CTF 3

RF
Low Level
and
Pulse Compression Control

- RF Diagram

- Low Level RF
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  - Phase Program Generation
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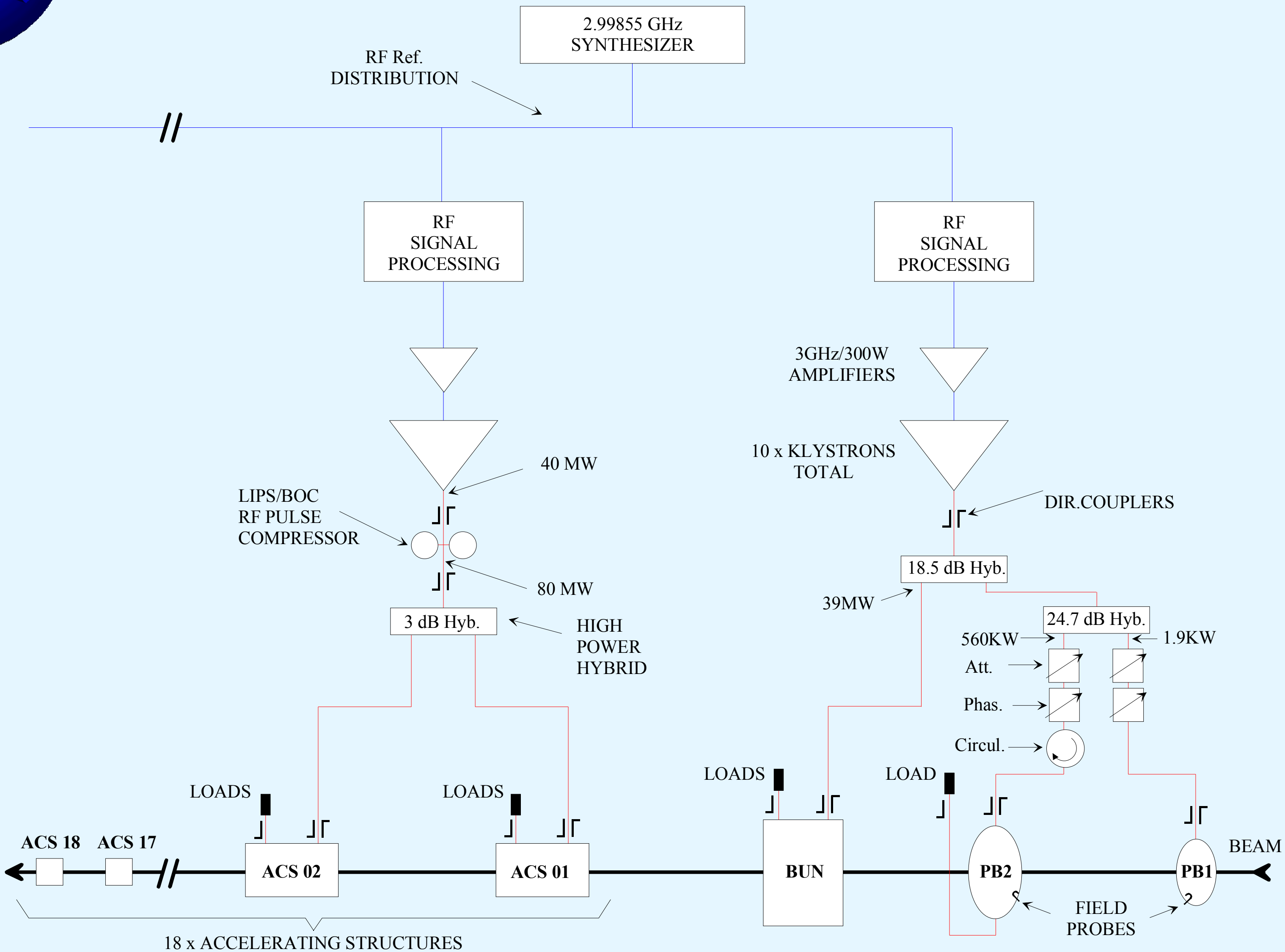
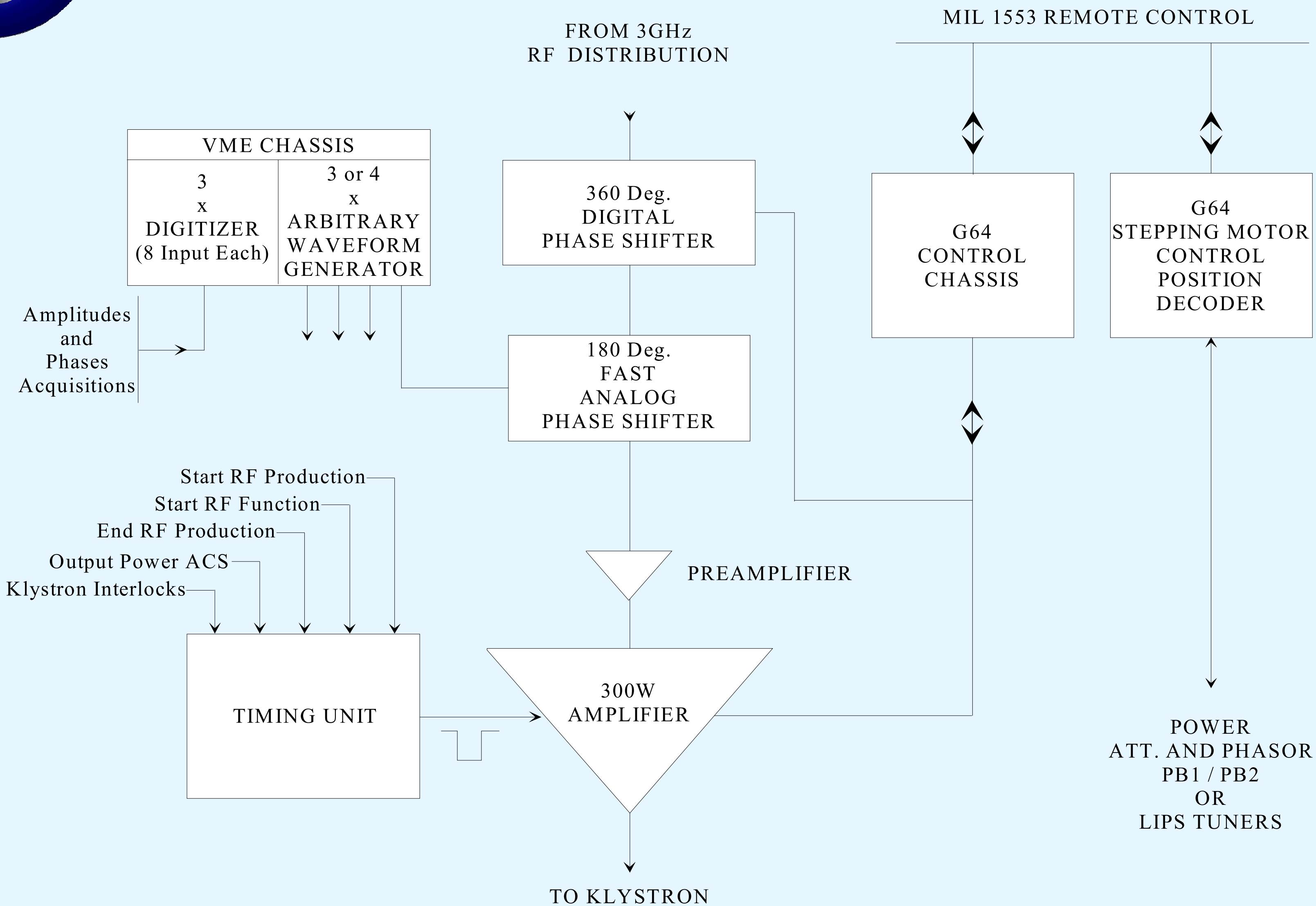
RF Diagram

