VXI bus

VX4286
32-Channel
Analog/Digital
Input Module
Service Manual

Tektronix

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VX4286
32-Channel Analog/Digital
Input Module

Section 1
Introduction

The VX4286 32-Channel Analog/Digital Input Module has thirty-two inputs, which can be configured under program control to function either as thirty-two digital inputs (Digital mode), as thirty-two comparator inputs with timetagging (Analog mode), or as sixteen channels of each.

In either mode, all input channels have individually programmable logic threshold voltages and can be programmed to active high or active low logic. Two logic threshold ranges are provided: ±10 V with an accuracy of 40 mV and resolution of 5 mV, or ±50 V with an accuracy of 100 mV and resolution of 25 mV. Each channel may be programmed to use either range or it may be instructed to autorange, selecting the most sensitive range suitable for a specified threshold voltage. The VX4286 module also has facilities for input conditioning modules, such as open collector outputs, A/C detection, or user-designed input circuitry.

In the analog mode, the VX4286 Module continuously monitors each analog input line for an input voltage level which is greater than or less than the programmed threshold voltage. When a voltage of the proper value is detected, the condition is captured in a latch and timetagged on the VX4286 Module; a VXI Request True interrupt is generated (in IEEE 488 systems such as the CDS 73A-IBX, the Request True interrupt generates an SRQ on the IEEE 488 bus). Interrupts can be programmed to be returned on complex AND/OR conditions of the channels. Once the interrupt has occurred, the system controller can then interrogate the VX4286 Module to determine the channel which caused the interrupt, and the time it happened. The monitoring feature can be programmably enabled for continual operation or may be enabled on by an external Arm command.

The system controller may select the format of the data returned, suitable to the application. The data may include relative or absolute time tag, channel information bit encoding or by channel number, and an individual "as-it-happened" report, or cumulative "everything-that-happened" report.

Additional features in Analog mode are debounce, and pulse detection. The debounce control is ideally suited for contact closures. This feature can be enabled or disabled

under program control in groups of four inputs. The debounce time can be programmed from 1/10 millisecond to 6 seconds. The FLIP command provides the ability to automatically switch polarity each time a transition occurs, allowing for detection and characterization of pulses.

In analog mode, the front panel display shows which channel, if any, is on the "wrong" side of its threshold. The display can represent realtime data, or latest event data, with user specified priority taken into account. All channels can be programmed to have user-selectable names for displaying.

In digital mode, input data can be sampled at the time an input request is made by the system controller or when an external strobe pulse is received. The front panel display shows the states of sixteen of the thirty-two bits, as programmably selected. The display can represent realtime or last latched data.

Thirty-two TTL output lines are provided on the VX4286 Module to reflect the state of the comparator status latch of each input comparator when the modules is used in Analog mode. In the Digital mode, the output lines function as hardware level shifters, converting the programmed input logic levels to TTL output logic levels on a continuous basis.

A TTL output (EQU OUT signal) provides an external signal during Analog mode, when any comparator status latch becomes set. It can also be programmed to not become active until some AND/OR combination of inputs has occurred.

Self test for this module verifies that all input thresholds are tested to within 5% of their required accuracy.

A voltmeter capability is provided to read back the DC voltage level on any channel, including maximum and minimum voltage levels.

