

Hewlett-Packard GmbH

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## HP3324A Product Note:

A multi-channel setup with programmable inter-channel phase  
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Thorough device test can rarely be done insitu. Consideration of repeatability, limit testing, and safety -quite apart from sheer feasibility- are some of the reasons for simulating input signals rather than trying to force the real environment to provide all desired situations at will.

Automotive, energy and navigation are example segments of the electronic control device market where these arguments are particularly important.

Typical measurement concerns in these segments are: the relative position or speeds of shafts, power line phase, and the computation of position from signal phase information. In the past, the problem has been to generate a number of synchronous signals with programmable phase difference. This product note explains how this can be solved by master/slaving a number of HP3324A synthesized function generators.

## General description

One HP3324A is equipped with Option 004 (master auto-cal) and the rest with Option 003 (slave auto-cal). This allows the phase between channels to be set up accurately on automatic or manual command without external phase measurement. A VHF switch (HP59307A) is required for automatic operation if more than two channels are needed. A second switch is necessary for more than five channels.

## Features and benefits

- No oscilloscope, phase meter or counter needed for calibration.  
Auto-cal accuracy is +/-1 to +/-7 degree, depending on waveform and amplitude mix. Refer to HP3324A data sheet.
- Manual or programmed operation.
- Extendable to virtually any number of channels.
- Output waveforms need not be the same, and are selectable from:  
sine (up to 21 MHz), square or triangle (up to 11 MHz),  
and ramp (up to 11 kHz). Minimum frequency is 1 mHz.
- Frequency resolution 9 digits. Stability 5ppm, can be improved to 0.05 ppm by fitting master 3324A with Option 001.
- Independent amplitude 1 mVpp to 10 Vpp into 50 ohm. Option 002 provides 4 mVpp to 40 Vpp into 500 ohm.

## Application example: control circuit for energy supply network.

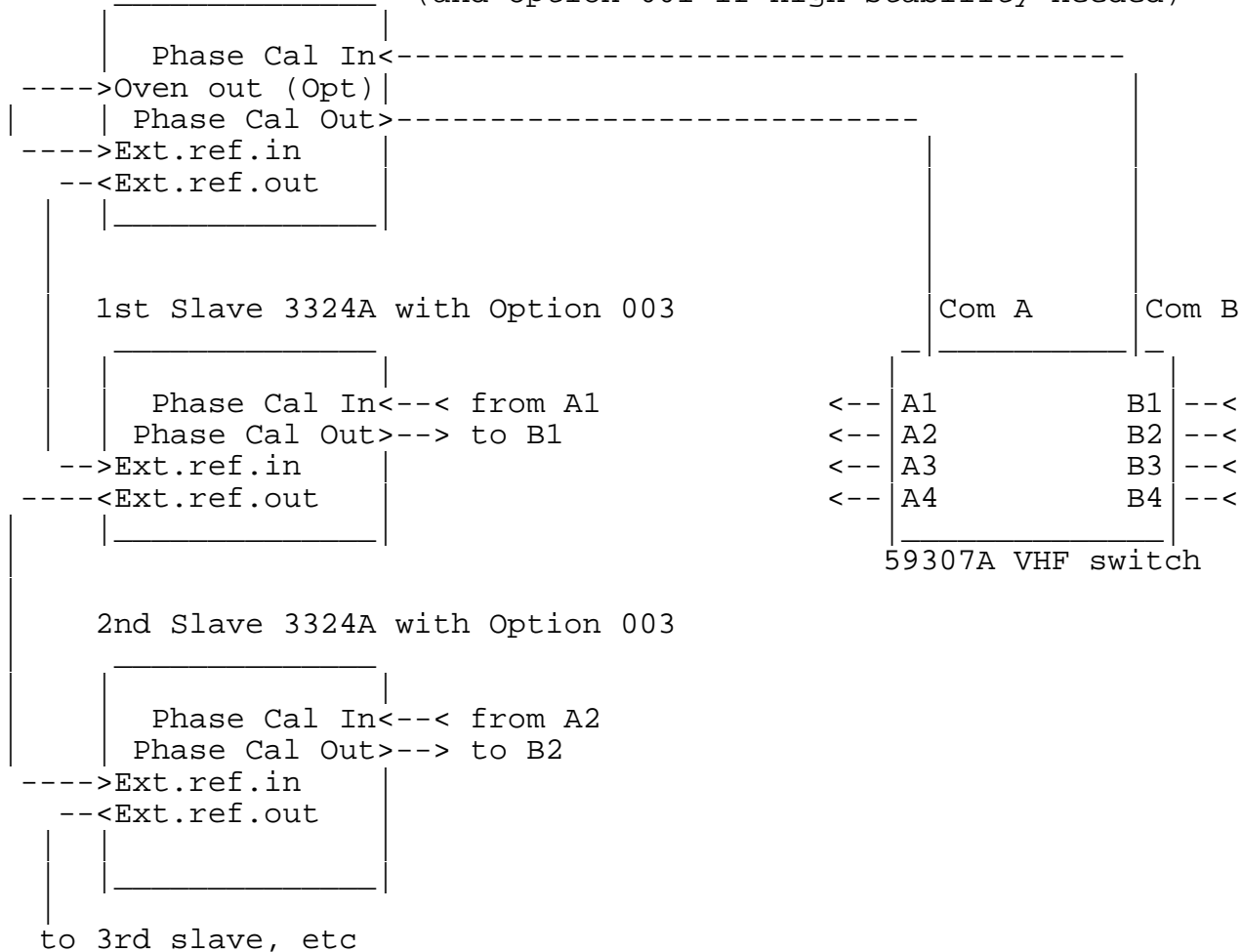
To test the design of a control circuit, three signals are needed to represent the voltages of a 3-phase supply. Additionally, a signal representing current lead or lag tests the response to power factor changes. As only one current phase need be simulated at a time, four 3324A's are adequate in this application.