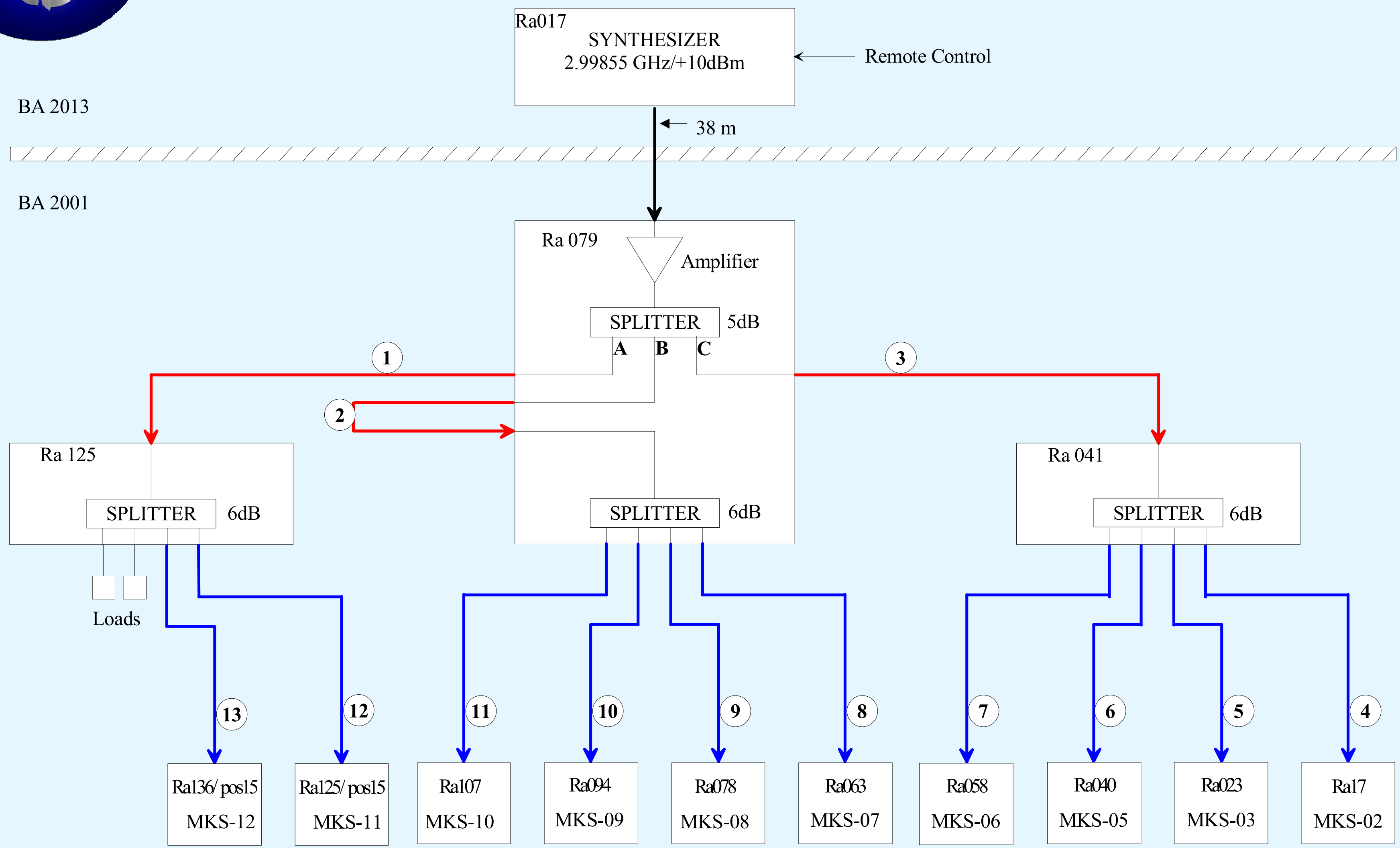


2.99855 GHz
SYNTHESIZER
RF Ref.
DISTRIBUTION
RF
SIGNAL
PROCESSING
RF
SIGNAL
PROCESSING
3GHz/300W
AMPLIFIERS
40 MW
10 x KLYSTRONS
TOTAL
LIPS/BOC
RF PULSE
COMPRESSOR
DIR.COUPLERS
18.5 dB Hyb.
80 MW
39MW
3 dB Hyb.
HIGH
POWER
HYBRID
24.7 dB Hyb.
560KW
1.9KW
Att.
Phas.
Circul.
LOADS
LOAD
LOADS
LOADS
ACS 18
ACS 17
ACS 02
ACS 01
BUN
PB2
PB1
BEAM
FIELD
PROBES
18 x ACCELERATING STRUCTURES

