

## PHASE LOCKED LOOP - FREQUENCY SYNTHESIZER

### 32XLR

#### (1) Dual phase locked loop system:

The Synthesizer has dual phase locked loops. One PLL is used for voltage controlled oscillator (VCO) phase comparator, and fixed crystal controlled oscillator. The other is used for voltage controlled multivibrator (VCM), phase comparator, and digital divider. The VCM is free running oscillator whose frequency can be shifted by changing the DC control voltage applied. Increasing this control voltage, the frequency of VCM becomes higher.

The output of the VCM is divided by the digital divider. The output of the digital divider is compared with a fixed reference frequency. The differences between these frequencies will drive the phase comparator to shift the oscillation frequency of VCM by DC tuning until the output of VCM becomes desirable frequency.

In other words , the output of the VCO is mixed with the fixed crystal oscillator output to produce a low frequency which can be compared to the output frequency of VCM. The difference between these frequencies will drive the phase comparator to shift the oscillation frequency of VCO by DC tuning until the output of VCO becomes the desired frequency.

#### (2) Circuit explanation:

The VCO (Q-32) is automatically tuned by the varactor (CD-26) and manually set by L-11 and L-12. The transistor switch (Q-31) is ON in transmit mode and OFF in receiving Mode. VCO output is supplied to loop-buffer amplifier (Q-33). The output of Q-33 is supplied to the output buffer-amplifier (Q-34) and loop mixer (Q-35). The other input to Q-35 comes from the output of the 21.65 mhz oscillator (Q-38) in receiving mode and the 26.315 mhz oscillator (Q-37) in transmit mode. Q-35 output is filtered by the low-pass filter which consists of L-13, C-162 and converted to a pulse by Q-36 to obtain a sufficient level to IC-7, the phase comparator. The VCM (Q-39, Q-40, Q-41 and Q-42) is automatically tuned by DC voltage supplied to Q-41 and Q-42. The VCM output is supplied to the programable divider IC-10. The programable divider is supplied to the phase comparator (IC-9) which compares the pulse to the 5KHZ output of the reference divider (IC-8). IC-8 consists

of the 5.12 mhz oscillator and fixed divider for the 5 khz output. The phase comparator (IC-9) output is filtered through R-182 and C-188 to produce a DC tuning for the input to O-41 and Q-42.

Note: When the loop is locked, IC-9 produces DC voltage in proportion to the VCM frequency. If IC-9 output is at 0 or 1 logic level, the loop is not locked yet.

The VCM output is supplied to phase comparator (IC-7) and compared to Q-36 output.

Note: When the loop is locked, IC-7 produces DC voltage in proportion to VCO frequency. If IC-7 output is at 0 or 1 logic level, the loop is not locked yet.

PLL SYNTHESIZER ALIGNMENT

(At Channel 11)

1. Voltage controlled oscillator (VCO)
  - (A) Channel switch to Channel 11
  - (B) A frequency counter to TP-1, TP-2
  - (C) Short TP-10 to ground and adjust coil L-12 for 21.6 mhz
  - (D) Open TP-6 and press mike button and adjust coil L-11 for 26.3 mhz
2. Local oscillator and mixer
  - (A) Open TP-10 and a frequency counter to TP-1, TP-2
  - (B) Rotate the delta tune control to center position and adjust coil L-15 for 22.42 mhz
  - (C) Open TP-6 and press mike button, adjust C-173 for 27.085 mhz

TRANSMITTER ALIGNMENT

1. RF alignment
  - (A) Wattmeter to antenna jack
  - (B) Connect TP-6
  - (C) Press mike button and adjust T-9, L-4 and L-5 for maximum output
2. Modulation performance check
  - (A) Inject 1 khz to the microphone input with audio generator
  - (B) Adjust the audio generator output level to 3 to 4 millivolts, modulation should be approximate 90%
3. RF Meter alignment
  - (A) Press mike button and adjust R-3 for 4 watts on RF meter

CHANNEL 9 - SCAN PERFORMANCE CHECK

1. Transmit

- (A) Connect 50 ohm wattmeter to antenna jack
- (B) Connect a frequency counter to antenna jack
- (C) Turn the CH-9 scan switch to hold
- (D) Press mike button
- (E) Output frequency should be 27.065 mhz

2. Receive

- (A) Connect signal generator to antenna jack set output at 1 millivolt, 1 khz, 30% modulation
- (B) Connect 8 ohm load with audio voltmeter to external speaker jack
- (C) Rotate the volume control to maximum clockwise position and squelch control to threshold
- (D) Turn CH-9 scan switch to scan
- (E) Rotate the channel selector switch to any channel except channel 9, set signal generator to 27.065 mhz

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RECEIVER ALIGNMENT

(At Channel 11)

1. Receiver performance check:

- (A) Connect the RF signal generator to the antenna jack. Set generator output at 0.5 microvolt, 1 khz 30% modulation.
- (B) Connect the 8 ohm load with audio voltmeter to external speaker jack.
- (C) Rotate the volume control to the maximum clockwise position and the squelch control to the maximum counter clockwise position.
- (D) Turn the channel 9 scan switch to off.
- (E) Set the channel selector switch to channel 11 and the signal generator to 27.085 mhz.
- (F) Audio output level should be more than 3 volts.
- (G) Adjust the volume control for 1 volt indication on audio voltmeter. Remove the modulation from signal generator, indication on audio voltmeter should drop 10 db or more.