LED'S

P4

STB ARM

EQU OUT

P5

HALT SWITCH

OFF

ON

MSD   LSD

LOGICAL ADDRESS

INT LEVEL

+5V FUSE

ACCESS FOR
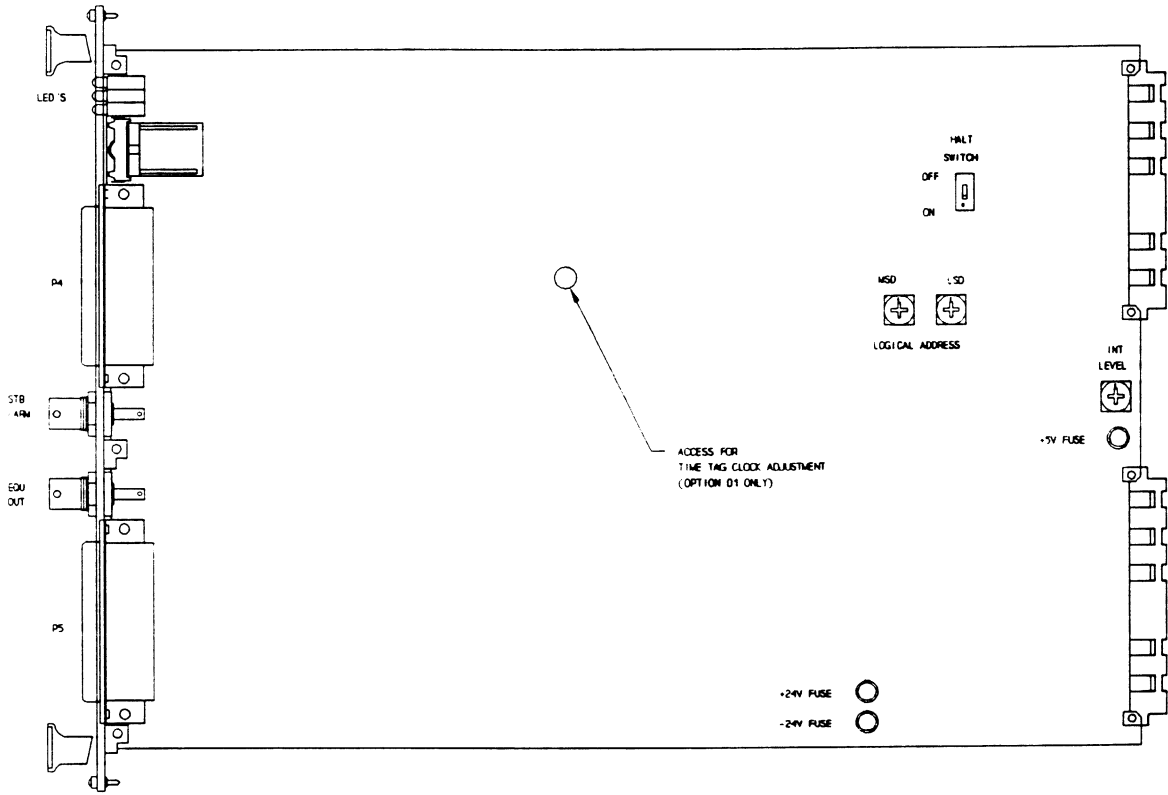TIME TAG CLOCK ADJUSTMENT
(OPTION 01 ONLY)

+24V FUSE
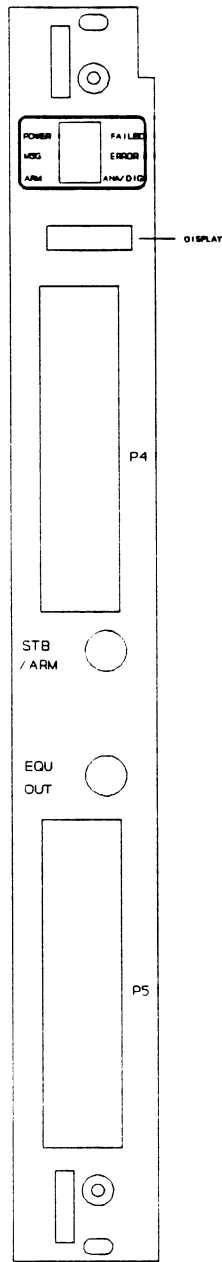
-24V FUSE

Figure 1: VX4286 Controls and Indicators

Figure 2: VX4286 Front Panel

Section 2
Adjustment and Calibration

The VX4286 Module must be calibrated every twelve months for the module to meet its published accuracy specifications. Calibrate the VX4286 Module at the temperature at which it will be operating. Calibration to the published accuracy specifications has been performed at CDS prior to shipping. Allow a ten minute warm-up period before performing the calibration.

Test Equipment Required

- 73A-853 Extender Card or equivalent

- Voltage calibrator with a 50V DC range absolute accuracy of 0.03%, and maximum noise specification of < 1 mV rms (DC to 10 KHz).

Additional test equipment required with Option 01 installed:

- 1 MHz frequency standard

- Dual trace 10 MHz or greater oscilloscope

- Standard screwdriver with 0.1" blade or 1/16" square end adjustment tool

Calibration Procedure

Voltage Threshold Calibration For Standard VX4286:

Allow a ten minute warm-up period before performing the calibration.

1) Repeat steps 2 through 12 below until all channels have been calibrated.

2) Use the CAL S,[N]<LF> command to initiate the calibration procedure for a single channel [N]. For example, for the first channel, CAL S,0<LF> would be sent. To speed up the process, a number of channels can be calibrated at once, depending upon the output current capability of the calibrator. For instance, if the calibrator is capable of outputting 8 mA, up to eight channels could be calibrated at the same time. (8 mA * 52K ohms min input impedance / 50 volts = 8.3 channels). In this case, the first channels would be programmed with CAL S,0 TO 7<LF>, the next with CAL S,8 TO 15<LF>, and so forth.

3)   Connect the output of the calibrator to the channel inputs of all channels given in the CAL S command sent in step 2. Do not connect the calibrator to any other inputs, as this could violate the calibrator specification for maximum output current.

