

Herschel
SPIRE DPU AVM 1553B Test Report

Document Ref.: SPIRE-IFS-REP-001385

Issue: 1

Distribution List :

K. King		
B. Swinyard		
E. Sawyer		
R. Cerulli		
A. di Giorgio		

Prepared by: Renato Orfei
Sergio Molinari
John Liù

Date: 8/10/2002

1	INTRODUCTION	3
1.1	PURPOSE OF THE DOCUMENT	3
1.2	ACRONYMS AND GLOSSARY	3
1.3	DOCUMENT LIST	4
1.3.1	<i>Applicable Documents</i>	4
1.3.2	<i>Reference Documents</i>	4
2	PHYSICAL LAYER	4
2.1	AMPLITUDE	4
2.2	RISE TIME/FALL TIME	6
2.3	DISTORSION, OVERSHOOT AND RINGING	8
2.4	OUTPUT ISOLATION	10
2.5	POWER ON/OFF NOISE	11
3	DATA LINK LAYER	11
3.1	MODE COMMANDS	11
3.1.1	<i>Transmitter Shutdown/Override</i>	12
3.1.2	<i>Transmit BIT (Built-In Test) Word</i>	12
3.1.3	<i>Terminal Flag Bit Inhibit/Override</i>	13
3.1.4	<i>Transmit Last Command</i>	13
3.2	DATA WRAP-AROUND	14
3.3	RECEIVE 1553 MESSAGE	15
3.4	TRANSMIT MESSAGE	16

1 Introduction

1.1 Purpose of the document

The purpose of this document is to report the results of the HW and SW tests carried out on the AVM of the SPIRE DPU concerning the STD-MIL-1553B interface with the Spacecraft, as specified in AD1.

1.2 Acronyms and Glossary

ACE	Advanced Computing Engine
ATP	Acceptance Test Plan
AVM	Avionic Model
BC	Bus Controller
CDMS	Computer Data Management System
DDC	Data Device Corporation
DLL	Data Link Layer
DPU	Digital Processing Unit
DSP	Digital Signal Processor
ESA	European Space Agency
GUI	Graphical User Interface
HIFI	Heterodyne Instrument for FIRST
HW	Hardware
ICU	Instrument Control Unit
IFSI	Istituto di Fisica dello Spazio Interplanetario
NA	Not Applicable
OBS	On-Board Software
PACS	Photoconductor Array Camera and Spectrometer
PHL	Physical Layer
RAM	Random Access Memory
RT	Remote Terminal
SPIRE	Spectral and Photometric Imaging Receiver
SA	Sub Address
SW	Software
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TC	Telecommand
TFL	Transfer Layer
TM	Telemetry

1.3 Document List

1.3.1 Applicable Documents

Document Reference	Name	Number/version/date
AD1	DPU/ICU Spacecraft Interface Test Plan	CNR-IFSI-2001-TR04 Issue: 1.1
AD2	MIL-STD-1553B	21 September 1978
AD3	Packet Structure Interface Control Document	SCI-PT-ICD-7527 Issue 1.0
AD4	Herschel/Planck Instrument Data Rates	H-P-1-ASPI-TN-0204 Issue: 1

1.3.2 Reference Documents

Document Reference	Name	Number/version
RD1	MIL-HDBK-1553A	
RD2	Payload and Spacecraft Interface Board Specification	DPU-SP-CGS-002 Issue: 1

2 Physical Layer

The tests carried out for the PHL are those specified in AD1, Sect. 4, “Output characteristics”. The testing equipment for these tests was be a DDC BU-61580 board configured as BC and managed through the ACE Manager GUI provided by DDC. The BC was connected via transformer-coupled stubs to the DPU/ICU. Signals were measured using a break-out box connected to the DPU J03 and J04 connectors (pins 2 and 6) for the main bus “A” and the main bus “B” respectively, and a Tektronix TDS 380 Oscilloscope.

2.1 Amplitude

A valid, legal transmit command is sent to the DPU, requesting the maximum number of words that it is capable of sending. The amplitude of the waveform transmitted by the DPU is measured peak-to-peak.

The amplitude of the waveform transmitted by the for bus A and Figure 2.1-2 for bus B) are:

Vpp	Vpp min.	Vpp max.	Vpp meas.	Pass/Fail
Bus A	18.0	27.0	23.92	Pass
Bus B	18.0	27.0	23.84	Pass

