WOODWARD

Application Note 51295
(Revision NEW)
Original Instructions

Highland Technology
V375 VME 4-channel Speed Card

⚠ **General Precautions**	**Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.** **Practice all plant and safety instructions and precautions.** **Failure to follow instructions can cause personal injury and/or property damage.**

⚠ **Revisions**	**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:** **www.woodward.com/publications** **The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.**

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Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

Warnings and Notices

Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE **Battery Charging Device**	**To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.**

Electrostatic Discharge Awareness

NOTICE **Electrostatic Precautions**	**Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:** • **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).** • **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.** • **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.** **To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Highland Technology V375 VME 4-channel Speed Card

Introduction

The Highland Technology V375 is 4-channel waveform generator (speed card), with 4 independently programmable outputs. The outputs can be set to have up to 50 harmonics per channel with variable phase angles, dc offset, and peak-peak amplitudes. This card can be run in a NetCon® control, NetCon expansion (with copper XCVR modules), MicroNet™ control, MicroNet expansion (with copper XCVR modules), and the MicroNet Plus main chassis. This card cannot be run in a MicroNet Plus expansion chassis.

In order to run in a Woodward chassis, the card must have the 5503-180 Generic VME adapter (low current, no +12 V or –12 V) (drawing #9934-170 and 9934-169) with the following modifications:

- Open pins P1-C14 (AM5), P1-A23 (AM4), and P2-C25. These pins must be removed from the extender card P1 and P2, otherwise modules in the chassis will not function properly.
- Jumper P1-B32 (+5 V) to P1-C14 and P1-A23.

VME Addressing

The Highland card VME base addressing is set by DIP switches located on the card. The VME addressing is slot specific; however, the Highland card does not need to be physically located in the slot whose address is used to address it. There cannot be an I/O card assigned in GAP™ (graphical application program) for the slot address that is used for the Highland addressing (that is, if the Highland card is addressed as main chassis slot 3, then main chassis slot 3 cannot have a card that is programmed in GAP). The VME addressing in Woodward systems is such that the Highland card needs to be set to 24 bit addressing. This is done by setting the DIP switch labeled as A16=A24 to the off position (A24). The upper 8 address bits (24–31) of the VME address do not need to be set on the Highland card. Bits 8–23 do need to be set to correspond to the address being used to write/read the card.

For example, if the address of main chassis slot 3 is used with an offset of 0000 C000, the DIP switches will be set as:

23 off	18 off	13 off
22 off	17 off	12 off
21 off	16 off	11 off
20 off	15 on	10 off
19 off	14 on	9 off

IMPORTANT **If the Highland card is put into an expansion chassis, the DIP switches are set the same as if it were in the main chassis.**

Main Chassis

Slot	VME Address
2	8000 0000
3	8008 0000
4	8010 0000
5	8018 0000
6	8020 0000
7	8028 0000
8	8030 0000
9	8038 0000
10	8040 0000
11	8048 0000
12	8050 0000
13	8058 0000
14	8060 0000

Expansion Chassis 1

Slot	VME Address
2	8100 0000
3	8108 0000
4	8110 0000
5	8118 0000
6	8120 0000
7	8128 0000
8	8130 0000
9	8138 0000
10	8140 0000
11	8148 0000
12	8150 0000
13	8158 0000
14	8160 0000

GAP

There are four individually controllable waveform outputs located on the Highland card. These outputs are labeled as waveform W, X, Y, and Z (0, 1, 2, and 3). A GAP program has been written that will set each of the four channels so that they can be run from 0–36 000 Hz and can be set to run to approximately 360 000 Hz. The GAP is located on the sharedir\oemeng\Highland speed card and is named Highland.gap. The following sections will detail the GAP operation.

The Highland card is directly addressed through the VME bus by doing VME reads/writes using the CALC_PLUS block.

Sheet 5 INIT Highland-Read from Card HIGHLAND.CARD_DATA block

This block is a status read of the Highland card, and is only used as a status check.