An exception is when eight channels are being calibrated at once and they are one of the groups 0-7, 8-15, 16-23, or 24-31. In this case, the VX4286 Module will relay-isolate the unused channels upon reception of the CAL S command. The isolated channels would be 8-15 for calibrating channels 0-7, 0-7 for 8-15, 24-31 for 16-23 and 16-23 for 31-24. This isolation allows calibrators with enough output current for eight channels but not for sixteen channels to be directly connected to all sixteen channels on the connector. The isolated channels will be reconnected with the next CAL E, CAL AB, CAL S, or RST command.

4)   Program the calibrator for -10.000 volts.

5)   Send the CAL A,-10 command to the VX4286. The CAL A command will automatically wait five millilseconds before beginning the calibration, to accommodate the settling time of the calibrator. If the settling time of the calibrator is greater than five milliseconds, be sure that enough settling time has passed between the setting of the calibrator and the programming of the VX4286 module.

6)   Wait for the CAL A command to complete, a period of a half-second times the number of channels specified with the CAL S command.

7)   Read the VX4286. If the 00,NO ADDITIONAL ERRORS TO REPORT response is returned, continue to next step. If the 62,CAL ERROR CHAN [CHAN]: [VOLT] VOLTAGE READS TOO LOW/HIGH response is returned, where [CHAN] is the channel number, and [VOLT] is -10, then verify that the calibrator is putting out the correct voltage within its specified accuracy.

8)   Send a VOLTALL?L,[N]<LF> command, where [N] specifies the same channels as in step 2.

9)   Read the response from the VX4286. There is one message per channel. For controllers that do not support successive readbacks, the VOLTNEXT? command can be sent between readings.

Verify that the voltages returned are as follows:

	Average	Minimum	Maximum
+10V	9.985 to 10.015	9.980 to 10.010	9.990 to 10.020
-10V	-10.015 to -9.985	-10.020 to -9.990	-10.010 to -9.980
+50V	49.945 to 50.055	49.895 to 50.030	49.970 to 50.105
-50V	-50.055 to -49.945	-50.105 to -49.970	-50.030 to -49.895

If the voltages returned are outside these limits, make sure that excess noise does not exist on the calibration output. If this is not the problem, consult Tek/CDS at 1-800-CDS-ATE1.

10) Repeat steps 4 through 9 three more times using voltages +10, -50, and +50 where -10 volts was previously used.

11) Send the CAL E command to the VX4286.

12) Read the response of the VX4286. If the response reads 64,CALIBRATION COMPLETE, calibration was successful for these channel(s). Repeat the procedure again, continuing from step 2, until all channels have been calibrated. A listing of all channels that have not yet been calibrated can be obtained with the CAL? command.

If the response read was not 64,CALIBRATION COMPLETE, calibration was unsuccessful, and the previous calibration values remain unchanged. If the error is 63,CAL ERROR: ALL VOLTAGES NOT RECEIVED, this indicates that a successful CAL A command was not received for each voltage.

Note that this procedure is the suggested order. The voltages may be applied in any order.

Typical Calibration

The responses from the VX4286 are shown underlined. (Note that the VOLTNEXT? command is not required unless successive readback is not supported.)

```
CAL S,0TO7<LF>
CAL A,-10<LF>
(4 second delay)
00,NO ADDITIONAL ERRORS TO REPORT<CR><LF>
VOLTALL? L,0TO7<LF>
AVE =  -9.998, MIN =  -9.998, MAX =  -9.998<CR><LF>
VOLTNEXT?<LF>
AVE = -10.000, MIN = -10.000, MAX = -10.000<CR><LF>
VOLTNEXT?<LF>
AVE = -10.004, MIN = -10.006, MAX = -10.002<CR><LF>
VOLTNEXT?<LF>
AVE =  -9.998, MIN =  -9.998, MAX =  -9.998<CR><LF>
VOLTNEXT?<LF>
AVE = -10.000, MIN = -10.000, MAX = -10.000<CR><LF>
VOLTNEXT?<LF>
AVE = -10.004, MIN = -10.006, MAX = -10.002<CR><LF>
VOLTNEXT?<LF>
AVE =  -9.998, MIN =  -9.998, MAX =  -9.998<CR><LF>
VOLTNEXT?<LF>
AVE = -10.000, MIN = -10.000, MAX = -10.000<CR><LF>
CAL A,10<LF>
```