Tek **Stop**: Single Seq 10MS/s

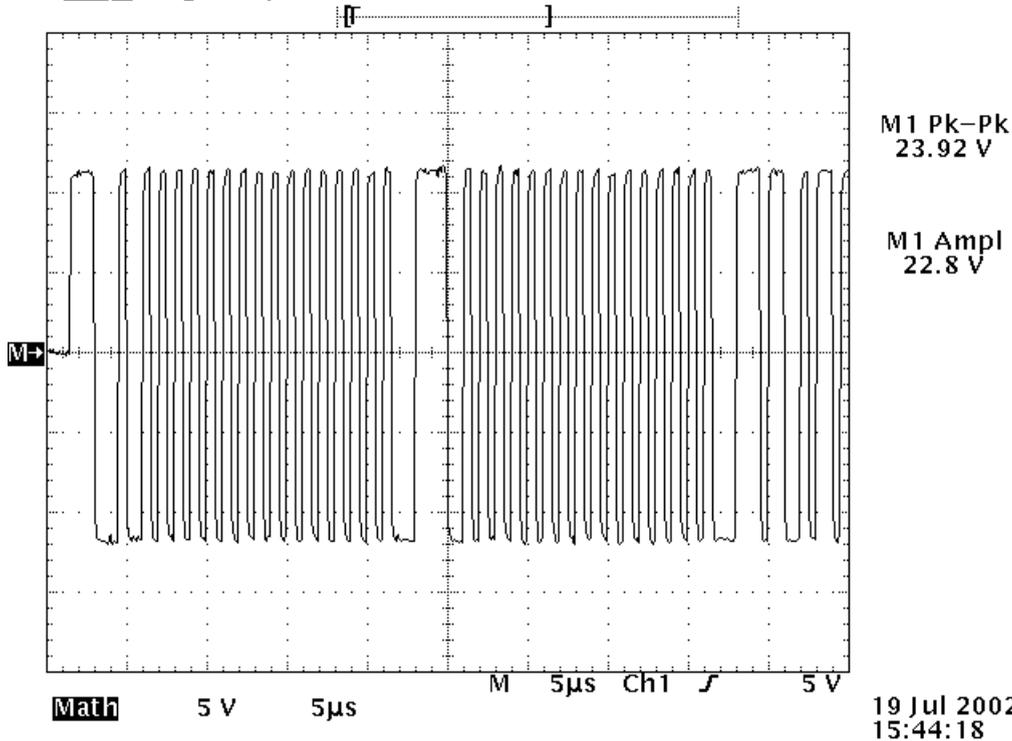


Figure 2.1-1 Output signal on Bus A

Tek **Stop**: Single Seq 10MS/s

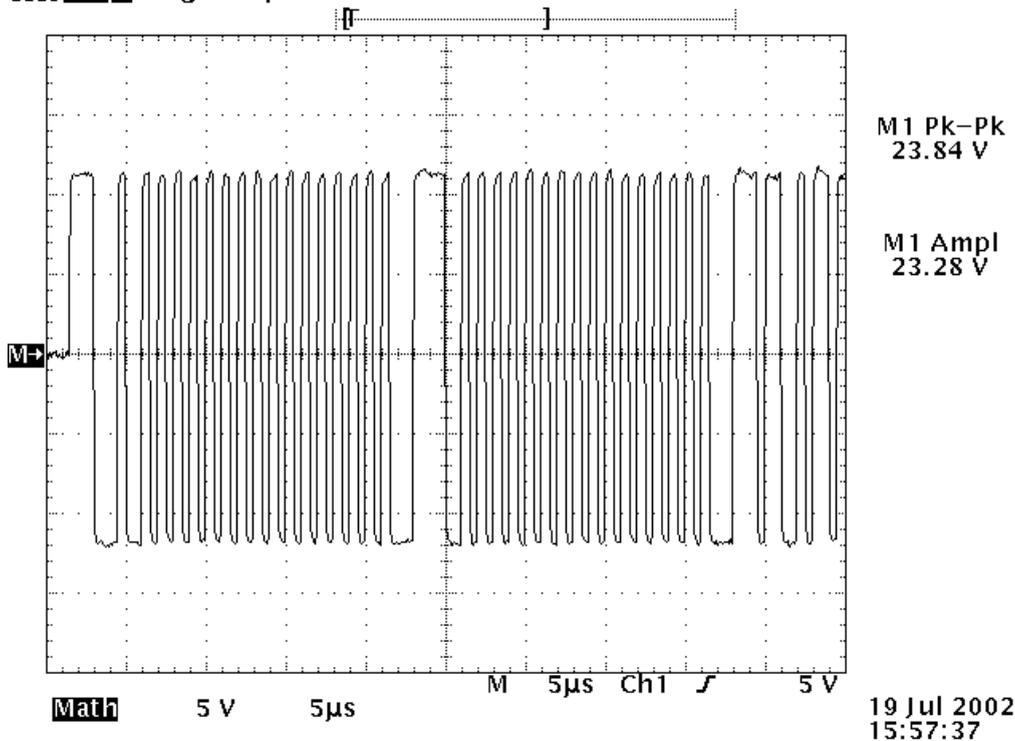


Figure 2.1-2 Output signal on Bus B

In **Figure 2.1-1** and **Figure 2.1-2**, the first 20 microseconds show the request of 32 words coming from the BC while the following waveforms show the response data from the DPU.

2.2 Rise time/Fall time

A valid, legal transmit command was sent to the DPU, requesting one data word. The rise and fall time of the DPU waveform is measured between the 10% and 90% points of the waveform. The measurements were taken at both the rising and falling edges of a sync waveform and a data bit waveform.

The rise and fall time of the DPU AVM Sync and Dataword waveforms (Figure 2.2-1 and Figure 2.2-2 for bus A; Figure 2.2-3 and Figure 2.2-4 for bus B) are:

Tr/Tf	Tr min. (nS)	Tr max. (nS)	Tr meas. (nS)	Tf meas. (nS)	Pass/Fail
Sync Bus A	100	300	168	152	Pass
Data Bus A	100	300	140	143	Pass
Sync Bus B	100	300	157	152	Pass
Data Bus B	100	300	131	133	Pass

