SM-1000 Series

ISA-Bus Arbitrary Waveform Function Generators

Functional Description

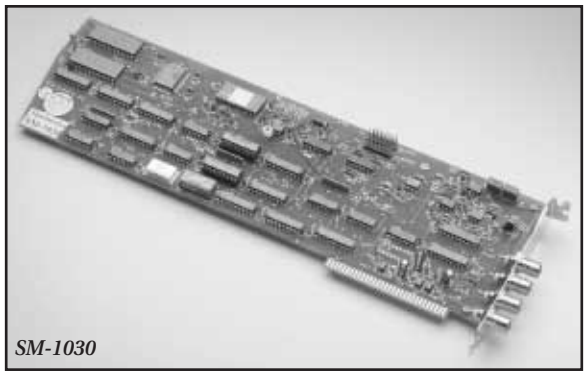
The SM-1000 Series is a family of digitally synthesized function, arbitrary waveform, and pulse generators designed for use in ISA-bus compatible PC/XT/AT computers. The boards deliver the full functionality and control you'd expect from a benchtop waveform generator without the cost and programming complexity of a typical GPIB instrument.

For Windows users, there is a standard Windows "SETUP.EXE" for ease of installation. Instead of LCDs, knobs, and buttons, the SM-1000 Series operates via a user-friendly display on part of your computer screen, using standard keyboard or mouse for control. Also, the SM-1000 Series are easy and intuitive to use because of the GUI control panel, delivering the look and feel of their "grandfathers," the benchtop instruments.

Host processor time is minimal for all devices; the host is accessed only when parameters are set or changed. After these events, the boards free-run with no demands on the host systems processor.

Internal expansion connectors allow linkage of up to 32 SM-1000 boards in a variety of configurations, delivering additional functions according to user needs.

The SM-1005 is a precision pulse generator. The SM-1010 is a versatile function generator that features full triggering, gating, waveform, and arbitrary waveform generation capability. The SM-1020 adds a pulse-generator output, and has capabilities for synchronizing clocks and control signals for multi-card applications. The SM-1030 offers the analog functions of the SM-1020 (excluding pulse