(4 second delay)
00,NO ADDITIONAL ERRORS TO REPORT<CR><LF>
VOLTALL? L,0TO7<LF>
AVE =   9.998, MIN =   9.998, MAX =   9.998<CR><LF>
AVE =   10.000, MIN =   10.000, MAX =   10.000<CR><LF>
AVE =   10.004, MIN =   10.002, MAX =   10.006<CR><LF>
AVE =   9.998, MIN =   9.998, MAX =   9.998<CR><LF>
AVE =   10.000, MIN =   10.000, MAX =   10.000<CR><LF>
AVE =   10.004, MIN =   10.002, MAX =   10.006<CR><LF>
AVE =   9.998, MIN =   9.998, MAX =   9.998<CR><LF>
AVE =   10.000, MIN =   10.000, MAX =   10.000<CR><LF>
CAL A,-50<LF>
(4 second delay)
00,NO ADDITIONAL ERRORS TO REPORT<CR><LF>
VOLTALL? L,0TO7<LF>
AVE = -49.987, MIN = -50.000, MAX = -49.975<CR><LF>
AVE = -50.000 MIN = -50.000, MAX = -50.000<CR><LF>
AVE = -50.013, MIN = -50.025, MAX = -50.000<CR><LF>
AVE = -49.987, MIN = -50.000, MAX = -49.975<CR><LF>
AVE = -50.000 MIN = -50.000, MAX = -50.000<CR><LF>
AVE = -50.013, MIN = -50.025, MAX = -50.000<CR><LF>
AVE = -49.987, MIN = -50.000, MAX = -49.975<CR><LF>
AVE = -50.000 MIN = -50.000, MAX = -50.000<CR><LF>
CAL A,50<LF>
(4 second delay)
00,NO ADDITIONAL ERRORS TO REPORT<CR><LF>
VOLTALL? L,0TO7<LF>
AVE =   49.987, MIN =   49.975, MAX =   50.000<CR><LF>
AVE =   50.000 MIN =   50.000, MAX =   50.000<CR><LF>
AVE =   50.013, MIN =   50.000, MAX =   50.025<CR><LF>
AVE =   49.987, MIN =   49.975, MAX =   50.000<CR><LF>
AVE =   50.000 MIN =   50.000, MAX =   50.000<CR><LF>
AVE =   50.013, MIN =   50.000, MAX =   50.025<CR><LF>
AVE =   49.987, MIN =   49.975, MAX =   50.000<CR><LF>
AVE =   50.000 MIN =   50.000, MAX =   50.000<CR><LF>
CAL S,8TO15<LF>
. . .
CAL S,16TO23<LF>
. . .
CAL S,24TO31<LF>
. . .
CAL E<LF>
64,CALIBRATION COMPLETE<CR><LF>

Frequency Calibration For VX4286 with Option 01 Installed:

Allow a ten minute warm-up period before performing the calibration.

1)   Use the FCAL S command to initiate the frequency calibration procedure.

2)   Send an OUTPUT ON command (this command is required only if a Channel 15 or 31's TTL Output is being used in the next step).

3)   Connect channel 1 of the oscilloscope to the EQU OUT BNC connector of the VX4286. The signal on the EQU OUT connector can also be accessed on the channel 15 TTL Output (P4) or channel 31's TTL Output (P5).

4)   Connect channel 2 of the oscilloscope to a 1 MHz frequency source. The scope should be triggered to this channel, and a stable 1 MHz signal should be displayed on the oscilloscope.

5)   Use a screwdriver or adjustment tool to adjust the crystal oscillator until the horizontal rolling of channel 1 with respect to the stable channel 2 is minimized. The adjustment location is shown in Figure 1. The rolling should be brought down to a level where channel 1 rolls less than a horizontal distance of 1 µsec in a 5 second period (1 µsec is one period of the 1 MHz frequency).

Section 3
Assembly And Disassembly

The VX4286 is shipped fully assembled. A schematic diagram that may also be used as a reference is included with this manual.

Section 4
Parts List

The following lists give the name and part number for all field replaceable parts of the VX4286. To order replacement parts, call your Tektronics representative.