Low Level RF Block Diagram



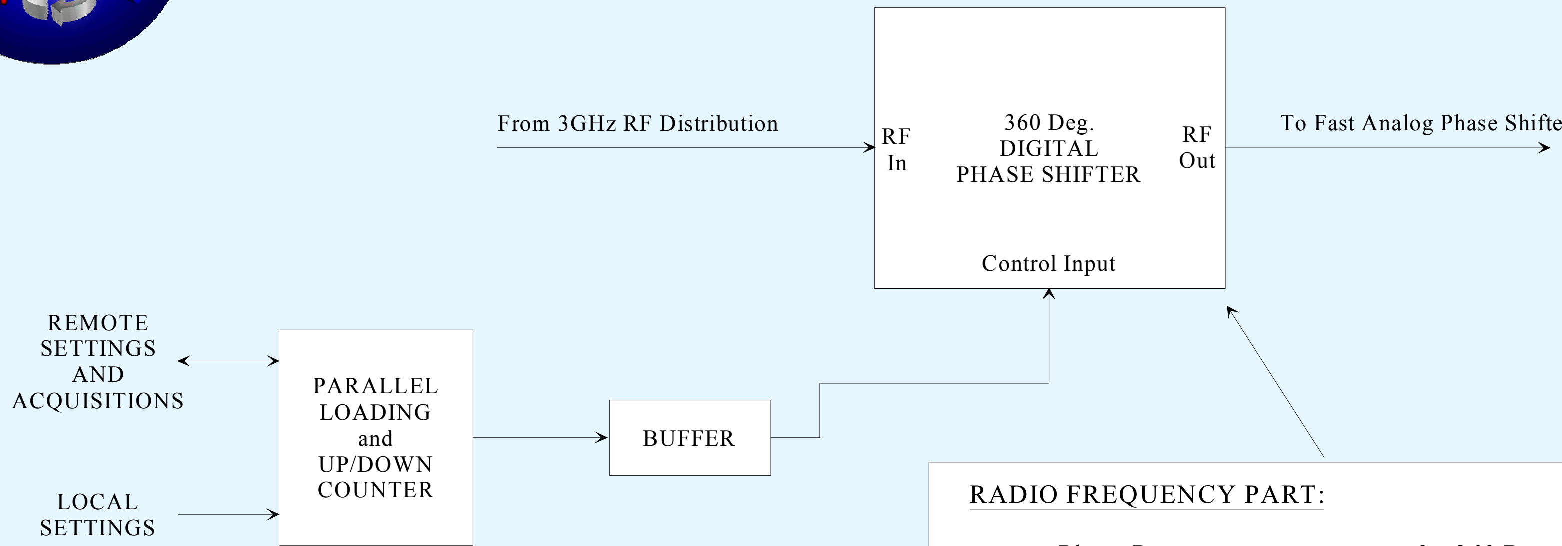
3GHz Ref. Distribution



Cables 1 to 3 same length (42m +/- 1cm)
Cables 4 to 13 same length (28m +/- 1cm))

CABLES ANDREW- HELIAX LDFS 5-50A 7/8"
Att. 8.31dB/100M at 3GHz
Velocity 89%

Digital Phase Shifter



RADIO FREQUENCY PART:

Phase Range	0 - 360 Deg.
Center Frequency:	3.0 GHz
Bandwidth:	100 MHz
Insertion Loss:	4 dB
VSWR, in and out	1.35 : 1 max
RF Input Power:	+ 3dBm (operating) + 20dBm (no damage)
Settling Time:	5 micro sec.
Temperature Stability:	< 0.15 Deg. / Deg.C
Operating Temperature	15 to 35 Deg. C
RF Connectors	SMA (F)

CONTROL PART:

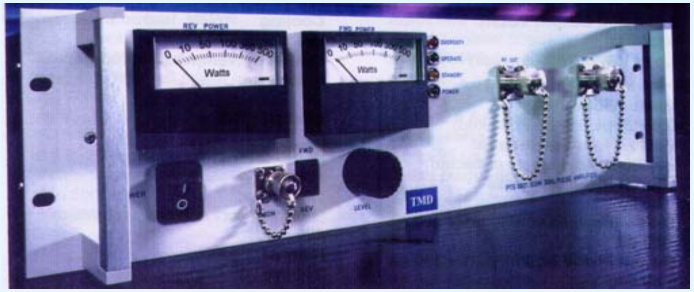
No. of Bits	10
TTL Level (Active "1")	10 Parallel Lines
Bits Weights (Binary):	LSB = 0.35 Deg. MSB = 180 Deg.

Fast Analog Phase Shifter

Phase Range	0 – 180 deg. min
Center Frequency	3.0 GHz
Bandwidth	> 30 MHz
Rise Time (Step = 90 deg)	< 10 ns
Temperature Stability	< 3 deg. (25 - 45 deg. C)
Phase Stability	< 0.5 deg
Voltage Control	0 - 10V
VSWR, in and out	1.35 : 1 max
RF Input Power	+ 3 dBm (operating)
	+ 20 dBm (no damage)
RF Connectors	SMA (F)