SM-1030

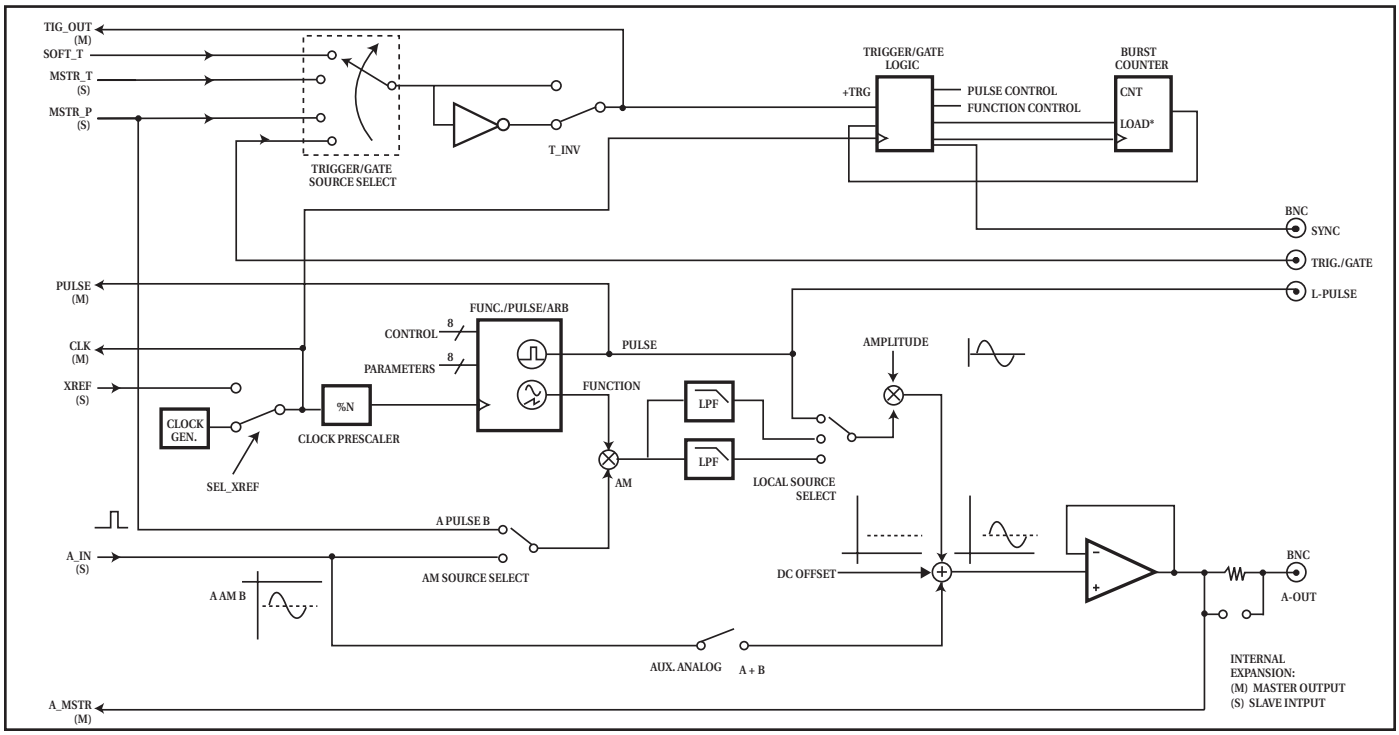
FEATURES

- Outstanding frequency range of up to 3MHz for sine wave
- Signals of unparalleled purity and other benefits of waves generated by Direct Digital Synthesis (DDS)
- Powerful 12-bit resolution with an onboard waveform memory
- 50ppm frequency stability
- Includes 10 standard waveforms
- CE approved
- Windows 3.X/95/98/NT/2000 32-bit driver support

APPLICATIONS

- Testing video circuits
- Ultrasonics, Telephony
- Simulation of biomedical signals
- Transducer testing
- Simulation of shock and vibration signals
- Verification of data acquisition equipment
- Communication modulation source
- Simulating engine signals

Block Diagram (SM-1020)



KEITHLEY

SM-1000 Series

WHY VIRTUAL INSTRUMENTS?

The SM-1000 Series instruments deliver high performance at an impressively low cost. But the advantages of virtual instruments go beyond cash savings.

A significant plus for card instruments is that they plug directly into a PC bus. External boxes that plug directly into a printer or serial port are useful, but a noteworthy benefit from cards such as the SM-1000s is that they connect to a PC through a standard I/O port, removing the requirement for an IEEE-488 interface card, cable, and power cord.

Enhancements to the capabilities of the basic PC platform have increased the utility of virtual instruments. Computers based on Pentium chips with additional processing bandwidth provide the speed needed to create responsive user interfaces that feel like stand-alone instruments.

Virtual instruments are as portable as the computer you plug them into. Portable CPUs equipped with SM-1000 boards travel more easily to worksites than cumbersome benchtop equipment.

Extensive software options are available for SM-1000 boards that make it easy for users to turn data into information. By making information accessible quickly, in terms that can be readily interpreted and applied, virtual instruments optimize time and effort for end users in a wide variety of applications.

generation), and enhanced higher-speed circuits deliver an impressive ten-fold increase in frequency range. Standard waveforms included with SM-1010, SM-1020, and SM-1030: Sine, Square, Ramp (positive and negative) Triangle, Havertriangle, Haversine, Trapezoid, Exponential, Sine x/x, and Gaussian noise.

The DDS Advantage

SM-1000 function generators (the SM-1010, -1020, and -1030) utilize Direct Digital Synthesis (DDS) to produce signals of unparalleled purity.

The easiest way to recognize the advantages of DDS is in comparison to a typical sampled arbitrary waveform generator. Non-DDS generators will construct output by storing a digitized waveform in a buffer that drives a D/A.

To produce the desired output frequency, non-DDS generators use onboard logic to vary the rate at which buffered data goes to the converter. Unfortunately, this method results in the signal containing aliases of the sample clock near the output frequency. The only option for removing such aliases is for the card to incorporate expensive tunable filters.

By contrast, DDS uses an output clock running at a constant frequency and, on the fly, varies the number of samples/waveforms to obtain the desired frequency. While clock aliases still appear in the signal, DDS offers two major advantages.

First, the clock aliases are always in the same place spectrally near the clock harmonics, so the output filter needn't be tunable. Second, the aliases are typically much higher in frequency than the output signal, so they can be removed with a simple output filter.

Additional advantages lend themselves to ease of use. DDS has very fine frequency resolution and very low phase noise, and operation over the full frequency range with the same size table. The frequency of the loaded wave's table can be changed without having to reload or resize the table, or readjust the sampling clock.

Also, when changing the output frequency, there is an instantaneous response to the new output frequency. It continues from its present phase position with new set frequency, preventing disruption to the device under test. Simply stated, there is no "reset" of the waveform output.

SM-1005

The SM-1005 is an economical precision pulse generator.

The SM-1005 can generate frequencies up to 5MHz. It can generate analog or TLL signals as narrow as 100ns or as wide as 100s. The TLL output has a programmable width and repetition rate; the analog output includes, in addition, programmable amplitude and offset. The wideband TLL-compatible pulse output has 10ns typical rise and fall times, regardless of pulse widths.