1. FUNCT_1 (vximfr)- Read of address xC000 is the manufacturer ID# and will always be 65262, FEEE hex.

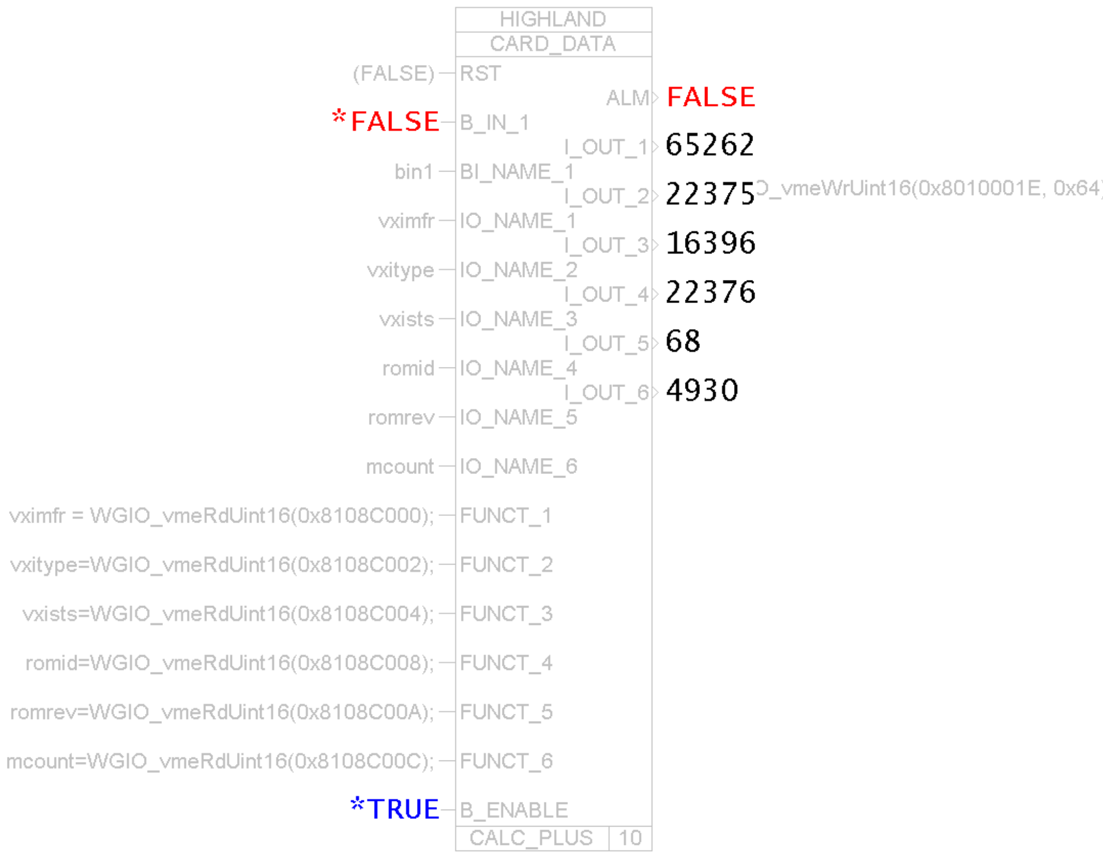
2. FUNCT_2 (vxitype)- Read of address C002 is the module type and will always be 22375, 5767 hex.

3. FUNCT_3 (vxists)- Read of address C004 is the module status register.

4. FUNCT_4 (romid)- Read of address C008 is the Highland card ROM ID# and will be 22376.

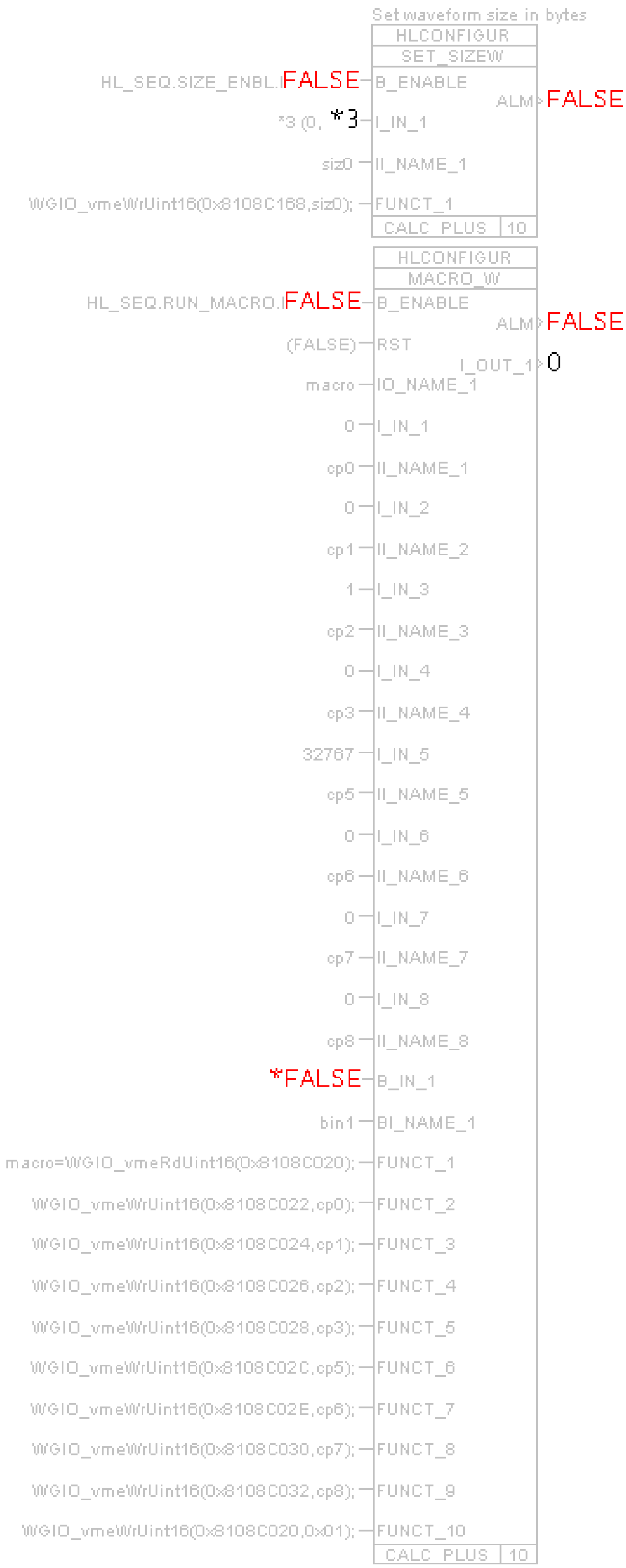
5. FUNCT_5 (romrev)- Read of address C00A is the revision of the ROM and will be 68 (rev A).