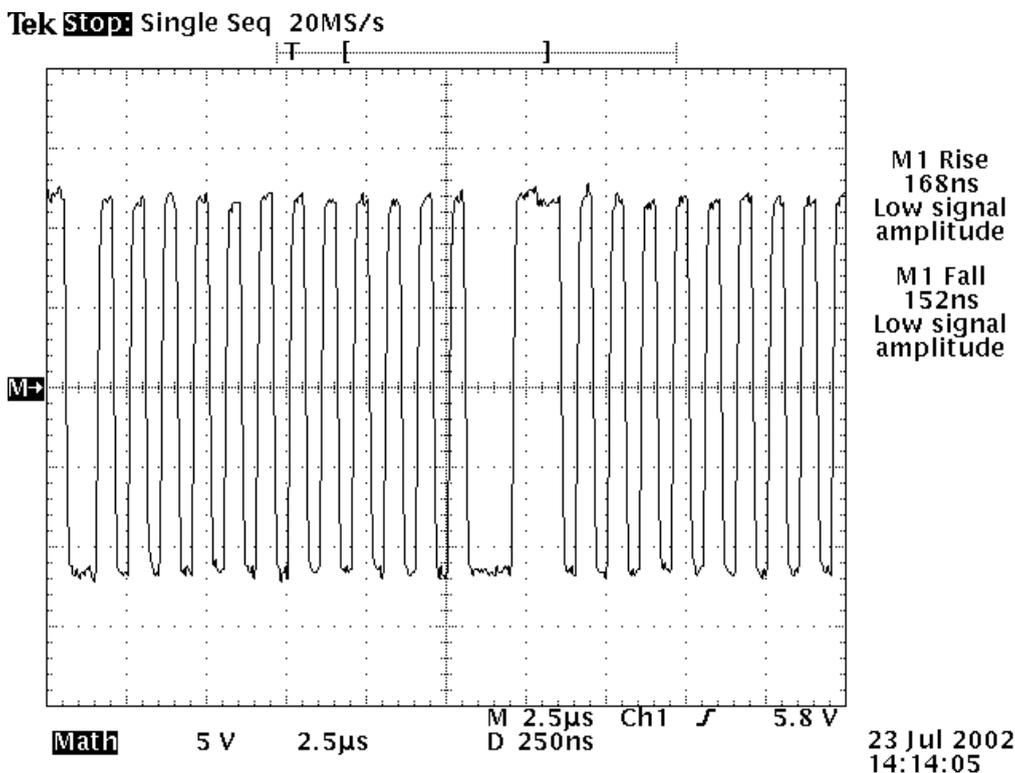
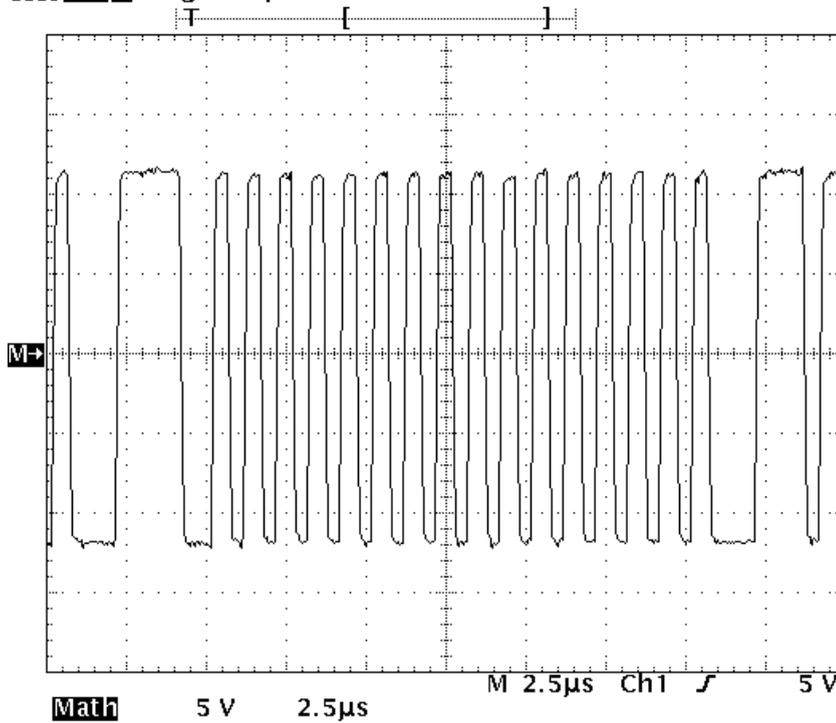