Among the several modes of operation for the SM-1005 are continuous, edge triggering (positive or negative), burst (up to 255 pulses), and gated (internal, external, or software), lending it to a wide variety of applications — precision timing (as in power control), laser etching, automated testing, multiplexing, and process control.

SM-1005s can also be used to expand the performance of the SM-1010, SM-1020, and SM-1030, enabling users to generate FSK, PSK, DTMF, or Pulse AM; they can also be used as general-purpose gating or triggering devices and as delay generators.

SM-1010

The economical, versatile SM-1010 produces low-noise, low-distortion sine waves, plus a large selection of other waveforms. Sampling update rates for the SM-1010 range up to 10 megasamples per second. Triggered, gated, burst, and continuous operating modes are the same as for the SM-1005.

New users typically have the SM-1010 installed and in service in about two minutes. Easy to use, the SM-1010 delivers the look and feel of benchtop equipment.

Frequency is programmable from DC to 300kHz, and the output level is adjustable to 8 volts p-p into 600Ω (16 volts p-p open circuit). Output frequencies are synthesized from a crystal reference oscillator with frequency stability of 50ppm.

SM-1000 Series

The digital synthesizer on the SM-1010 generates arbitrary waveforms from ASCII data loaded into 8K wave tables. Data can be created with a CAD-type waveform creation software package. Vertical resolution of the output waveforms is 8 bits.

SM-1020

The SM-1020 incorporates the essential features of the SM-1010, but with 12-bit vertical resolution for its ARB and function generator. The pulse-generator functions of the SM-1005 are included in the SM-1020. Using the master slave ability of the SM-1020, up to 32 SM-1020 boards can be configured to generate complex waveforms in a synchronized fashion. The various analog modes such as summing (superposition), AM modulation, and pulse modulation combine with a wide range of triggering and gating modes to generate the waveforms.

SM-1030

The SM-1030 is a stepped-up version of the SM-1020, boasting a frequency range of DC to 3MHz.

16 megasamples per second sampling and 40 volt per microsecond slew rate enable the SM-1030 to accurately reproduce ARB video waveforms having steep slopes or fine-grain, high-frequency detail.

On the SM-1030, frequency resolution ranges from 0.06Hz at the fastest to 0.6mHz at the slowest clock rates.

SPECIFICATIONS: SM-1010, SM-1020, SM-1030

	SM-1010	SM-1020	SM-1030 LF/WB
Max output Frequency:	300kHz	300kHz	300kHz/3MHz
Output update rate:	10MHz	10MHz	16MHz
Synthesis:	DDS	DDS	DDS
Resolution (bits):	8	12	12
Output ranges (V, p-p) terminated, unterminated:	0–8, 0–16	0–8, 0–16	0–8, 0–16/0–4, 0-8
Relative accuracy:	50ppm	50ppm	50ppm
Phase Adjust:	±180°	±180°	±180°
DC offset (V): terminated, unterminated:	±2, 4	±2, 4,	±2, 4
Output imped. (Ohms):	600	600	600/200
Filters:	RC lowpass	RC or Butterworth	RC or Butterworth
Wave table size (kWord):	8	8	8
Standard wave forms:	10	10	10
Pulse generator:	no	yes (see SM1005 specs)	no
Sine Wave Distortion f ≤ 20 kHz:	< 0.5% THD	< 0.15% THD	< 0.15% THD
Sine Wave Distortion f <1 kHz:	< 0.5% THD	< 0.05% THD	< 0.05% THD
Spurious noise:	–60 dBC typ	–72 dBC typ	–72 dBC typ
Noise floor:	–68 dBC typ	–75 dBC typ	–75 dBC typ
Language Support			
DOS: Quickbasic, C, C++:	.LIB	.LIB	.LIB
Windows: DLL, (VB, VC++):	yes	yes	yes
Windows 3.x/95/NT OCX (Activex):	yes	yes	yes

SPECIFICATIONS: SM-1005

LF/WB - LOW FREQUENCY/WIDEBAND OUTPUTS:
REP RATE: 0.01Hz to 5MHz, 20-bit control, 3 ranges
PULSE WIDTH: 100ns to 100s, 20-bit control, 3 ranges
OUTPUT BAND WIDTH: 0.01Hz to 200kHz (analog output)
0.01Hz to 5MHz (pulse output–TTL)
RISE/FALL TIME: 10ns typ
TRIGGERING MODES (ALL PRODUCTS):
Edge trigger, free run, burst (1–255), gated phase hold, gated return to zero phase.

ORDER	DESCRIPTION
SM-1005	5MHz Pulse Generator
SM-1010	300kHz DDS ARB
SM-1020	300kHz DDS ARB Low Noise
SM-1020 WNT	Windows NT Driver Software Upgrade
SM-1030	3MHz DDS ARB
SM-10	Master/Slave Cable

EMC: Conforms to European Union Directive 89/336/EEC.
SAFETY: Meets EN61010-1/IEC 1010.