6. FUNCT_6 (mcount)- Read of address C00C is the microprocessor update counter.



Sheet 6 Set Waveform Size & Setup Waveform

The function of this sheet is to setup the size of the memory location used to store the data for the waveform and initialize the card to write the data to the memory. The current GAP is setup to use a default sine wave for all waveforms. It is possible to write a waveform other than a sine, but that section of the GAP is not currently complete.


Set waveform size in bytes
HLCONFIGUR
SET_SIZEW
HL_SEQ.SIZE_ENBL.IFALSE
B_ENABLE
ALM
FALSE
*3 (0, *3
I_IN_1
siz0
II_NAME_1
WGIO_vmeWrUint16(0x8108C168,siz0);
FUNCT_1
CALC_PLUS 10
HLCONFIGUR
MACRO_W
HL_SEQ.RUN_MACRO.IFALSE
B_ENABLE
ALM
FALSE
(FALSE)
RST
I_OUT_1
0
macro
IO_NAME_1
0
I_IN_1
cp0
II_NAME_1
0
I_IN_2
cp1
II_NAME_2
1
I_IN_3
cp2
II_NAME_3
0
I_IN_4
cp3
II_NAME_4
32767
I_IN_5
cp5
II_NAME_5
0
I_IN_6
cp6
II_NAME_6
0
I_IN_7
cp7
II_NAME_7
0
I_IN_8
cp8
II_NAME_8
*FALSE
B_IN_1
bin1
BI_NAME_1
macro=WGIO_vmeRdUint16(0x8108C020);
FUNCT_1
WGIO_vmeWrUint16(0x8108C022,cp0);
FUNCT_2
WGIO_vmeWrUint16(0x8108C024,cp1);
FUNCT_3
WGIO_vmeWrUint16(0x8108C026,cp2);
FUNCT_4
WGIO_vmeWrUint16(0x8108C028,cp3);
FUNCT_5
WGIO_vmeWrUint16(0x8108C02C,cp5);
FUNCT_6
WGIO_vmeWrUint16(0x8108C02E,cp6);
FUNCT_7
WGIO_vmeWrUint16(0x8108C030,cp7);
FUNCT_8
WGIO_vmeWrUint16(0x8108C032,cp8);
FUNCT_9
WGIO_vmeWrUint16(0x8108C020,0x01);
FUNCT_10
CALC_PLUS 10

HI_CONFIGUR.SET_SIZEa Block

This block sets the memory size used to store the data for the waveform used on each channel. It is a VME write to address C168 for wave W, C188-X, C1A8-Y, and C1C8-Z. This size must be set before writing the data to the memory. The larger the size of the memory used the higher the resolution of the output signal. However, the higher the size the lower the maximum frequency output available. Default for our GAP is siz= 3 (512 words) for a maximum frequency of around 36 000. This block only needs to be run once on initial start-up or if the waveform size or data changes.

Below is a table of the size input.

SIZ contents	Blocksize (words)
0	64
1	128
2	256
3	512
4	1024
5	2048
6	4096
7	8192
8	16384
9	32768
10	65536

HI_CONFIGUR.MACRO_a Block

This block is responsible for setting up the memory location used to store the waveform data for each output channel. This block only needs to be run once on initial startup or if the waveform size or data changes.

1. Funct_1 Reads address C020 to clear the macro command register.
2. Funct_2 (cp0) writes address C022 with the channel number that will be set up (0=W, 1=X, 2=Y, 3=Z).
3. Funct_3 (cp1) writes address C024 with the starting memory address for the waveform data.
4. Funct_4 (cp2) writes address C026 with the number of harmonics to generate per waveform. This is set to 1 for all channels to generate only a single waveform with no harmonics.
5. Funct_5 (cp3) writes address C028 with the DC offset of the waveform output. This is set to 0V of offset.
6. Funct_6 (cp5) writes address C02C with the full scale amplitude of the waveform output. The value of 32767 gives a full scale output of ±10 Vp-p.
7. Funct_7 (cp6) writes address C02E with the phase angle offset of the main waveform. This is currently set to 0 degrees.
8. FUNCT_8 (cp7) writes address C030 with the full scale amplitude of the waveform output for the second harmonic. Set to 0 Vp-p.

9. FUNCT_9 (cp8) writes address C032 with the phase angle offset of the main waveform. This is currently set to 0 degrees.

10. FUNCT_10 Writes address C020 to initiate the macro function defined.

If multiple harmonics are required for any channel, the HI_CONFIGUR.MACRO_a block can be modified by adding Function repeats to write the corresponding cp addresses for that harmonic (up to 50). See sheet 22 of the Highland manual for more detail.

HI_CONFIGUR.READ_WAVa/ LOAD_WAVa

These blocks are intended to allow a read/write to Addresses C164 and C166 to setup a memory location to contain a waveform that is generated by the user. This logic has not been finished at this point.

Sheet 7 Initialize Waveform

The function of this sheet is to initialize the waveform output for each channel. The waveform source, amplitude, starting address in memory and other parameters are set up here. This block only needs to be run once on initial start-up or if the waveform size or data changes.