2. Receiver Alignment:

<u>Alignment</u>	<u>Generator Frequency &amp; Output</u>	<u>Generator Connection</u>	<u>Ajust</u>	<u>Adjust for</u>
2nd IF stage	455 khz-10 $\mu$ V	TP-3 and ground	T6, 7,8	Max.
1st IF stage	4.665 mhz-3 $\mu$ U	TP-1, TP-2	T4, 5	Max.
RF stage	27 mhz-0.5 $\mu$ V	Ant. jack	T1, 2, 3	Max.

PLL SYNTHESIZER

		T	R
Q-32	Voltage controlled oscillator (VCO)	27.085 mhz	22.42 mhz
Q-33,34	Buffer	27.085 mhz	22.42 mhz
Q-37	Oscillator		
Q-38	Oscillator		
Q-35	Mixer	770 khz	770 khz
Q-36	RF amp	770 khz	770 khz
IC-7	Phase comparator	770 khz	770 khz
IC-8	Reference oscillator and divider	5.12 mhz	5 khz
IC-9	Phase comparator	5 khz	5 khz
IC-10	Programable divider	770 khz	5 khz
Q-39,43	Voltage controlled multivibrator (VCM)	770 khz	770 khz

32XLR TO CHANGE SCAN FROM CHANNEL 9 TO ANY OTHER  
DESIRED CHANNEL SCANNING

DIODES TO BE CONNECTED FROM EMITTER OF Q-57 to IC-10

Channel	Pins # IC 10													
	2	3	4	5	6	7	8							
1	x						x							
2		x					x							
3	x	x					x							
4	x		x				x							
5		x	x				x							
6	x	x	x				x							
7				x			x							
8		x		x			x							
9	x	x		x			x							
10			x	x			x							
11	x		x	x			x							
12	x	x	x	x			x							
13						x	x							
14	x					x	x							
15		x				x	x							
16			x			x	x							
17	x		x			x	x							
18		x	x			x	x							
19	x	x	x			x	x							
20	x			x		x	x							
21		x		x		x	x							
22	x	x		x		x	x							
23		x	x	x		x	x							

SIGNAL FLOW (At Channel 11)

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RECEIVER

CD-4, CD-5	RF switch	27.085 mhz
Q-2	RF amplifier	27.085 mhz
PLL synthesizer	1st local	22.42 mhz
Q-4	1st mixer	4.665 mhz
PLL synthesizer	2nd local	5.12 mhz
Q-5	2nd mixer	455 khz
Q-6	1st IF amp	455 khz
Q-7	2nd IF amp	455 khz
CD-6	Detector	Audio
CD-7	An1	Audio
IC-3	Audio PA	Audio
IC-1	Squelch amp	DC

TRANSMITTER

PLL synthesizer	TX, osc	27.085 mhz
Q-9	RF amp	27.085 mhz
Q-10	RF amp	27.085 mhz
Q-11	RF driver	27.085 mhz
Q-12	RF PA	27.085 mhz
CD-3	RF meter det.	DC
Q-20	Audio amp	Audio
IC-3	Modulator	Audio
Q-18	Mod. AGC gate	Audio
CD-11, CD-12	Mod. AGC det.	Audio DC



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VOLTAGE CHART

	<u>Q-1</u>	<u>Q-2</u>	<u>Q-3</u>	<u>Q-5</u>	<u>Q-6</u>	<u>Q-7</u>
Base	1.4	1.8	-0.7	1.95	0.6	2.2
Collector	1.15	7.7	0	7.9	2.2	8.1
Emitter	1.15	1.15	-0.2	1.25	0	1.6

	<u>Q-8</u>	<u>Q-9</u>	<u>Q-10</u>	<u>Q-11</u>	<u>Q-12</u>
Base	0	0.8	0.1	-0.4	-0.42
Collector	5.9	7.1	9.1	12.0	12.0
Emitter	0	0	0	0	0

	(RV) <u>Q-13</u>	(Tx)	(RV) <u>Q-15</u>	(Tx)	(RV) <u>Q-17</u>	(Tx)
Base	8.0	0	8.0	8.0	0	2.1
Collector	8.2	8.2	0.6	0	13.8	2.2
Emitter	8.6	0	8.2	8.2	0	2.8