SERVICE MANUAL

VX4286

DIGITAL ANALOG COMPARATOR MODULE

REFERENCE DESIGNATOR	CDS PART NUMBER	QTY.	PART DESCRIPTION	MFG. NUM.	MFG. PART NUMBER
	96000-00015	1	1 IN WHT FRONT AND SPINE VXI BUS MANUAL	0546	96000-00015
BACKLOADED RESISTOR SUBASSEMBLY	VX4286SA1	1	RESISTOR SUBASSEMBLY FOR VX4286	0026	VX4286SA1
FOR USE WITH W7-W10	40430-00125	0.50	TUBING HEAT SHRINK .093 IN BLK	0009	FIT-221 3-32 4FT
FOR USE WITH HS1561,HS1571	47000-04880	2	HEAT SINK MOUNTING KIT TO-220	0204	4880
FOR USE WITH P4,P5	45008-20418	4	SCREW LOCK ASSEMBLY FOR D CONNECTOR	0108	D-20418-2
C02,05,07,09,10,1041,1081,1091 11,1141,1142,1211,1231,1252,1281 13,1351,1381,14,1411,1431,1441 1471,1511,1531,1541,21,231,24,32 37,39,41,43,44,45,49,54,61,63,71 73,74,76,78,79,81,83,84,87,91,93	20128-10006	52	CAP FXD CER .1UF 20% 50VDCW	0058	C322C104M5U5CA
C1241,1251,1354,1355	22022-20008	4	CAP FXD TA 22UF 10-20% 20-25VDCW	0106	199D226X9025CA1
C1352,1353,1551	25070-10005	3	CAP FXD POLYPROP .01UF 2.5% 50VDCW	0340	KP1830-.01 50 2.5%
C1481,1491,1581,1582,1591,99	22022-22008	6	CAP FXD TA 22UF 10-20% 35WVDC	0106	199D226X0035EE2
C1552,1561	20129-33006	2	CAP FXD CER .33UF 20% STABLE 50VDCW	0005	SR215E334MAA
C47,57	21528-10002	2	CAP FXD MICA 10PF 5% 100VDCW	0012	DM15-100D
CR04	32000-04148	1	DIODE SILICON 75V 1A 5%	0078	1N4148
CR111,122,131,132,1411,1412,1421 1422,1423,1431,1433,1511,1522 1531,1532,211,212,221,222,223 231,233,611,612,621,622,623,631 633,711,722,731,732,811,822,831 832,911,912,921,922,923,931,933	32000-04149	44	DIODE SILICON 75V 1A 5%	0078	1N4149
CR1471,1472,1473,1474,1475,1476 1551,1571,1572,1573,1574,1575 1576,1591	32000-04001	14	DIODE SILICON 50V 1A 5%	0357	1N4001
CR54	32000-05260	1	DIODE ZENER 43V .5W 5%	0074	1N5260B
DCL1	40408-14286	1	LABEL VX4286 DWG 01927	0026	40408-14286

REFERENCE DESIGNATOR	CDS PART NUMBER	QTY.	PART DESCRIPTION	MFG. NUM.	MFG. PART NUMBER
DCL2	40409-14286	1	LABEL VX4286 -03247	0026	40409-14286
DS01,02	32000-03120	2	DIODE LED BI-LEVEL RED GRN 15 MA WITH RES	0039	553-0312
DS03	32000-03220	1	DIODE LED BI-LEVEL GRN GRN 15 MA WITH RES	0039	553-0322
DS20	32050-01414	1	DISPLAY 4 CHAR LED WITH MEMORY GREEN	0101	DLG1414
E40,43,50,53	92301-00440	4	SCREW PHIL PNHD 4-40X5-16 BRITEZINC	0137	4-40X5-16 PHIL PNH
E41,44,51,54,82,83	92302-00440	6	WASHER STAR NUMBER 4 INTERNAL ZINC	0137	4 IN STAR WASH ZIN
E42,45,52,55,84	92303-00440	5	HEX MACHINE NUT 4-40 ZINC	0137	HEX MACH NUT 4-40
E80	47000-74065	1	BRACKET 73A FRONT PANEL CENTER DRW 01676 REV 890	0026	47000-74065
E81	92301-10440	1	SCREW PHIL PNHD 4-40 X .1875 BRITE ZINC	0137	4-40X3-16 PHIL PNH
F1571,1572	42202-73020	2	FUSE MICRO 2AMP 125V FAST PLUG IN CLEAR CAP	0061	273 002
F89	42202-73040	1	FUSE MICRO 4AMP 125V FAST PLUG IN CLEAR CAP	0061	273 004
FP1	47006-14286	1	FACE PLATE VX4286 CARD DRW 02328 REV 910	0026	47006-14286
FP10,11	92505-25005	2	WASHER WAVY 2.7MM	0026	92505-25005
FP12,13	92501-25010	2	SCREW M2.5X10 CHEESEHEAD	0026	92501-25010
FP18,20	92500-25011	2	COLLAR SCREW M 2.5 X 11 SL NICKEL	0266	21100-379
FP19,21	92510-00464	2	SLEEVE CAPTIVE SCREW GRAY	0266	21100-464
FP2,22,4,8	40406-00140	1	EJECTOR HANDLE C-TOP VX1400	0266	20817-328
FP23,3,5,9	40406-00141	1	EJECTOR HANDLE C-BOTTOM VX1400	0266	20817-327
FP6,7	92500-25005	2	SCREW 2.5MM PHIL CSK 5MM	0026	92500-25005
HS1561,1571	47000-06073	2	HEAT SINK FOR TO 220 PKG 20 DEGG W RSA	0204	6073-B