IMPORTANT **All address references are for wave W.**

1. FUNCT_1 (src0) writes address C160 with the source register to use for the data stored in memory. To ensure the channels run independently, this input needs to be set to the same value as the cp0 input on the MACRO_a block on sheet 7 for the corresponding channel. This has been hard coded to be this way.

2. FUNCT_2 (div0) writes address C162 with the value of the frequency source divisor which can be set from 0–255 (1–256). This is set to 0 (divide by 1) on initialization. See sheet 17 of the Highland manual for more detail.

3. FUNCT_3 (amp0) writes address C140 with the peak-to-peak amplitude of the waveform output. The amplitude is scales as a ±10 Vp-p signal with 32767 equal to 10 Vp-p.

4. FUNCT_4 (siz0) writes address C168 with the size of the memory to use for the signal waveform. This signal must be equal to the size set in the HL_CONFIGUR.SET_SIZEa block on sheet 6.

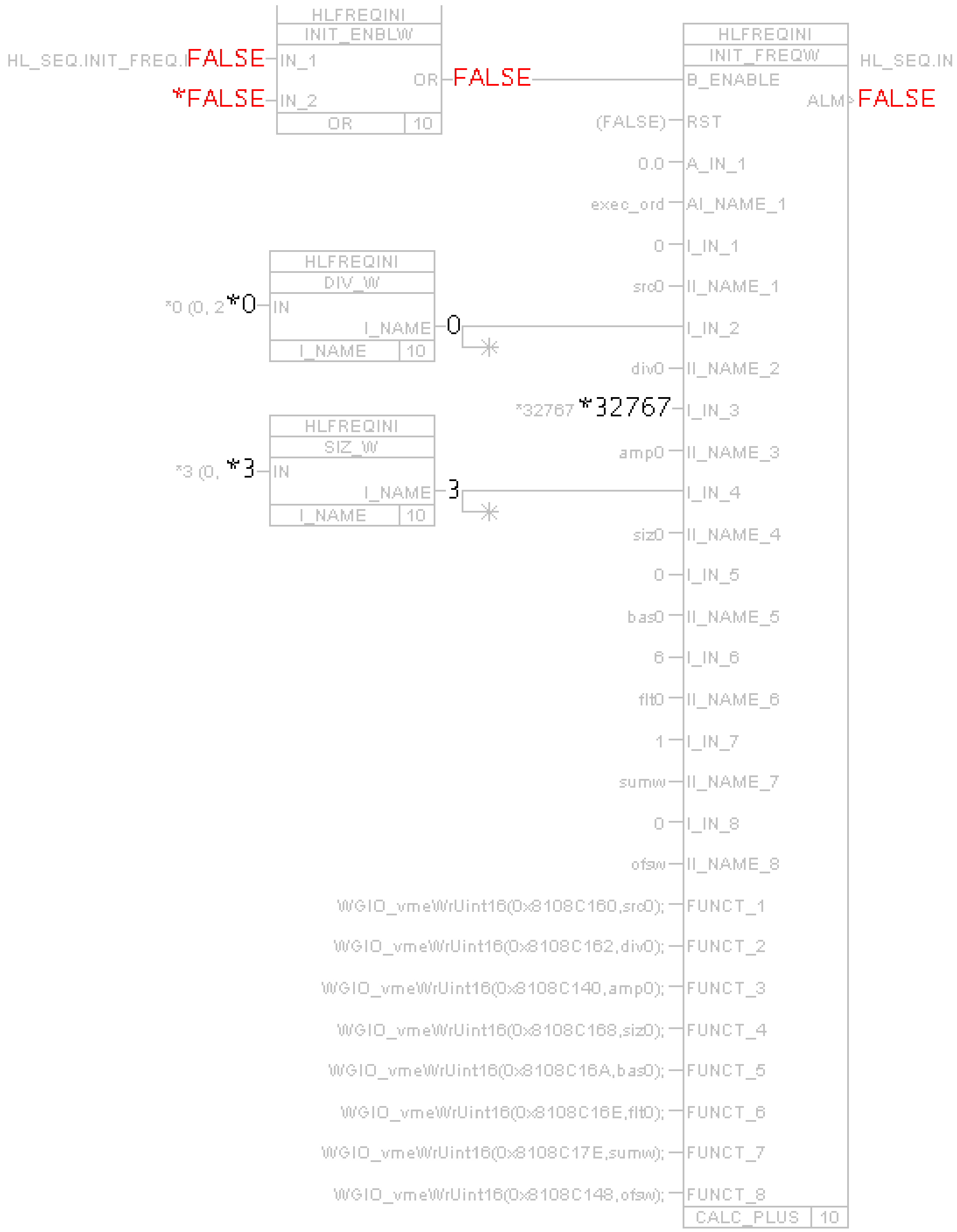
5. FUNCT_5 (bas0) writes address C16A with the starting address in memory of the waveform data. This is set to 0 to start looking at the data previously stored by the MACRO block.

6. FUNCT_6 (flt0) writes address C16E with the waveform filter control value. This is a low-pass filter with the following values.