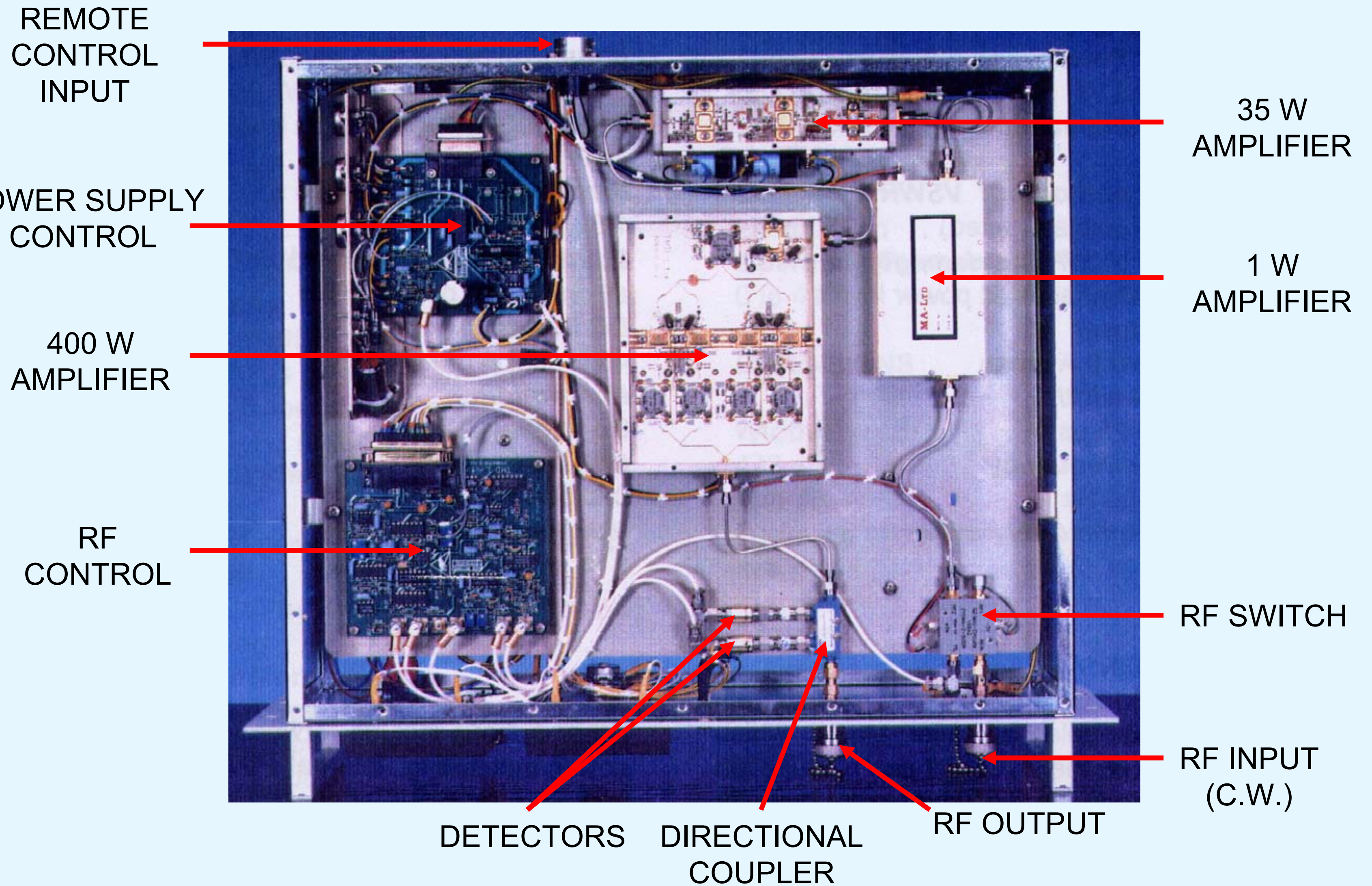
3GHz/300W Pulsed Amplifier

Characteristics

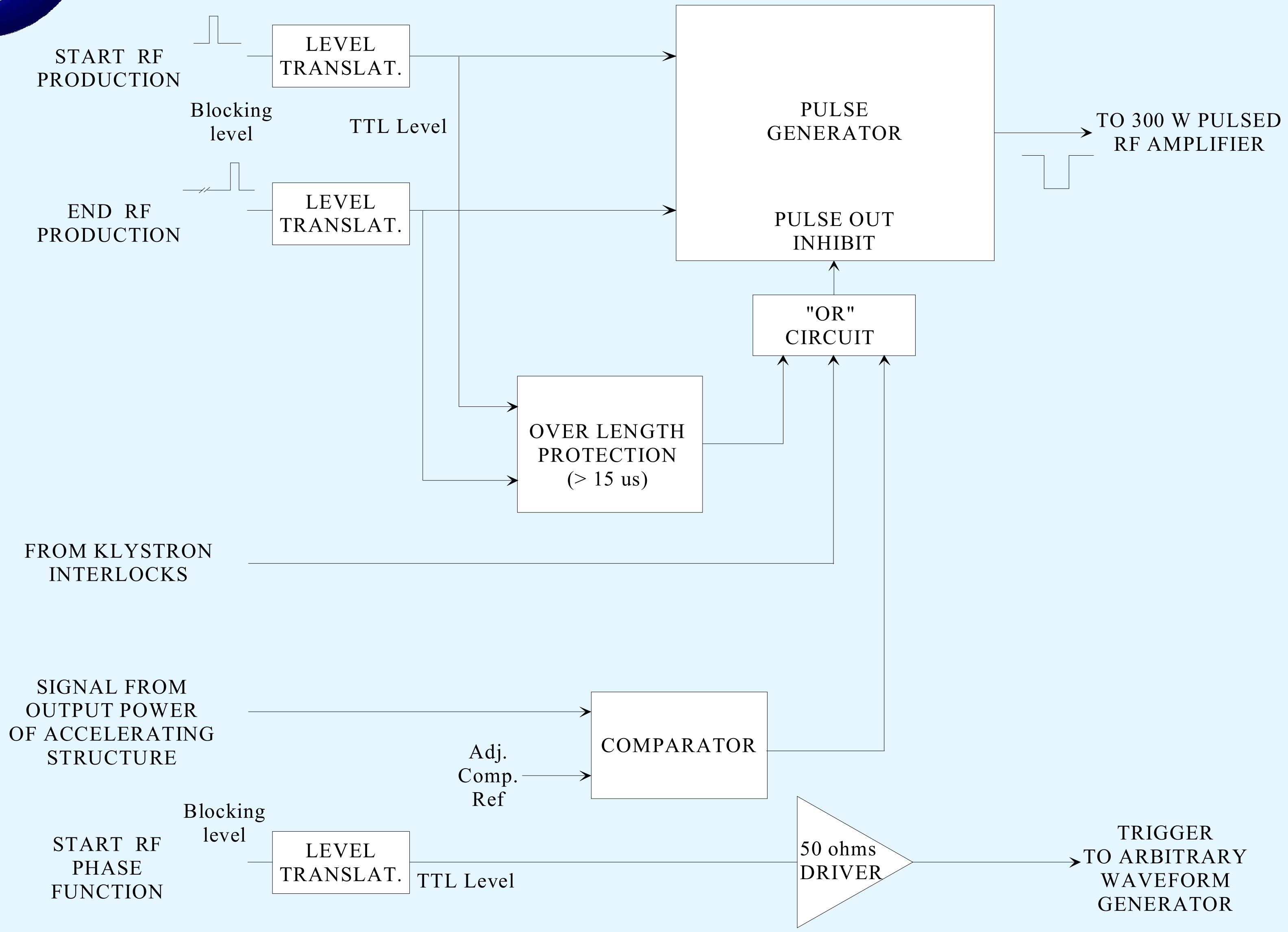


Frequency Range:	2975-3025 MHz
Gain:	46 dB min
Class:	C
Output Power (adjustable):	10-300 W (peak)
Input/Output Impedance:	50 ohms
Input/Output VSWR:	< 1.5 : 1
Load VSWR (no damage):	Infinity Open output and short circuit protection by RF Isolators
Pulse Width:	0.5-20 us. (internally limited)
Pulse Repetition:	0-500 Hz
Output Rise/Fall Times:	< 80 ns.
Output PW Stability after 300 ns:	< 0.2 dB
Output Phase Stability after 300ns:< +/- 3 deg.	
Phase Drift 3.6 - 6.0 us at 300 W:	< 1.5 deg
Pulse Ringing at 3.6 us at 300 W:	< 2 deg ptp at phase reversal 180 deg
Pulse Ringing at 3.7 us at 300 W:	< 1 deg ptp after phase reversal 180 deg
Power Monitoring:	Forward and Reverse Power Meter
Video Output:	2 V into 50 ohms at 300 W
Cooling:	Forced Air by Internal Fan
Operating Temperature:	0 to 40 deg. C