Figure 2.2-1 Sync waveform for Bus A

Tek **Stop** Single Seq 20MS/s

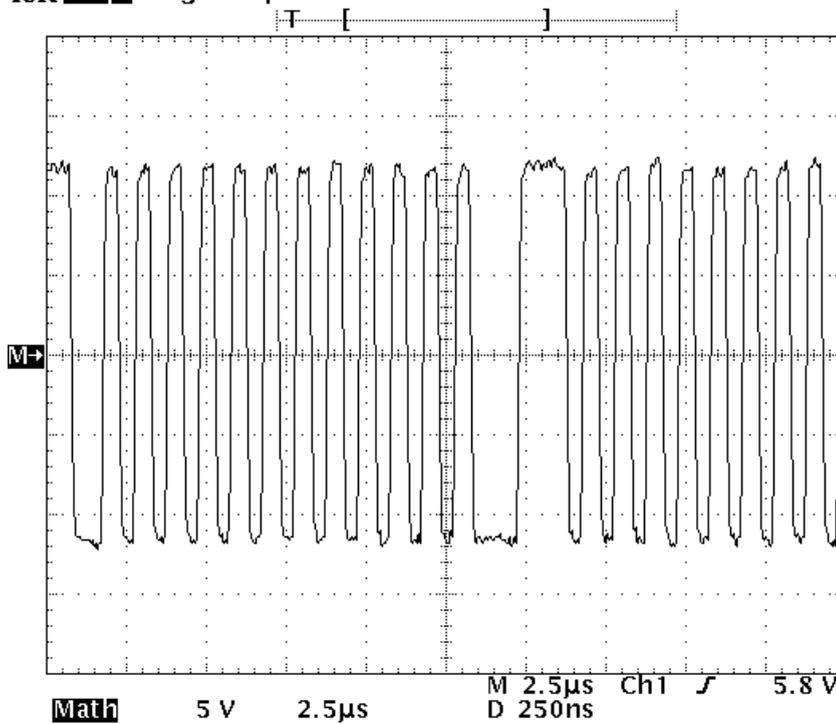


M1 Rise
140ns
M1 Fall
143ns

19 Jul 2002
15:51:02

Figure 2.2-2 Data word waveform for Bus A

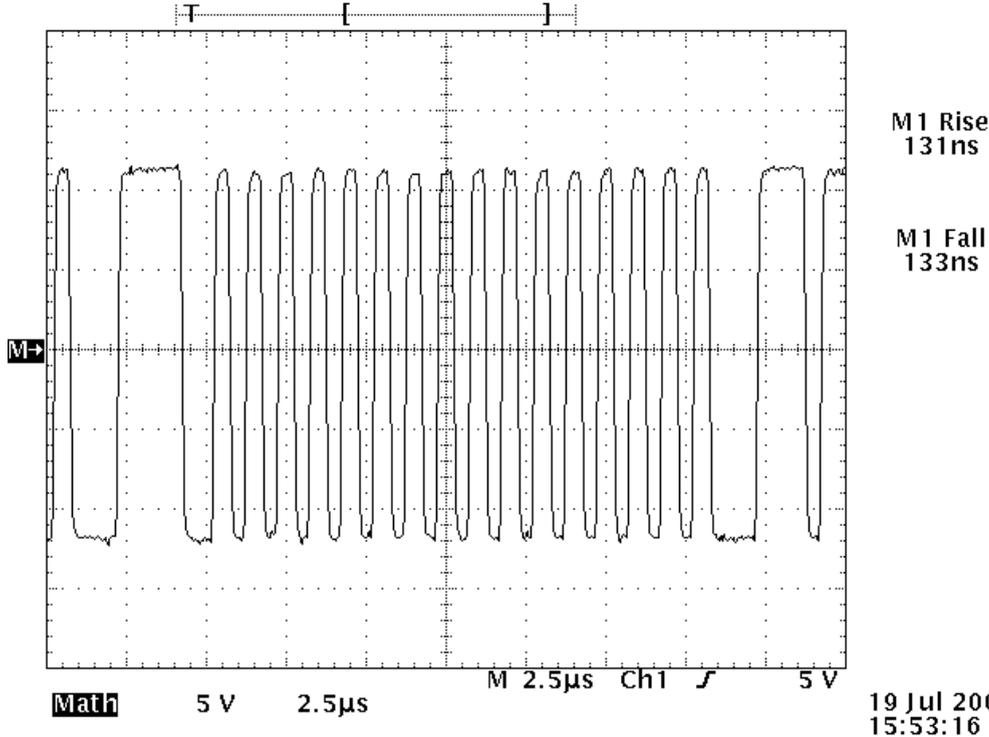
Tek **Stop** Single Seq 20MS/s



M1 Rise
157ns
Low signal
amplitude
M1 Fall
152ns
Low signal
amplitude

23 Jul 2002
14:16:32

Figure 2.2-3 Sync waveform for Bus B

Tek Stop: Single Seq 20MS/s

Figure 2.2-4 Data word waveform for Bus B

2.3 Distortion, overshoot and ringing

A valid legal transmit command was sent to the DPU, requesting it to transmit one data word. The distortion of the waveform, distortion voltage (VD), was measured as indicated in Fig. 2 of RD1. Pass criteria shall be $VD < +900\text{mV}$ peak, line-to-line, for transformer coupled stubs. The worst measured parameter, VD (see figure 7 for bus A and figure 8 for bus B) are:

Vd	Vd min. (mV)	Vd max. (mV)	Vd meas. (mV)	Pass/Fail
Bus A	0	900	494	Pass
Bus B	0	900	586	Pass