FLT value	Cutoff
0	3 kHz
1	6 kHz
2	15 kHz
3	30 kHz
4	60 kHz
5	150 kHz
6	300 kHz
7	OFF (pulse mode)

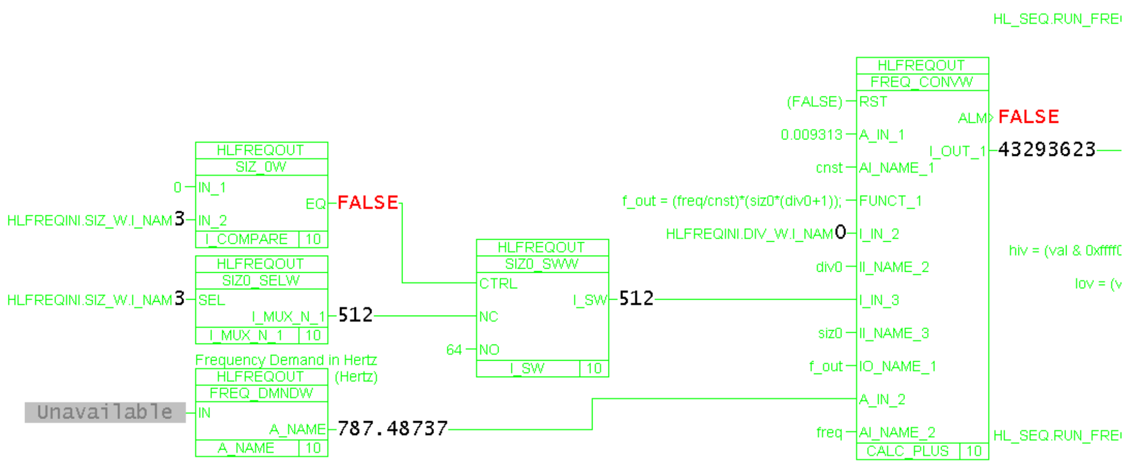
7. FUNCT_7 (sumw) writes address C17E with the value of the waveform amplifier to use for the waveform output. These are set for output 0 to use amplifier 0 etc. Note that these values are bit specific not channel specific. For example wave output 2 requires bit 2 of the register to be set (4 hex).

8. FUNCT_8 (ofsw) writes address C148 with the DC offset value for the waveform output. This is scaled as a ±10 Vdc level with 32767= +10 and –32768= –10.

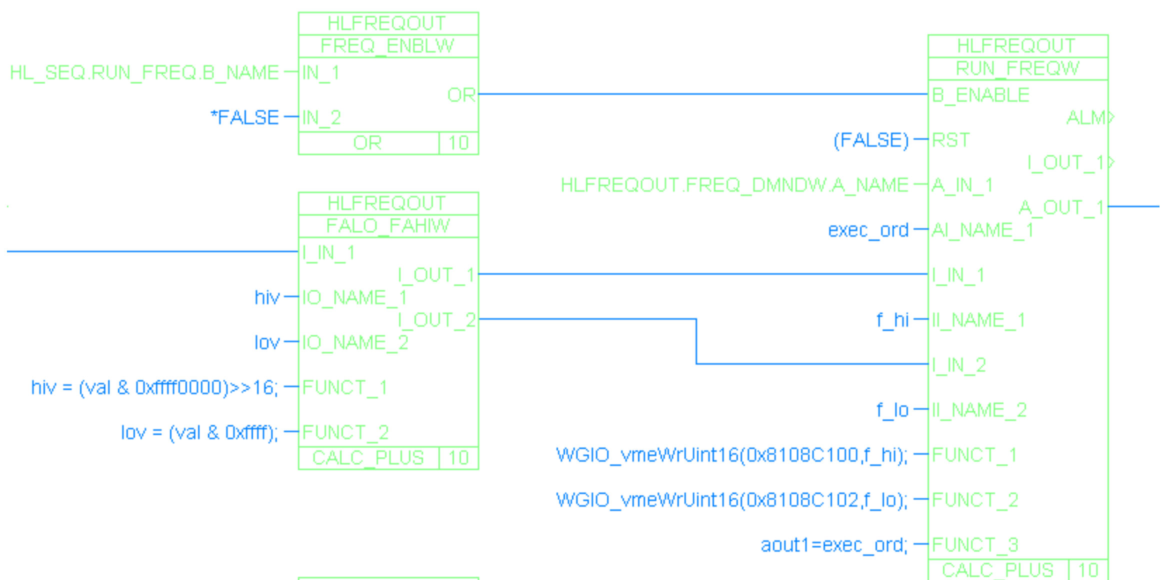

HLFREQINI
INIT_ENBLW
HL_SEQ.INIT_FREQ.IFALSE
IN_1
OR
FALSE
*FALSE
IN_2
OR 10
HLFREQINI
INIT_FREQW
HL_SEQ.IN
B_ENABLE
ALM
FALSE
(FALSE) RST
0.0 A_IN_1
exec_ord AI_NAME_1
0 I_IN_1
src0 II_NAME_1
HLFREQINI
DIV_W
*0 (0, 2 *0 IN
I_NAME 0
I_NAME 10
I_IN_2
div0 II_NAME_2
*32767 *32767 I_IN_3
HLFREQINI
SIZ_W
amp0 II_NAME_3
*3 (0, *3 IN
I_NAME 3
I_NAME 10
I_IN_4
siz0 II_NAME_4
0 I_IN_5
bas0 II_NAME_5
6 I_IN_6
flt0 II_NAME_6
1 I_IN_7
sumw II_NAME_7
0 I_IN_8
ofsw II_NAME_8
WGIO_vmeWrUint16(0x8108C160,src0); FUNCT_1
WGIO_vmeWrUint16(0x8108C162,div0); FUNCT_2
WGIO_vmeWrUint16(0x8108C140,amp0); FUNCT_3
WGIO_vmeWrUint16(0x8108C168,siz0); FUNCT_4
WGIO_vmeWrUint16(0x8108C16A,bas0); FUNCT_5
WGIO_vmeWrUint16(0x8108C16E,flt0); FUNCT_6
WGIO_vmeWrUint16(0x8108C17E,sumw); FUNCT_7
WGIO_vmeWrUint16(0x8108C148,ofsw); FUNCT_8
CALC_PLUS 10