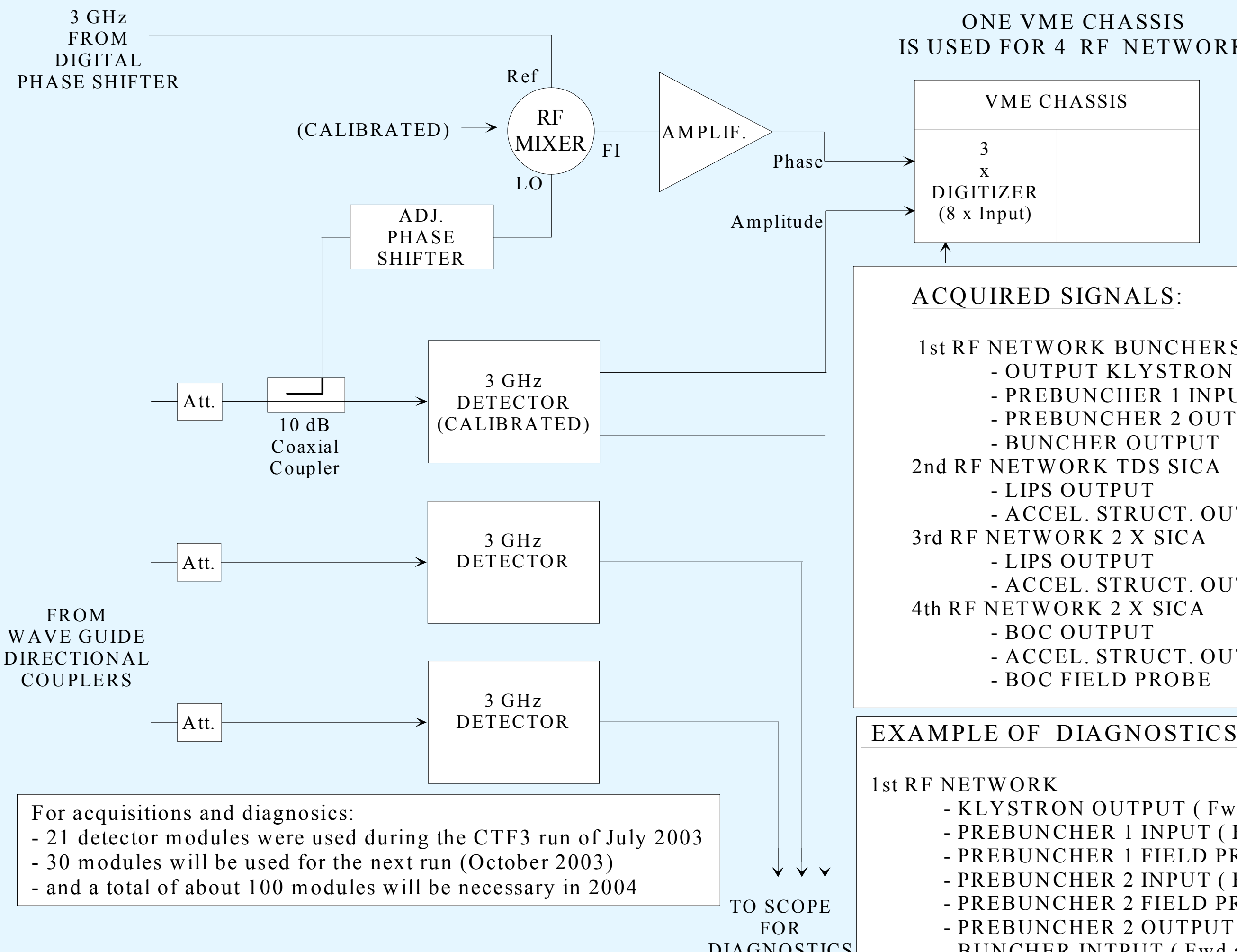
3GHz/300W Pulsed Amplifier
Top View



Timing Module



Amplitude , Phase Acquisitions and diagnostics



ACQUIRED SIGNALS:

1st RF NETWORK BUNCHERS
- OUTPUT KLYSTRON
- PREBUNCHER 1 INPUT
- PREBUNCHER 2 OUTPUT
- BUNCHER OUTPUT

2nd RF NETWORK TDS SICA
- LIPS OUTPUT
- ACCEL. STRUCT. OUTPUT

3rd RF NETWORK 2 X SICA
- LIPS OUTPUT
- ACCEL. STRUCT. OUTPUT

4th RF NETWORK 2 X SICA
- BOC OUTPUT
- ACCEL. STRUCT. OUTPUT
- BOC FIELD PROBE

For acquisitions and diagnosics:
- 21 detector modules were used during the CTF3 run of July 2003
- 30 modules will be used for the next run (October 2003)
- and a total of about 100 modules will be necessary in 2004