Tek **Stop** Single Seq 20MS/s

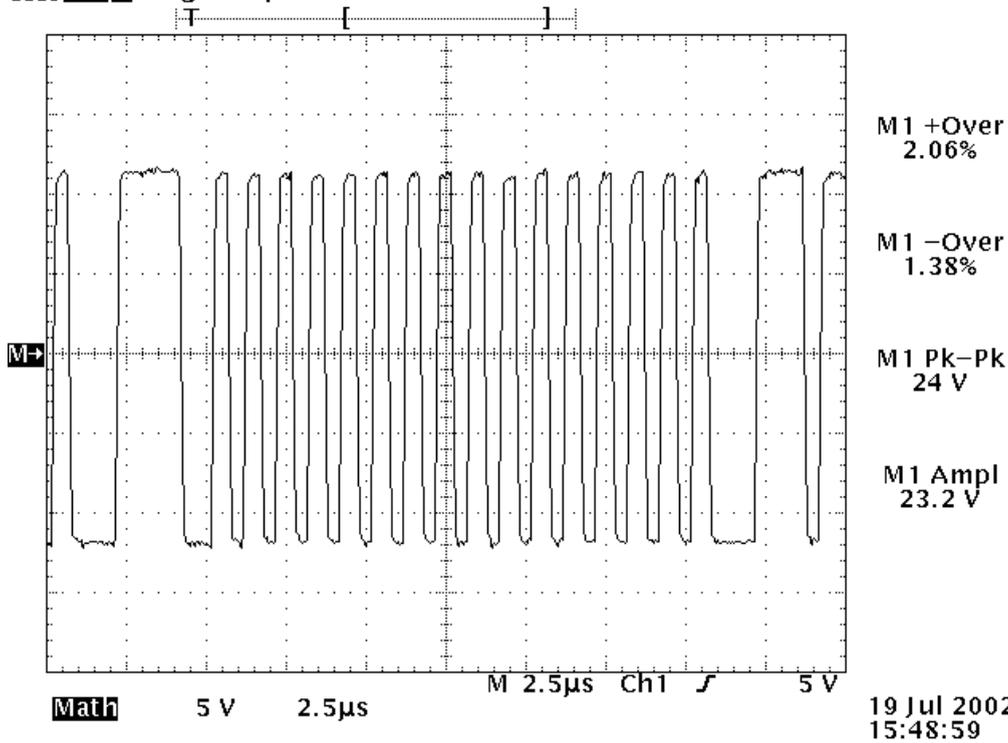


Figure 2.3-1 Data word waveform for Bus A

Tek **Stop** Single Seq 20MS/s

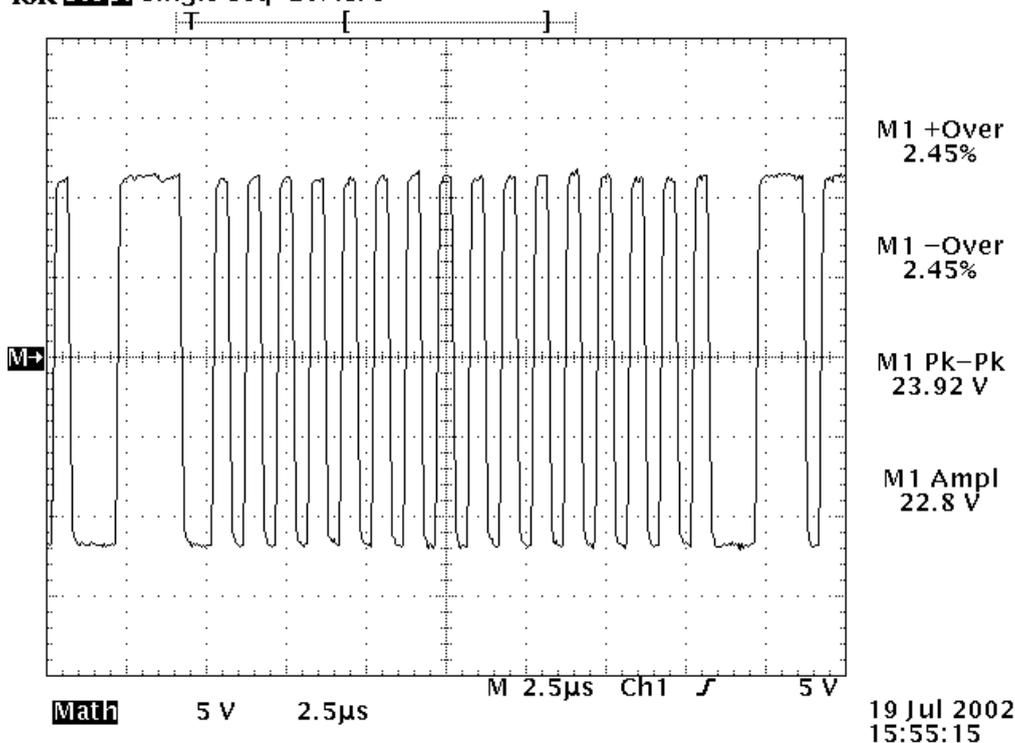


Figure 2.3-2 Data word waveform for Bus B

2.4 Output isolation

When the active bus is the “A”, the measurement is taken on bus “B”, and when the active bus is “B” the measurement is taken on bus “A”.

Bus “A“ Active Vpp (V)	Bus “B” Vpp (mV)	A/B (dB)	A/B (dB) Measured	Pass/Fail
24	(<120 mV)	> 45 dB		NOTE
Bus “B“ Active Vpp (V)	Bus “A” Vpp (mV)	B/A (dB)	B/A (dB) Measured	Pass/Fail
23.9	(<120 mV)	> 45 dB		NOTE

NOTE: The above measurements cannot be carried out in normal laboratory conditions and with normal instrumentation as the 50 Hz noise on the lines (pins 2 and 6) is too large to allow a reasonable trigger of the oscilloscope (see Figure 2.4-1).