Sheet 8 Highland Frequency Outputs

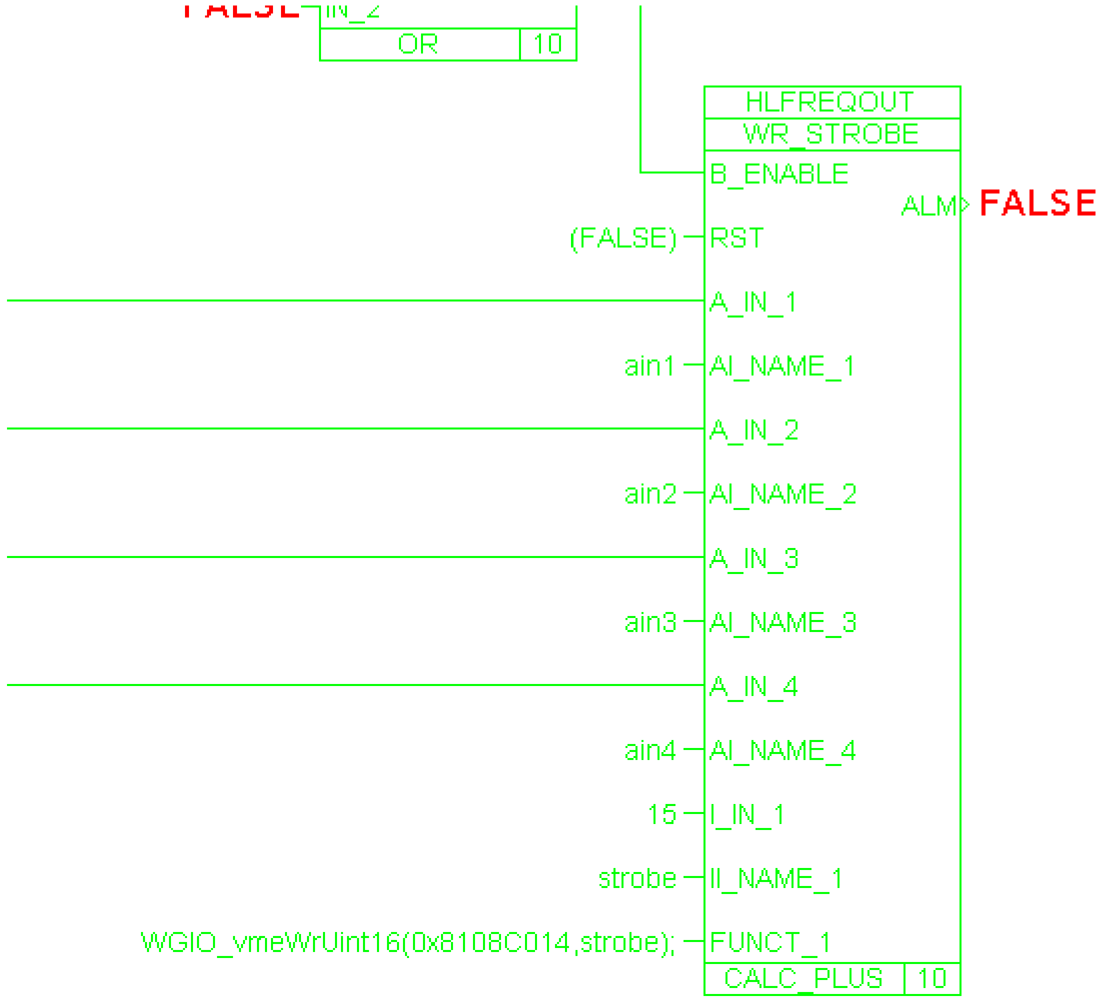
The function of this page is to enable the Highland card to output the requested frequency to the individual channels.



The above section of the GAP uses the function of (freq/cnst)*(siz0*(div0+1)) to calculate the value required for the Highland card generate the requested frequency. Every count of the register used for the frequency is equal to 0.009 313 Hz. The number of points loaded into the wave memory is equal to the block size setup for the channel or (siz0*(div0+1).