## Setting up for the first time

After racking or stacking the synthesizers, "daisy chain" the rear panel Reference connectors, and interconnect the Phase Cal connectors as shown in the following diagram:

Master 3324A with Option 004

(and Option 001 if high stability needed)



Now use the following procedure to equalize the path lengths of the master Phase Cal Output to the various slave Phase Cal Inputs:

1. Set the following parameters of all 3324As to zero:  
Phase,  
Assign Phase 0,  
Calibration Delay, } Select Util menu and roll.  
Signal Delay. }
2. Set same frequency, waveform and amplitude on all 3324As.
3. Press 1st slave's Shift and Phase Cal keys.
4. When auto phase cal complete, measure the time interval between corresponding points on the master and 1st slave outputs. Measure from the master signals FORWARDS to the slave signal, even if this means nearly a full cycle (this simplifies handling the other slaves).
5. Enter this value in ps in the 1st slave's Calibration Delay (Util menu).
6. Do auto phase cal again, verify phase is OK.
7. Repeat steps 3 to 5 for the other slaves in turn.

Using the setup

Try to use the same path lengths from the 3324A outputs to the device under test. If this is not feasible, use a similar procedure to that above, measuring the signals at the DUT, and entering the delay into the appropriate slave's Signal Delay (Util menu).

From here on, correct phase relationship is simply a matter of setting each slave to the required phase. Subsequently, whenever frequency, waveform or amplitude are changed an auto-cal should be performed on each slave.

Start-up tools

An UNSUPPORTED disk is available in order to assist implementation in an automated environment with the following software:

1. HP ITG (Interactive Test Generator) applications driver and instrument driver IDHP3324PS. These run only on HPBasic platforms, and are NOT supported.
2. An HPBasic routine for users to build into their own programs. A listing appears at the end of this document. This routine is NOT supported.

#### HP3324A Auto-cal ITG applications driver

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 To load the auto-cal driver, first load the file IDHP3324PS as many times as you have HP3324As. Each time you will be asked "stand alone or slave" and you should respond with "slave". Subsequently, change the driver name to "Master", "Slave1", "Slave2" etc. Now load file ADPC3324A, and enter switch address and driver names in the first panel as required.

The file ADPC3324A generates a small panel (see inset below) that allows the phase of the master (M) and any slave (Sn) 3324A to be changed, as well as the common frequency (F). Auto-cal is implemented with the CAL label (an exclamation mark indicates when this should be done)