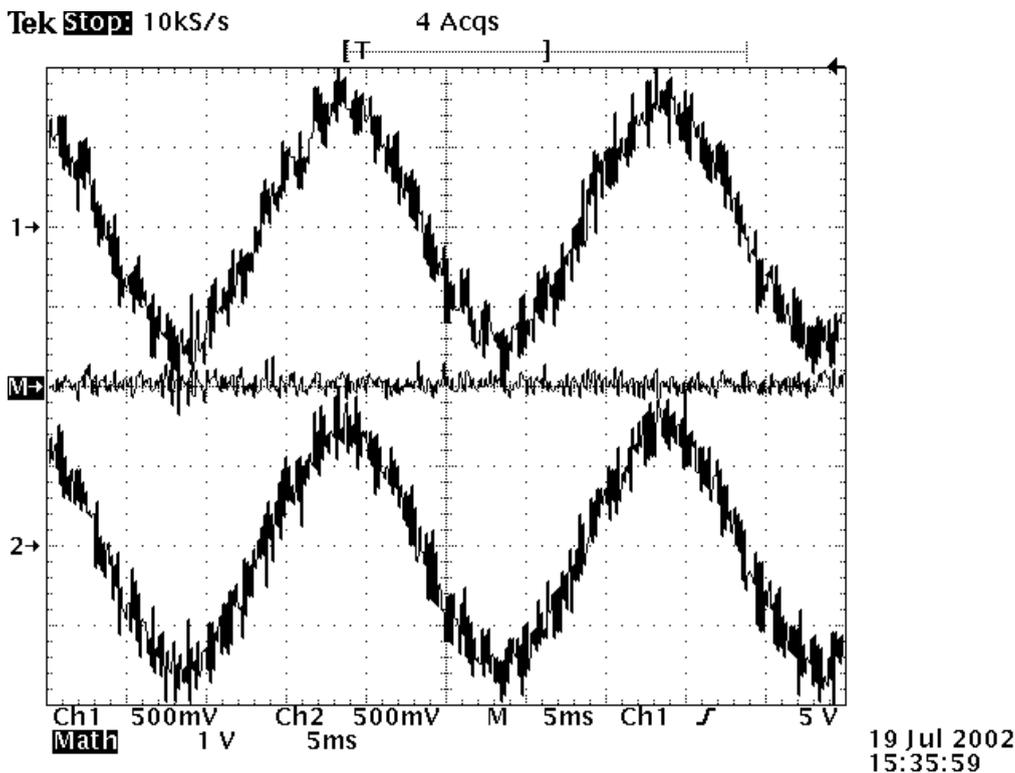


Figure 2.4-1

2.5 Power On/Off noise

This test cannot be carried out in normal laboratory conditions and with normal instrumentation as the 50 Hz noise on the lines (pins 2 and 6) is too large to allow a reasonable trigger of the oscilloscope (see Figure 2.4-1).

3 Data Link Layer

The tests carried out for the PHL are those specified in AD1, Sect. 4.6. An external PC equipped with a BU-65549 1553 interface board and the ACE Manager GUI, both provided by DDC, will be used as BC for the tests in this subsection.

3.1 Mode Commands

The reports for these tests will consist of the ACE BC log files recorded during tests execution. The pass criteria reported in test procedures of AD1 are mostly based on the content of 1553 status word that the DPU sends back to the BC in response to every message. According to RD1, a clear status word is one in which bits 0,1,2,4,9 and 10 are set to 0. The ACE BC log file reports the status word for each message with the label **Stat1**.

3.1.1 Transmitter Shutdown/Override

This is the ACE BC log file recorded during the test procedure. The test is **passed**.

File: BC_test5.2.1.5.2 07/23/02 04:07AM		Total Messages: 00010	
Msg: 1	Type: RT to BC Cmd1: AD46 Data: 0000 0000 0000 0000 0000 0000	Time: 1348µS 21-T-10-06	BSW: 8000 Stat1: A800 CHANNEL A
Msg: 2	Type: RT to BC Cmd1: AD46 Data: 0000 0000 0000 0000 0000 0000	Time: 1524µS 21-T-10-06	BSW: A000 Stat1: A800 CHANNEL B
Msg: 3	Type: Mode No Data Cmd1: AFE4 Data:	Time: 1580µS 21-T-31-04	BSW: 8000 Stat1: A800 CHANNEL A
Msg: 4	Type: RT to BC Cmd1: AD46 Data:	Time: 1736µS 21-T-10-06	BSW: B200 NO RESPONSE CHANNEL B
Msg: 5	Type: RT to BC Cmd1: AD46 Data: 0000 0000 0000 0000 0000 0000	Time: 1912µS 21-T-10-06	BSW: 8000 Stat1: A800 CHANNEL A
Msg: 6	Type: Mode No Data Cmd1: AFE5 Data:	Time: 2070µS 21-T-31-05	BSW: B200 NO RESPONSE CHANNEL B
Msg: 7	Type: RT to BC Cmd1: AD46 Data:	Time: 2226µS 21-T-10-06	BSW: B200 NO RESPONSE CHANNEL B
Msg: 8	Type: Mode No Data Cmd1: AFE5 Data:	Time: 2282µS 21-T-31-05	BSW: 8000 Stat1: A800 CHANNEL A
Msg: 9	Type: RT to BC Cmd1: AD46 Data: 0000 0000 0000 0000 0000 0000	Time: 2458µS 21-T-10-06	BSW: A000 Stat1: A800 CHANNEL B
Msg: 10	Type: RT to BC Cmd1: AD46 Data: 0000 0000 0000 0000 0000 0000	Time: 2634µS 21-T-10-06	BSW: 8000 Stat1: A800 CHANNEL A

3.1.2 Transmit BIT (Built-In Test) Word

This is the ACE BC log file recorded during the test procedure. The test is **passed**.

File: BC_test5.2.2.1.4.asf 09/04/02 04:18AM		Total Messages: 00001	
Msg: 1	Type: Mode Tx Data Cmd1: AFF3 Data: 0000	Time: 1186µS 21-T-31-19	BSW: 8000 Stat1: A800 CHANNEL A

3.1.3 Terminal Flag Bit Inhibit/Override

This is the ACE BC log file recorded during the test procedure. The test is **passed**.