REFERENCE DESIGNATOR	CDS PART NUMBER	QTY.	PART DESCRIPTION	MFG. NUM.	MFG. PART NUMBER
J1011,1311,31,61	45020-08020	4	DIP SHUNT HEADER 20 PIN	0004	1-435704-0
K1001,1002,1101,1201,1301,1341 1342,1401,1402,1501,30,401,402 50,60,70,801,802	83000-20004	18	RELAY DPDT 178 OHM 5V	0432	EA2-5
L1591,1592	27051-00200	2	INDUCTOR WIDE-BAND FERRITE CHOKE	0042	VK 200 10-3B
L89	27051-50007	1	INDUCTOR 5 UH 5A .015 OHMS 50MHZ FR	0037	IHA-501
P1,2	45003-09600	2	CONNECTOR DIN 96 PIN MALE RT ANGLE SOLDER	0265	10-8457-096-00209
P4,5	45008-50003	2	RT ANGLE DD-50 PIN PC MOUNT	0193	147-1150P-02-D4338
P8,9	45002-00002	2	CONNECTOR BNC ISOLATED BLK HEAD	0255	31-010
PCB1	41140-42860	1	P.C. BOARD VERSION 8L 9112	0498	41140-42860
Q031,19	51100-00300	2	TRANSISTOR VMOS N-FET	0102	VN0300L
Q032,04,1141	51100-03906	3	TRANSISTOR PNP SWITCHING	0107	2N3906
Q1551,1552,1553,1554	51100-03646	4	TRANSISTOR NPN HIGH SPEED SWITCH	0074	MPS3646
R031,04,1551,54	14024-10005	4	10K RES FILM 1-4W 1% 100PPM	0035	RN55D1002F
R032,1051,1453,1557,19,80	10117-33004	6	3.3K RES COMP 1-4W 5%	0087	R25J-3.3K-5%
R07,1021,1322,18,32,58,62	12008-33004	7	3.3K RES NETWORK SIP 5% 1.5W 9-PKG	0027	750-101-R3.3K
R1081	10117-00000	1	0 OHM RESISTOR	0054	ZEROHM
R110,123,126,136,1414,1433,1512 1523,1526,1535,214,232,614,633 712,723,726,735,812,823,826,836 914,932	10117-75007	24	7.5M OHM RES COMP 1-4W 5%	0087	R25J-7.5MEG-5%
R111,112,122,124,125,131,137 1412,1421,1424,1426,1431,1434 1436,1511,1513,1522,1524,1525 1531,1536,212,221,224,226,231 233,235,612,621,624,626,631,634 636,711,713,722,724,725,731,736 811,813,822,824,825,831,837,912 921,924,926,931,933,935	14070-46405	56	46.4K RES FILM 1W .1% 25PPM	0037	CPF-1-4642-B-T-9

REFERENCE DESIGNATOR	CDS PART NUMBER	QTY.	PART DESCRIPTION	MFG. NUM.	MFG. PART NUMBER
R113,121,132,134,1411,1423,1435 1514,1521,1532,1533,211,223,234 611,623,635,714,721,732,733,814 821,832,834,911,923,934	14070-57604	28	5.76K RES FILM 1W .1% 25PPM	0037	CPF-1-5761-B-T-9
R114,133,1415,1432,615,632,815 833	14024-20006	8	200K RES FILM 1-4W 1% 100PPM	0035	RN55D2003F
R1151,1191,1321,1381,1391,1481 1484,1581,1582,52	10117-10004	10	1K RES COMP 1-4W 5%	0087	R25J-1K-5%
R1251	14036-60403	1	604 OHM RES FILM 1-4W .1% 25 PPM	0037	RN55E6040B
R1252	14036-15003	1	150 OHM RES FILM 1-4W .1% 25PPM	0035	RN55E1500B
R1281,1482,1483,29,471,472,473 551	10117-18005	8	18K RES COMP 1-4W 5%	0087	R25J-18K-5%
R1291,1558,1591,39,552,791,792 793,95	10117-47004	9	4.7K RES COMP 1-4W 5%	0087	R25J-4.7K-5%
R1351	10127-10001	1	1 OHM RES COMP 1-2W 5%	0087	R50J-1-5%
R1352	14044-12003	1	120 OHM RES FILM 1-4W .1% 10PPM	0037	PTF-65120RBT-13
R1552,1553,1554,1555	14024-20005	4	20K RES FILM 1-4W 1% 100PPM	0035	RN55D2002F
R1556	10117-51004	1	5.1K RES COMP 1-4W 5%	0087	R25J-5.1K-5%
R1592	14024-82503	1	825 OHM RES FILM 1-4W 1% 100PPM	0035	RN55D8250F
R57	10117-10007	1	1M RES COMP 1-4W 5%	0087	R25J-1M-5%
S38	42050-10101	1	SWITCH DIP 1POS SPST	0093	JS-8794-01
S681,682	42050-10301	2	SWITCH DIP ROTARY HEX	0007	DRW-16C
S79	42050-10300	1	SWITCH DIP ROTARY BCD ENCODED	0007	DRW-10C
SH1	47007-14286	1	SHIELD FRONT VX4286 CARD 02628 REV 9103	0026	47007-14286
SH10,11,13,14,17,2,20,31,4,5,7,8	92500-25010	12	SCREW M 2.5 X 10 CSK OVAL PHIL NIK PL	0266	21100-500
SH12,3,6,9	92519-25019	4	STANDOFF HEX M2.5 X 19.5MM DRW 01801 REV 900	0026	92519-25019