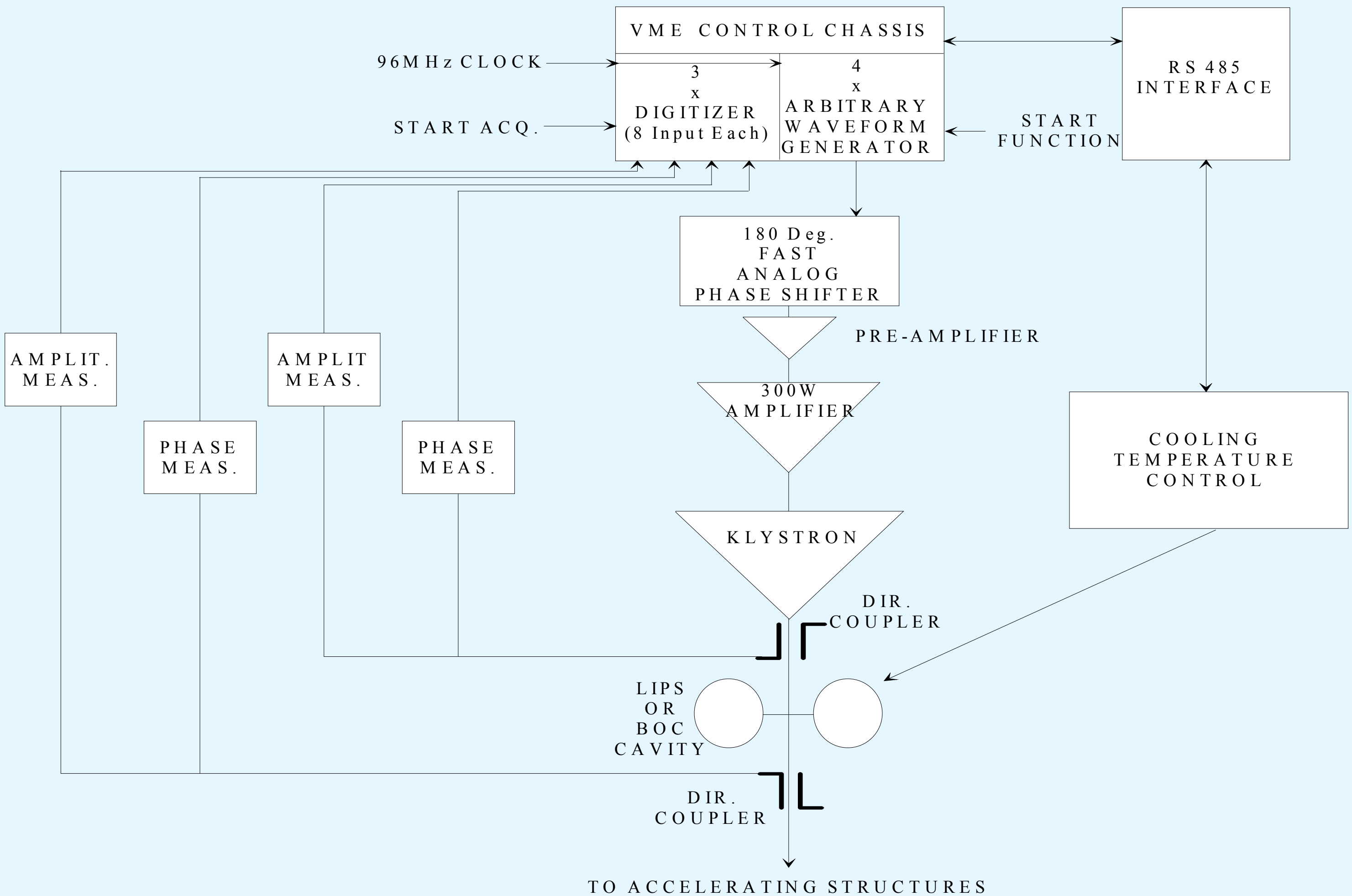
EXAMPLE OF DIAGNOSTICS SIGNALS

1st RF NETWORK
- KLYSTRON OUTPUT (Fwd and Refl.)
- PREBUNCHER 1 INPUT (Fwd and Refl.)
- PREBUNCHER 1 FIELD PROBE
- PREBUNCHER 2 INPUT (Fwd and Refl.)
- PREBUNCHER 2 FIELD PROBE
- PREBUNCHER 2 OUTPUT (Fwd)
- BUNCHER INTPUT (Fwd and Refl.)
- BUNCHER OUTPUT (Fwd)

2nd RF NETWORK
- ......

Pulse Compression Control

Block Diagram



Pulse Compression Control

Data Acquisition System

DIGITIZER CHARACTERISTICS:

Channel Nb:	8
Nb of bits:	12
Sampling Clock (Ext./ Int.):	100MHz
Memory of Each Channel:	256 k sample
Input Impedance:	50 ohms

The phase of output klystron signal and output LIPS or BOC with respect to 3GHz Ref. (output of Digital Phase Shifter) will be measured as well as their amplitude. The resulting pulses are applied to the VME Data Acquisition module. With the clock frequency of 96 MHz and a RF pulse of 5.5 us, about 530 points per signal will be measured and stored during the RF pulse. The clock signal and trigger for the start of acquisition is supplied by the timing system. The trigger has to be different for the different klystrons in order to take into account the traveling time of the electrons down the linac as well as the cables and wave guides length.

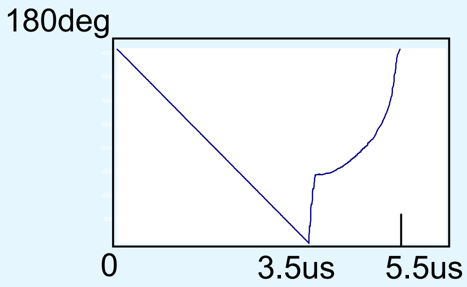
In software the data points are scaled so that the amplitude signals show MW and the phase signals degrees and they are then displayed on a screen in control room. In addition the slope of the amplitude signal at output of LIPS or BOC can be calculated during the pulse compression. If the top is not flat, the pulse compression cavity is retuned by an amount which can be derived from the steepness of the slope. This can be used to calculate the required change in temperature of the cooling water.

Pulse Compression Control

Phase Program Generation

ARBITRARY WAVEFORM GENERATOR CHARACTERISTICS:

Model:	VWG from Joerger Enterprises
Output by module:	1