File: BCtest5.2.2.1.6.primo 07/23/02 04:41AM		Total Messages: 00001	
Msg: 1	Type: BC to RT	Time: 41470µS	BSW: 8000 CHANNEL A
	Cmd1: A941	21-R-10-01	Stat1: A800
Data:	A5A5		
File: BCtest5.2.2.1.6.secondo 07/23/02 04:44AM		Total Messages: 00005	
Msg: 1	Type: BC to RT	Time: 1162µS	BSW: 8000 CHANNEL A
	Cmd1: A941	21-R-10-01	Stat1: A801
Data:	A5A5		
Msg: 2	Type: Mode No Data	Time: 1218µS	BSW: 8000 CHANNEL A
	Cmd1: AFE6	21-T-31-06	Stat1: A801
Data:			
Msg: 3	Type: BC to RT	Time: 1292µS	BSW: 8000 CHANNEL A
	Cmd1: A941	21-R-10-01	Stat1: A800
Data:	A5A5		
Msg: 4	Type: Mode No Data	Time: 1346µS	BSW: 8000 CHANNEL A
	Cmd1: AFE7	21-T-31-07	Stat1: A800
Data:			
Msg: 5	Type: BC to RT	Time: 1420µS	BSW: 8000 CHANNEL A
	Cmd1: A941	21-R-10-01	Stat1: A801
Data:	A5A5		
File: BCtest5.2.2.1.6.terzo 07/23/02 04:46AM		Total Messages: 00001	
Msg: 1	Type: BC to RT	Time: 1132µS	BSW: 8000 CHANNEL A
	Cmd1: A941	21-R-10-01	Stat1: A800
Data:	A5A5		

3.1.4 Transmit Last Command

This is the ACE BC log file recorded during the test procedure. The test is **passed**.

File: BC_test5.2.2.1.8 07/23/02 10:28PM		Total Messages: 00004	
Msg: 1	Type: RT to BC Cmd1: AD46 Data: 0000 0000 0000 0000 0000 0000	Time: 1032µS 21-T-10-06	BSW: 8000 Stat1: A800 CHANNEL A
Msg: 2	Type: Mode Tx Data Cmd1: AFF2 Data: AD46	Time: 1108µS 21-T-31-18	BSW: 8000 Stat1: A800 CHANNEL A
Msg: 3	Type: BC to RT Cmd1: A941 Data: A5A5	Time: 1182µS 21-R-10-01	BSW: 8000 Stat1: A800 CHANNEL A
Msg: 4	Type: Mode Tx Data Cmd1: AFF2 Data: A941	Time: 1256µS 21-T-31-18	BSW: 8000 Stat1: A800 CHANNEL A

3.2 Data Wrap-Around

The procedure for this test has been executed using a dedicated C program that uses 1553 software libraries provided by DDC and running on a PC where a DDC BU-61580 board was installed. The program list follows.

```
#undef          RAND_MAX
#define         RAND_MAX    0xFFFF
#include        <stdace.h>

void main()
{
BuConf_t      myconf;
BuError_t     err,bcerr;
U16BIT        datain[32],dataout[32],a;
int           i,j;
FILE          *filein,*fileout;
//----- Open ACE libraries
err=BuInit("ace_card1.cfg",&myconf);
if (BuValid()) {
printf("ACE Libraries successfully opened\n");
} else printf("Problems with ACE Libraries\n");
//-----
// open file to store data sent to the DPU
fileout=fopen("sent_data.dat", "w");
// open file to store data words received from the DPU
filein=fopen("received_data.dat", "w");
BuBCOpen(); // Configure BC
srand(time(0)); // initialize random seed
// execute procedure 10000 times
for (i=0;i<10000;i++){
for (j=0;j<32;j++){
a=rand(); // get the random data word
fprintf(fileout,"%0.2x\t",a); // write it in the SENT DATA file
dataout[j]=a; // fill in the 32 word array
}
fprintf(fileout,"\n");
// sends 32 data words to DPU (RT21) to SA30R using Bus A
err=BuBCSendData(CW_CHANNELA,21,30,dataout,32);
// receives 32 data words from DPU (RT21) from SA30T using Bus A
```

```

err=BuBCGetData(CW_CHANNELA,21,30,datain,32);
// write received data into RECEIVED DATA file
for (j=0;j<32;j++) fprintf(filein,"%0.2x\t",datain[j]);
fprintf(filein,"\n");
// compare SENT and RECEIVED arrays: they should be identical
for (j=0;j<32;j++)
    if (datain[j] != dataout[j])
        printf("Error on message %d word %d \n",i,j);
}
fclose(filein);
fclose(fileout);
//-----
BuBCclose(); // stops BC
BuClose(); // Close software libraries
}

```

The error message notifying a non-identity between sent and received data was never issued by the program during its execution. In addition, the sent and received data files were also compared and found identical. The test is passed.

3.3 Receive 1553 Message

A set of RECEIVE messages was prepared on the BC using the **ACE Menu** GUI. All messages contained 32 words with random content and were sent to various SA of the DPU. After sending the messages to the different SAa, the Dual Port RAM of the 1553 chip on the DPU side was inspected at locations where received data words were stored. *The contents of these memory locations should be identical to the data words sent by the BC.*

The addresses of these locations are contained in the RT look-up table for memory management control, which is placed at a fixed location in the 1553 chip memory (mapped on the DPU Data Memory). The look-up table for RECEIVE SAa goes from 0x8f000140 for SA0R to 0x8f00015f for SA31R. We illustrate the test results for one particular run.