HP Interactive Test Generator				Help
File	Instruments...	Applications		
MASTER3324,718				
[Reset] Signal[On] Output[Front] [Main Panel]				
Waveform [ Sine ] Phase [ 0.0 DEG ]				
Offset [ 0 ][ V ] [Assign P 0]				
Amplitude [ 1m ][Vpp]				
[Ampl. Cal. ] Sig del [ 0 ps ]				
Frequency [ 2k ] Ref del [ 3000 ps ]				
PC3324A,0				
[Reset] Delay [3000] [Cal]				
F[ 2 k ] M[ 0.0 DEG ]				
S1 [32.5DEG] S2 [ ? ]				
S3 [ ? ] S4 [ ? ]				
SLAVE3324,718				
[On] Output[Front] [Main Panel]				
Sine ] Phase [ 32.5 DEG ]				
Offset [ 0 ][ V ] [Assign P 0]				
Amplitude [ 1m ][Vpp]				
[Ampl. Cal. ] Sig del [ 0 ps ]				
Frequency [ 2k ] Ref del [ 0 ps ]				

#### HPBasic Auto-cal routine

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 The routine PHASECAL implements the HP3324A's built-in phase-cal feature for setups with up to five function generators connected as shown in the above diagram.

The routine simply switches each slave in turn to the master and triggers the

3324A-internal auto phase cal measurement.

```

1      INTEGER A,B,C,D,E,F  ! this main program is only a dummy program
2      A=0                  ! to be replaced by other main programs
3      B=0
4      C=0
5      D=0
6      E=0
7      F=0
8      INPUT "SWITCH ADDRESS",A,"MASTER ADDRESS",B,"SLAVE1 ADDRESS",C,"SLAVE2 AD
RESS",D,"SLAVE3 ADDRESS",E,"SLAVE4 ADDRESS",F
9      CALL Save_ib_address(A,B,C,D,E,F)
10     CALL Phase_cal
11     END
12     !=====
13     SUB Save_ib_address(INTEGER Switch,Master,Slave1,OPTIONAL INTEGER Slave2,
Slave3,Slave4)
14     COM /Hpibdata/ INTEGER Switch_addr,Master_addr,Slave_addr(1:4)
15     INTEGER I
16     MAT Slave_addr= (0)      ! clear addresses
17     Switch_addr=Switch
18     Master_addr=Master
19     Slave_addr(1)=Slave1
20     IF NPAR>3 THEN Slave_addr(2)=Slave2
21     IF NPAR>4 THEN Slave_addr(3)=Slave3
22     IF NPAR>5 THEN Slave_addr(4)=Slave4
23     SUBEND
24     !=====
25     SUB Phase_cal
26     COM /Hpibdata/ INTEGER Switch_addr,Master_addr,Slave_addr(1:4)
27     INTEGER I,J
28     REAL Master_phase,Frequency
29     DIM Lf$(2)
30     Lf$=CHR$(13)&CHR$(10)      ! separator for switch commands
31     ON TIMEOUT 7,30 GOTO End    ! device select code 7 for HP-IB card
                                   assumed !!!
32     IF Master_addr THEN
33         OUTPUT Master_addr;"IPH"      ! read master phase
34         ENTER Master_addr USING "K";Master_phase
35         OUTPUT Master_addr;"PH 0DEIFR" ! set phase during calibration to 0
36         ENTER Master_addr USING "K";Frequency ! read frequency from master
as reference for slaves
37         FOR I=1 TO 4
38             IF Slave_addr(I)<>0 THEN
39                 IF Switch_addr THEN      ! connection of slave by switch
40                     OUTPUT Switch_addr;"A"&VAL$(I)&Lf$&"B"&VAL$(I) ! change this
line if using other VHF switch than HP59307A ( connects each slave to master )
41                 ELSE
42                     ! manual connection of selected slave
43                     DISP "Please connect SLAVE"&VAL$(I)&" to MASTER instrument, con
firm with any key"
44                     ON KBD ALL GOTO Confirmed
45                     GOTO 44              ! wait for keypress
46                 Confirmed: OFF KBD
47                 DISP "
"
48             END IF
49             OUTPUT Slave_addr(I);"FR"&VAL$(Frequency)&"HZ" ! set slave to sa
me frequency as master
50             OUTPUT Slave_addr(I);"PC" ! start calibration
51             J=SPOLL(Slave_addr(I))
52             ! if calibration is failed, ( J AND 8 ) is <> 0, a failure rout
ine could be done here ( to ensure failure , use ISE command of 3324A )
53             END IF
54             NEXT I
55             OUTPUT Master_addr;"PH"&VAL$(Master_phase)&"DE" ! restore phase of

```

```
master
55      BEEP 160,.05      ! finished
56      END IF
57 End:      !
58      OFF TIMEOUT
59      SUBEND
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