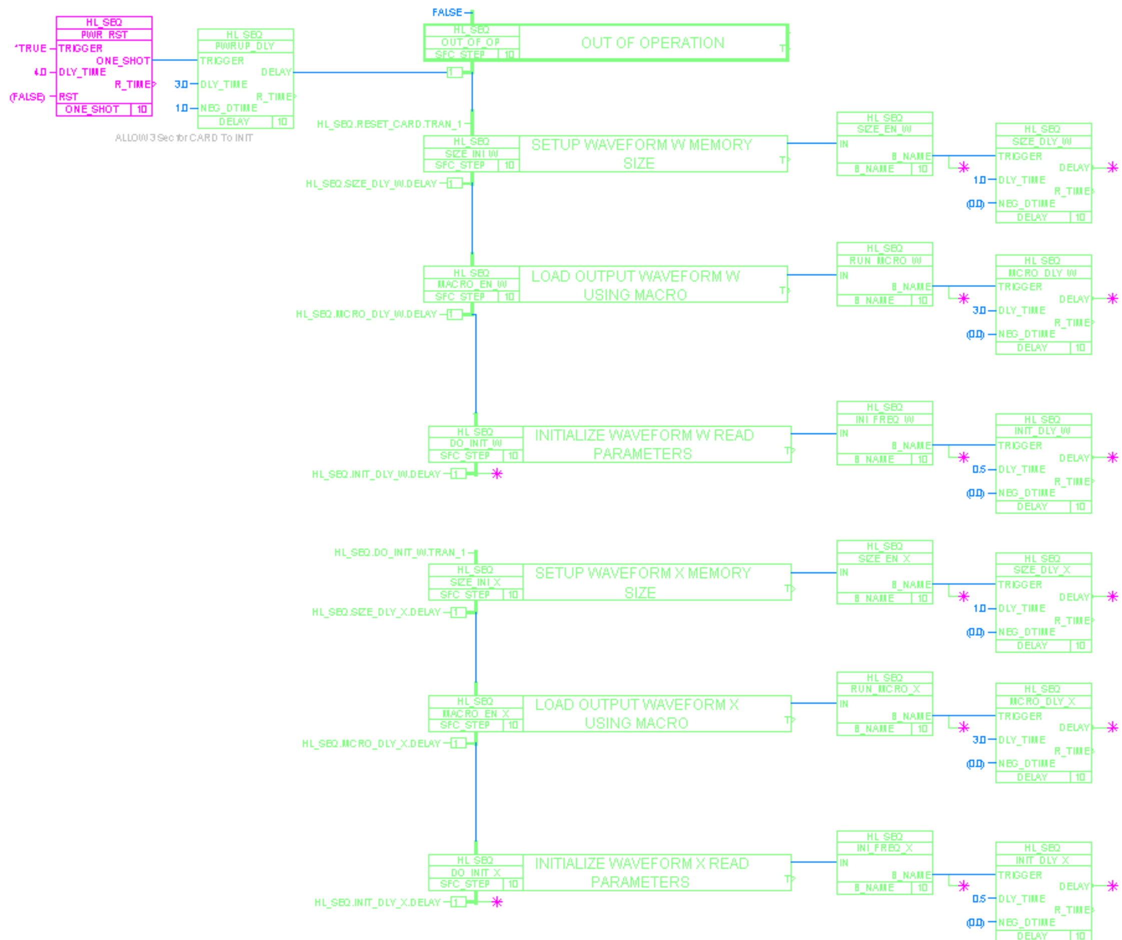
The calculated value needs to be written to two 16 bit registers located at address C100 and C102. Address C100 (f_hi) is the MSB and C102 (f_lo) is the LSB of the requested frequency value. Block HLFREQOUT.FALO_FAHIW takes the 32bit value from I_IN_1 and splits it into 2 16 bit words to write to the addresses on the Highland card. Note that both of these addresses must be written anytime that the frequency is to be changed, and must be done with the strobe bit for the channel set to 0.