A RECEIVE message was sent to DPU at SA11R; this is the corresponding BC log file which also reports the sent data words:

```

File: BC.asf 09/04/02 05:23AM                               Total Messages: 00001

Msg: 1      Type: BC to RT      Time: 1678µS      BSW: 8000  CHANNEL A
          Cmd1: A960             21-R-11-00      Stat1: A800
          Data: A45E 426C 70DD 11FA 983E AA6C 66B1 5295
                5030 FE51 1429 CCEA 9001 DD43 9AAD 1234
                FF5E BC87 6834 A5A5 BE57 44FF 1A1A 78AE
                45FA 11AA 62BB 56AA 73BD FE34 AAB2 CC46

```

DM address 0x8f00014b contains the pointer to the DM location where the data words for SA11R are stored, which is 0x8f0002a0. The picture below is the snapshot of the DM for the 32 locations starting from 0x8f0002a0 (the two trailing 0s should not be considered):

RAM	[8f0002a0]	0000a45e00
RAM	[8f0002a1]	0000426c00
RAM	[8f0002a2]	000070dd00
RAM	[8f0002a3]	000011fa00
RAM	[8f0002a4]	0000983e00
RAM	[8f0002a5]	0000aa6c00
RAM	[8f0002a6]	000066b100
RAM	[8f0002a7]	0000529500
RAM	[8f0002a8]	0000503000
RAM	[8f0002a9]	0000fe5100
RAM	[8f0002aa]	0000142900
RAM	[8f0002ab]	0000ccea00
RAM	[8f0002ac]	0000900100
RAM	[8f0002ad]	0000dd4300
RAM	[8f0002ae]	00009aad00
RAM	[8f0002af]	0000123400
RAM	[8f0002b0]	0000ff5e00
RAM	[8f0002b1]	0000bc8700
RAM	[8f0002b2]	0000683400
RAM	[8f0002b3]	0000a5a500
RAM	[8f0002b4]	0000be5700
RAM	[8f0002b5]	000044ff00
RAM	[8f0002b6]	00001a1a00
RAM	[8f0002b7]	000078ae00
RAM	[8f0002b8]	000045fa00
RAM	[8f0002b9]	000011aa00
RAM	[8f0002ba]	000062bb00
RAM	[8f0002bb]	000056aa00
RAM	[8f0002bc]	000073bd00
RAM	[8f0002bd]	0000fe3400
RAM	[8f0002be]	0000aab200
RAM	[8f0002bf]	0000cc4600

The data words are identical to the ones sent by the BC and reported in the above BC log file. This test has been repeated many times and was always passed.

3.4 Transmit message

A set of TRANSMIT messages was prepared on the BC using the **ACE Menu** GUI. All messages commanded the DPU to transmit 32 words and were sent to various SA of the DPU. Before sending the messages we manually loaded with random words the DM memory blocks corresponding to the various transmit SAs. The addresses of these locations are contained in the RT look-up table for memory management control, which is placed at a fixed location in the 1553 chip memory (mapped on the DPU Data Memory). The look-up table for TRANSMIT SAs goes from 0x8f000160 for SA0T to 0x8f00016f for SA31T.

After sending the messages to the different SAs, the data words reported in the BC log file were compared to the values we manually loaded into the DM. The two sets of data words should be identical. We illustrate the test results for one particular run.

The 32 locations of the DM starting at 0x8f000b80, corresponding the DM area block for SA17T, were manually filled with random words as follows (the two trailing 0s should not be considered):

```
RAM [8f000b80] 0000af3400
RAM [8f000b81] 0000365700
RAM [8f000b82] 0000ed8900
RAM [8f000b83] 0000991100
RAM [8f000b84] 0000cff900
RAM [8f000b85] 00001a1a00
RAM [8f000b86] 0000973300
RAM [8f000b87] 0000cc7700
RAM [8f000b88] 00005a5a00
RAM [8f000b89] 0000ff9000
RAM [8f000b8a] 00001c1c00
RAM [8f000b8b] 000097dd00
RAM [8f000b8c] 000011aa00
RAM [8f000b8d] 000045cb00
RAM [8f000b8e] 000088aa00
RAM [8f000b8f] 000021aa00
RAM [8f000b90] 0000cadb00
RAM [8f000b91] 000056ff00
RAM [8f000b92] 0000dd6600
RAM [8f000b93] 000033df00
RAM [8f000b94] 0000ae9000
RAM [8f000b95] 0000da3100
RAM [8f000b96] 0000faf900
RAM [8f000b97] 0000428900
RAM [8f000b98] 0000149000
RAM [8f000b99] 0000528800
RAM [8f000b9a] 0000ad7800
RAM [8f000b9b] 0000313100
RAM [8f000b9c] 0000daff00
RAM [8f000b9d] 0000ee5600
RAM [8f000b9e] 0000fe4000
RAM [8f000b9f] 0000a31100
```

A TRANSMIT message was sent to DPU at SA17T, and this is the corresponding BC log file which also reports the data words received by the BC:

```
File: BC_testSA17T.asf 09/04/02 05:43AM          Total Messages: 00001
Msg: 1      Type: RT to BC          Time: 1648µS    BSW: 8000  CHANNEL A
           Cmd1: AE20              21-T-17-00    Stat1: A800
           Data: AF34 3657 ED89 9911 CFF9 1A1A 9733 CC77
                5A5A FF90 1C1C 97DD 11AA 45CB 88AA 21AA
                CADB 56FF DD66 33DF AE90 DA31 FAF9 4289
                1490 5288 AD78 3131 DAFF EE56 FE40 A311
```

The data words are identical to the ones present in the DM of the DPU. This test has been repeated many times and was always passed.