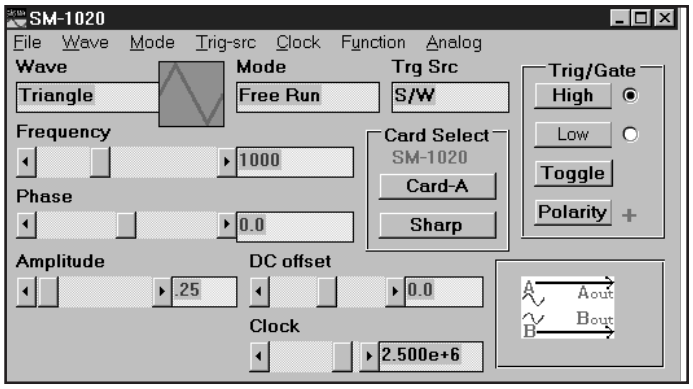
SM-1000 Series

Software Support

Keithley SM-1000 Series boards include a Windows-based control panel written in Visual Basic and a DOS-based control panel. Source code for the Windows-based program is provided, enabling you to modify and adapt the panel for your application. DOS drivers for QuickBasic and Microsoft/Borland C and Windows 3.x/95/98 drivers are supplied for language-based programming, and can be added directly to your application program. The Series ships with a Windows 3.x/95/98 DLL for use with application software such as TestPoint, and with an ActiveX (OCX) control for Windows 95/98 that can be linked to a variety of applications and is a convenient tool for off-line development. Windows NT support is available as an option.

The SM-1000 Series generators are compatible with a wide range of software applications such as TestPoint, LabWindows/CVI, and other popular packages via the 16- and 32-bit DLLs.

DOS and Windows drivers for QuickBasic, VisualBasic, Quick C, C/C++, and Visual C++ are suppled and may be added directly to your application programs.



SAMPLE PROGRAM

Visual Basic example
Shows how easy it is to generate a square wave output using an option selection

```
Private Sub SquareOption_Click
   ShowFault FPGSquareWave(SelectedFpg)
End Sub

***Uses a scroll to adjust amplitude***

Private Sub Amplitude_KeyPress(KeyAscii As Integer)
   Dim state As Integer
   Dim Valu As Double
   If (KeyAscii = 13) Then  ' an enter key
        Valu = Val(Amplitude.Text)
        ShowFault FPGSetAmplitude(SelectedFpg, Valu)
        AmplitudeHScroll.Value = Int(Valu / 0.05)
        KeyAscii = 0
   End If
End Sub

***Shows how easy it is to initialize board and display what board type you have***
Private Sub Form_Load()
   Dim i As Integer
   cfgfile = app.Path & "\" & ConfigFile
   SelectedFpg = 0 'Select fpgA as default
   i = FPGInit(cfgfile)       'init all cards indicated in fpg.cfg file

   'Set up card to generate triangle wave 4V, p-p
   i = FPGTriangleWave(SelectedFpg)
   i = FPGSetAmplitude(SelectedFpg, 4#)   ' Set amplitudes to 4V
   End Sub

***Uses a scroll to adjust frequency***
Private Sub Frequency_KeyPress(KeyAscii As Integer)
   Dim Valu As Double
   If (KeyAscii = 13) Then  ' an enter key
        Valu = Val(Frequency.Text)
        ShowFault FPGSetFrequency(SelectedFpg, Valu)
        FreqHScroll.Value = Int((Valu / 5#) - 30000)
        KeyAscii = 0
   End If
End Sub
```

*****Borland C++ example code showing frequency sweep*****

```
/*******************************************************
 *  Frequency sweep function.  Start at f_start, stop
 *  at f_stop, total time t_time.  Update every 50 mS.
 *******************************************************/
void f_sweep(struct state *pointer, double f_start, double f_stop, double t_time){
            double f,delta_f;
            clock_t tick;
            long int i;   /* updates of freq. 50mS */
            delta_f = (f_stop - f_start) * (0.05 / t_time);
            tick =  clock();  /* take start time in mS ** to be fixed ****/
            if(f_stop > f_start){
                 for(f = f_start; f <= f_stop; f += delta_f, tick += 50){
                 set_freq( f , pointer);
                 pointer->frequency = f;
                 i = 0;
            while( ( clock() <= tick ) && ( i < 100000L ) ) i++; /* wait for time tick */
                 }
            }
            else{
            for(f = f_start; f >= f_stop; f += delta_f, tick += 50){
            set_freq( f, pointer);
            pointer->frequency = f;
            i = 0;
            while( ( clock() <= tick ) && ( i < 100000L ) ) i++; /* wait for time tick */
} } }
```