC key.

E. Restore normal operation by commanding:

AUTO ON
CLOS

and removing the transmitter aperture cover.

F. Observe that performance is okay.