REFERENCE DESIGNATOR	CDS PART NUMBER	QTY.	PART DESCRIPTION	MFG. NUM.	MFG. PART NUMBER
SH15,18,21,23	92201-19451	4	STANDOFF HEX M2.5 THRU X .538L DRW 01673 REV 920	0026	92201-19451
SH16,19,30,34	92500-25017	4	SCREW 2.5MM X 16MM 90 DEG CSK FLHD PHIL STAINLS	0420	DIN965M2.5X16
SH22	47007-74002	1	SHIELD BACK CONN MTG CONFIG -01816 REV 9004	0026	47007-74002
SH23,24,25,26,27,28,29,32	92519-25004	8	REAR SHIELD SPACER 73A DRW 01807 REV 890	0212	19501-A-0029
U05	79805-58256	1	IC CMOS 32K X 8 SRAM 120NS	0052	HM62256P-12
U06	76603-74645	1	IC TTL AS OCTAL BUS TRANSCEIVER	0107	74AS645
U07	73003-74574	1	IC TTL ALS OC TRI LATCH NON INV TI ONLY	0107	74ALS574
U08,18	73005-74574	2	IC HCT OCTAL TRISTATE LATCH NON-INVERT	0107	74HCT574
U09,19	73308-74645	2	IC TTL ALS OCTAL BUS TRANSCEIVER	0107	74ALS645-1
U1041,1541,24,84	20110-00018	4	IC MUXED SAMPLE HOLD 2.5US AQU 8 CHANNEL 15V	0011	SMP18FP
U1051,1261	73302-07404	2	IC TTL ALS HEX INVERTER	0107	74ALS04
U1052	79801-01231	1	IC CMOS RESET POWER DOWN	0238	DS1231-20
U1061,27,34,66,95	73005-74273	5	IC HCT OCTAL D-TYPE FLIP FLOP W RESET	0088	74HCT273N
U1071	77825-07432	1	IC TTL ALS QUAD 2-INPUT OR GATE	0107	74ALS32
U1091,1271,1361,76	79008-74238	4	IC HCT 3-TO-8 LINE DECDR DEMULTIPLEXER	0107	74HCT238
U11,13,1411,1431,71,73,91,93	61010-00365	8	IC QUAD COMPARATOR	0078	LP365N
U1121,42	79811-23030	2	IC CMOS LCA 10X10 70MHZ 84 PIN PLCC	0404	XC3030-70PC84C
U1141	20100-07528	1	IC DUAL D-A 8-BIT DO NOT SUB PMI	0011	AD7528JN
U1151	73002-74652	1	IC TTL LS OCTAL TRANSCEIVER WITH REGISTERS	0107	74LS652

REFERENCE DESIGNATOR	CDS PART NUMBER	QTY.	PART DESCRIPTION	MFG. NUM.	MFG. PART NUMBER
U1161,961	73309-74244	2	IC HCT OCTAL BUFFER NON-INVERTING	0107	74HCT244
U1171	77825-74832	1	IC TTL ALS HEX 2-INPUT OR DRIVER	0107	74ALS832
U1181	76606-07400	1	IC HCT QUAD 2-INPUT NAND GATE	0088	74HCT00
U1191,1381,1481	73005-07474	3	IC HCT DUAL D-TYPE FLIP FLOP	0092	74HCT74N
U1241	61000-00348	1	OP AMP QUAD	0078	LM348N
U1242	61020-00105	1	INSTRUM AMP UNITY GAIN	0023	INA105KP
U1251	20100-00811	1	IC D-A CONVERTER 12-BIT VOLTAGE OUTPUT	0023	DAC811KP
U1281	77203-07408	1	IC TTL ALS QUAD 2-INPUT AND GATE	0107	74ALS08
U1291,86,99	73001-07431	3	IC LS DELAY ELEMENT	0107	74LS31
U1341	52200-00584	1	REFERENCE PIN PROG 5MA 30PPM	0011	AD584JH
U1371,78	79008-74138	2	IC HCT 3-TO-8 LINE DECDR DEMULTIPLEXER	0107	74HCT138
U1391	73003-07474	1	IC TTL ALS DUAL D-TYPE EDGE TRIG FLIP-FLOP	0107	74ALS74
U14,1441,74,94	81001-00850	4	IC CMOS ANALOG SWITCH ARRAY	0102	DG485DJ
U1491	79010-74151	1	IC TTL AS 1-OF-8 DIGITAL MUX	0107	74AS151
U1581	74201-74123	1	IC TTL DUAL RETRIGGERABLE	0107	74LS123
U1591	78403-07414	1	IC HCT HEX SCHMITT INVERTING BUFFER	0088	74HCT14
U16,46	73006-74573	2	IC TTL AS OCTAL D-TYPE LATCH	0107	74AS573
U17	79814-00439	1	PAL PROGRAMMED 5AC312 REV A 73A-SUPER 8	0000	
U25	79813-00190	1	PROGRAMMED PROM U25 73A-510	0000	
U28,29,79,1111,1211,26,36,41,51 56	73308-74244	10	IC TTL ALS OCTAL BUFFER NON-INVERTING	0107	74ALS1244
U35	79813-00191	1	PROGRAMMED PROM U35 73A-510	0000	