Nb of bits:	12
Clock (Ext./ Int.):	100MHz
External Trigger:	TTL active “1”
Sync. Output:	TTL active “1”
Memory:	256 k word SDRAM
Output:	+/- 4 V
Input Impedance:	50 ohms



The arbitrary waveform generator houses the phase program for the pulse compression and the frequency offset. The function looks like shown in fig. above for a positive frequency offset. For a negative frequency offset the function is a mirror image of that one. The clock frequency can be the same as the one used for the data acquisition system.

For a pulse width of 5.5 us the clock frequency of 96 MHz gives about 530 data points. The values are loaded from the control system into the internal 256k word SDRAM of the waveform generator. It should be possible from the control system to modify the phase program. In the beginning this will be done manually by looking at the phase signal of the compressed pulse and the amplitude flatness. Later the procedure could be made semi-automatic or even automatic as suggested by I. Syratchev.

Pulse Compression Control

Temperature Control

Tuners are used for LIPS cavity. BOC is tuned by changing the cooling water temperature and both LIPS and BOC could be fine-tuned by the same way. During the initial setting-up the resonant frequency of the cavity is found by measuring the amplitude of signal at output of this cavity as function of frequency around the nominal value of 2998.55 MHz without phase program. The cavity is tuned when the amplitude of the signal is minimum after filling time. From the difference between the nominal and the measured frequency the new temperature is calculated (I.Syratchev). For fine-tuning the shape of compressed pulse can be used.

For use with LIL the temperature controller has only been used in manual control mode. For CTF3 it is desirable to be able to use in remote mode. The unit can only communicate with an RS485 serial data bus so for remote control a RS485 interface card will be needed.