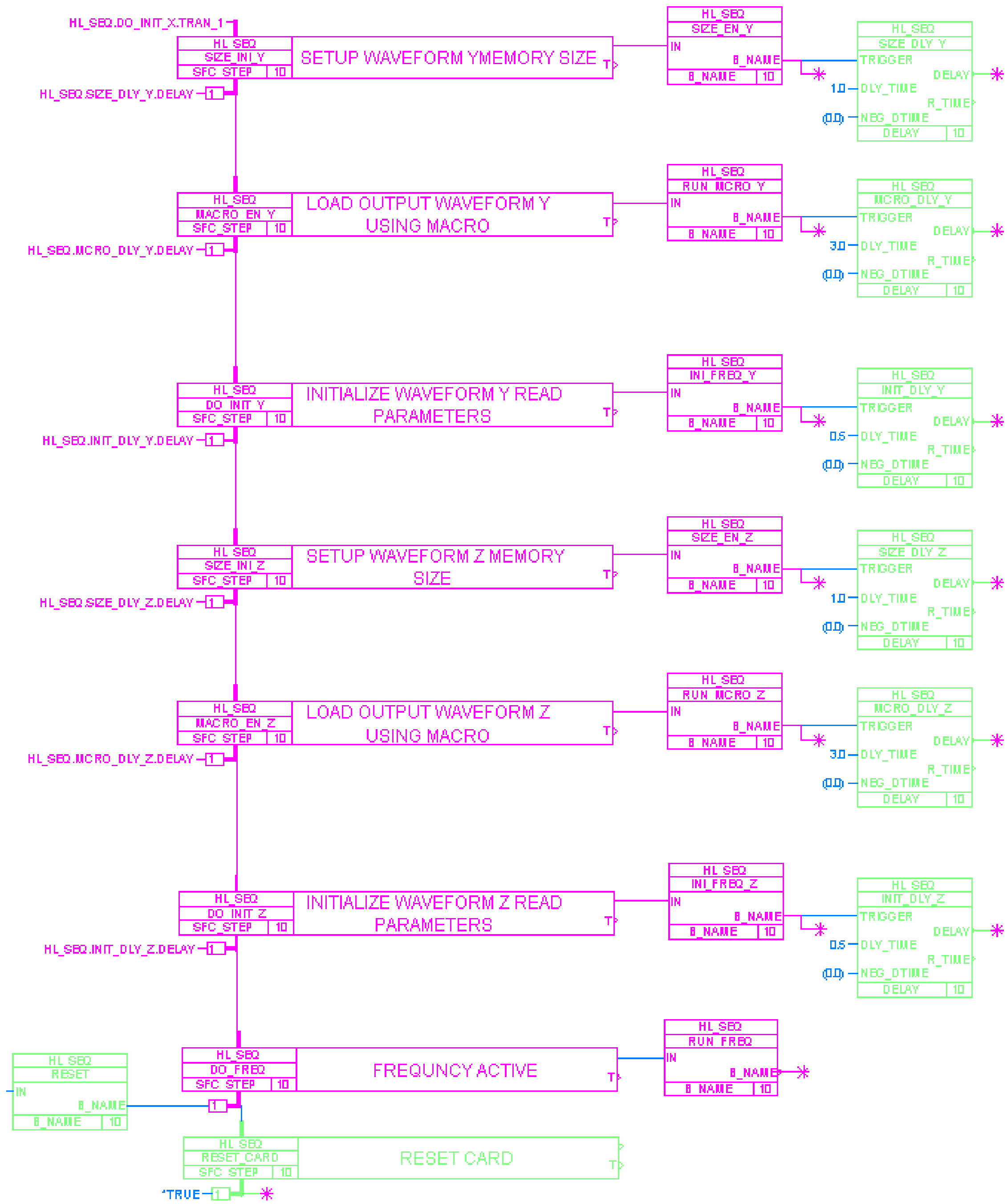


Block HLFREQOUT.WR_STROBE writes the strobe bits for channels W, X, Y, and Z to Address C014. The strobes for each channel are bit addressed in this register i.e. channel Y = bit 2 (4hex). The code is set to strobe all four channels.

Sheet 9 Sequencing

This sheet is set to start up three seconds after the CPU has finished initializing and will automatically run through the proper sequence to initialize all four channels. To ensure proper initialization of all channels on power up, each channel must be initialized separately.





HL_SEQ.DO_INIT_X.TRAN_1
HL_SEQ SIZE_INI_Y SFC_STEP 10
SETUP WAVEFORM YMEMORY SIZE
HL_SEQ.SIZE_DLY_Y.DELAY
HL_SEQ SIZE_EN_Y
HL_SEQ SIZE_DLY_Y
HL_SEQ MACRO_EN_Y SFC_STEP 10
LOAD OUTPUT WAVEFORM Y USING MACRO
HL_SEQ.MCRO_DLY_Y.DELAY
HL_SEQ RUN_MCRO_Y
HL_SEQ MCRO_DLY_Y
HL_SEQ DO_INIT_Y SFC_STEP 10
INITIALIZE WAVEFORM Y READ PARAMETERS
HL_SEQ.INIT_DLY_Y.DELAY
HL_SEQ INI_FREQ_Y
HL_SEQ INIT_DLY_Y
HL_SEQ SIZE_INI_Z SFC_STEP 10
SETUP WAVEFORM Z MEMORY SIZE
HL_SEQ.SIZE_DLY_Z.DELAY
HL_SEQ SIZE_EN_Z
HL_SEQ SIZE_DLY_Z
HL_SEQ MACRO_EN_Z SFC_STEP 10
LOAD OUTPUT WAVEFORM Z USING MACRO
HL_SEQ.MCRO_DLY_Z.DELAY
HL_SEQ RUN_MCRO_Z
HL_SEQ MCRO_DLY_Z
HL_SEQ DO_INIT_Z SFC_STEP 10
INITIALIZE WAVEFORM Z READ PARAMETERS
HL_SEQ.INIT_DLY_Z.DELAY
HL_SEQ INI_FREQ_Z
HL_SEQ INIT_DLY_Z
HL_SEQ RESET
HL_SEQ DO_FREQ SFC_STEP 10
FREQUNCY ACTIVE
HL_SEQ RUN_FREQ
HL_SEQ RESET_CARD SFC_STEP 10
RESET CARD
TRUE

Requirements to Run the Highland Card

As the GAP is currently written, the addressing is set for slot 3 of the first expansion chassis. The Highland card can be placed in any slot in the first expansion chassis; but, there cannot be a card programmed into the GAP for this slot!

1. The DIP switches on the card must be set as follows:

23 off	18 off	13 off
22 off	17 off	12 off
21 off	16 off	11 off
20 off	15 on	10 off
19 on	14 on	9 off

2. Requested frequency for each output needs to be connected to the following locations in GAP

channel W–
HLFREQOUT.FREQ_DMNDW.IN

channel X–
HLFREQOUT.FREQ_DMNDX.IN

channel Y–
HLFREQOUT.FREQ_DMNDY.IN

channel Z–
HLFREQOUT.FREQ_DMNDZ.IN

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 51295.

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