REFERENCE DESIGNATOR	CDS PART NUMBER	QTY.	PART DESCRIPTION	MFG. NUM.	MFG. PART NUMBER
U37,45	79825-88002	2	IC SUPER 8 CPU ROMLESS 20 MHZ	0117	Z08800A20PSC
U38,392	77203-07430	2	IC TTL ALS 8-INPUT NAND GATE	0107	74ALS30
U391	76602-07438	1	IC TTL S QUAD 2-INPUT NAND BUFFER W-OC	0107	74S38
U44	79814-00381	1	PAL PROGRAMMED 22V10 REV A 73A-510	0000	
U48	79814-00374	1	PAL PROGRAMMED C16L8 REV A 73A-332	0000	
U49	79814-00368	1	PAL PROGRAMMED 20L8 REV B 73A-332	0000	
U54	73405-02803	1	IC HIGH-VLT-CUR DARLINGTON TRANS ARRAY	0531	ULN2803A
U58	73308-74245	1	IC TTL ALS OCTAL BUS TRANSCEIVER	0107	74ALS245
U59	71701-74682	1	IC TTL LS 8-BIT COMPARATOR	0107	74LS682
U69	73313-74760	1	IC TTL AS OCTAL BUFFER NON-INV	0107	74AS760
U87	79814-00380	1	PAL PROGRAMMED 18P8L REV A 73A-510	0000	
U88	79814-00467	1	PAL PROGRAMMED EP1810 REV A	0000	
U962	79805-80021	1	IC CMOS 128 X 16 EPROM	0316	M6M80021L
U97	76510-07410	1	IC TTL ALS TRIPLE 3-INPUT NAND GATE	0107	74ALS10
VR1351	52000-00317	1	VOLTAGE REGULATOR 3-TERMINAL ADJUSTABLE	0078	LM317MP
VR1561	52000-07815	1	VOLTAGE REGULATOR 15 1.5A	0078	LM7815CT
VR1571	52000-07915	1	VOLTAGE REGULATOR -15V 1.5A	0074	MC7915CT
W10,7,8,9	90000-21002	1	WIRE HOOK-UP 22 GA BLACK STRANDED PVC	0017	9983-10
X1011,1012,1311,1312,311,312,611 612	45002-03010	8	SOCKET STRIP 10 SECTION 1 ROW .095 IN HEIGHT	0275	SL-110-T-12
X1121,42	45010-00084	2	SOCKET 84 PIN PLCC	0243	QILE84P-410-T
X1571,1572,89	42300-28105	3	FUSE SOCKET MICRO VERTICAL .025 LEADS .1 CNT	0061	281 005

REFERENCE DESIGNATOR	CDS PART NUMBER	QTY.	PART DESCRIPTION	MFG. NUM.	MFG. PART NUMBER
X20	45014-00000	1	SOCKET VERTICAL 14 PIN DIP	0268	14-6810-90C
X25,35	45012-28128	2	SOCKET 28-PIN DIP MACHINED	0089	ICA-286-S-TG30
X37,45	45010-48100	2	SOCKET 48-PIN DIP	0089	ICN-486-S5-G
X44	45012-24032	1	SOCKET 24 PIN SKINNY DIP	0004	2-641932-1
X88	45010-80186	1	SOCKET 68 PIN PLCC	0243	QILE68P-410T
Y55	89499-20000	1	CRYSTAL OSC 20.000MHZ 50 PPM	0037	XO-43A-20.000
Y57	89500-20000	1	CRYSTAL 20.000 MHZ 50 PPM	0062	MP-1 20.000