	(RV) <u>Q-18</u>	(Tx)	(RV) <u>Q-19</u>	(Tx)	<u>Q-20</u>
Base	0.11	0.06	0.03	-0.51	0.2
Collector	0.03	0.07	0.03	0.07	2.3
Emitter	0	0	0	0	0.8

	<u>Q-21</u>	<u>Q-22</u>	<u>Q-23</u> (Brite) (Dim)
Base	13.2	3.0	8.0
Collector	8.2	13.2	13.8
Emitter	13.8	2.4	7.4

	<u>Q-31</u>	<u>Q-32</u>	<u>Q-34</u>	<u>Q-35</u>	<u>Q-36</u>
Base	4.8	1.6	4.8	0.42	0.6
Collector	0	7.2	8.2	3.5	4.4
Emitter	5.4	2.0	4.2	0	0

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VOLTAGE CHART

	(Tx)	<u>Q-37</u>	RF	(RV)	<u>Q-38</u>	RF
Base	2.0	2.0	2.2	3.8	2.5	2.5
Collector	7.8	7.8	0	7.8	0	0
Emitter	2.2	2.2	1.5	4.4	1.8	1.8

	<u>Q-39</u>	<u>Q-40</u>	<u>Q-41</u>	<u>Q-42</u>	<u>Q-43</u>
Base	6.8	6.8	3.0	3.0	0.5
Collector	6.8	6.8	6.2	6.2	3.8
Emitter	6.2	6.2	2.4	2.4	0

	<u>Q-4</u>	FET's <u>Q-33</u>
Gate	0	2.5
Drain	5.6	8.2
Source	0	5.4

## 32XLR

FUNCTION OF IC's

IC-1	Squelch Amp	IC-8	Ref. osc. & Divider
IC-2	NB Amplifier	IC-9	Phase comparator
IC-3	PA & Modulator	IC-10	Probrammable Divider
IC-7	Phase Comparator		

FUNCTION OF DIODES

CD-1 & 2	SWR & PWR for meter	CD-15	Polarity Protect
CD-3	RF Meter Det	CD-25	Rectifier
CD-4 & 5	RF Switch	CD-26	Clamp
CD-6 & 7	Detector	CD-27	Varactor
CD-8	Trans. Temp Regulate	CD-28	Steering Diode
CD-9	LED Tx Indicator	CD-29	Steering Diode
CD-10	Audio Transformer Switch	CD-41	Rectifier
CD-11 & 12	Mod. AGC Detector	CD-42	Steering Diodes
CD-13	Regulator at 6.2V	CD-43	Steering Diodes
CD-14	Relay Inductance Short	CD-44	Steering Diodes
		CD-45-46- 47	Matrix Diode
		CD-48	LED Scan Indicator
		CD-49	Rectifier
		CD-51/ 58	Channel Switch

IC

IC - 1 Squelch

Pin	1	2	3	4	5	6	7
Off	0.71	0.61	0	0	1.35	0	0.08
On	0.2	0.66	0	0	1.35	0	4.4

IC-2 Noise Blanker

Pin	1	2	3	4	5	6	7
Off	0	0.02	8.2	8.2	0.03	0.03	0
On	0	0.02	8.2	8.2	8.2	0.02	0

IC-3 Audio

Pin	1	2	3	4	5	6	7	8	9	10
	13.75	12.6	4.0	8.3	1.3	3.4	3.4	1.3	0	6.8

IC-7 Phase Comparator (at Channel 11)

Pin	1	2	3	4	5	6	7	8	9
	1.7	3.6	3.6	8.2	8.2	0	3.8	4.4	0

IC-8 Ref. Osc. and Divider

Pin	1	2	3	4	5	6	7	8	9
	3.7	3.5	3.5	0	7.8	0	3.9	0	0

IC-9 Phase Comparator

Pin	1	2	3	4	5	6	7	8	9
	3.6	4.1	4.1	7.8	7.8	0	3.9	0	0

IC-10 Programable Divider

Pin	1	2	3	4	5	6	7	8	9
	0	5.8	0	5.8	5.8	0	0	5.8	0

Pin	10	11	12	13	14	15	16
	0	0	0	5.8	3.8	3.8	7.2

IC

OFF - SCAN - HOLD

		OFF	SCAN	HOLD
Q-52	Base	0	0 - 0.65	0
	Collector	0	8.7 - 0	0
Q-53	Base	0	0.65 - 0	0
	Collector	0	0 - 8.7	0
Q-54	Base	0.75	0 - 0.75	0
	Collector	0	7.9 - 0	7.9
Q-55	Base	0	0.9 - 0	0.9
	Collector	7.3	0 - 7.3	0
Q-56-58	Base	7.1	0 - 7.1	0
Q-57	Base	0	7.8 - 0	7.8

FUNCTION OF TRANSISTORS IN

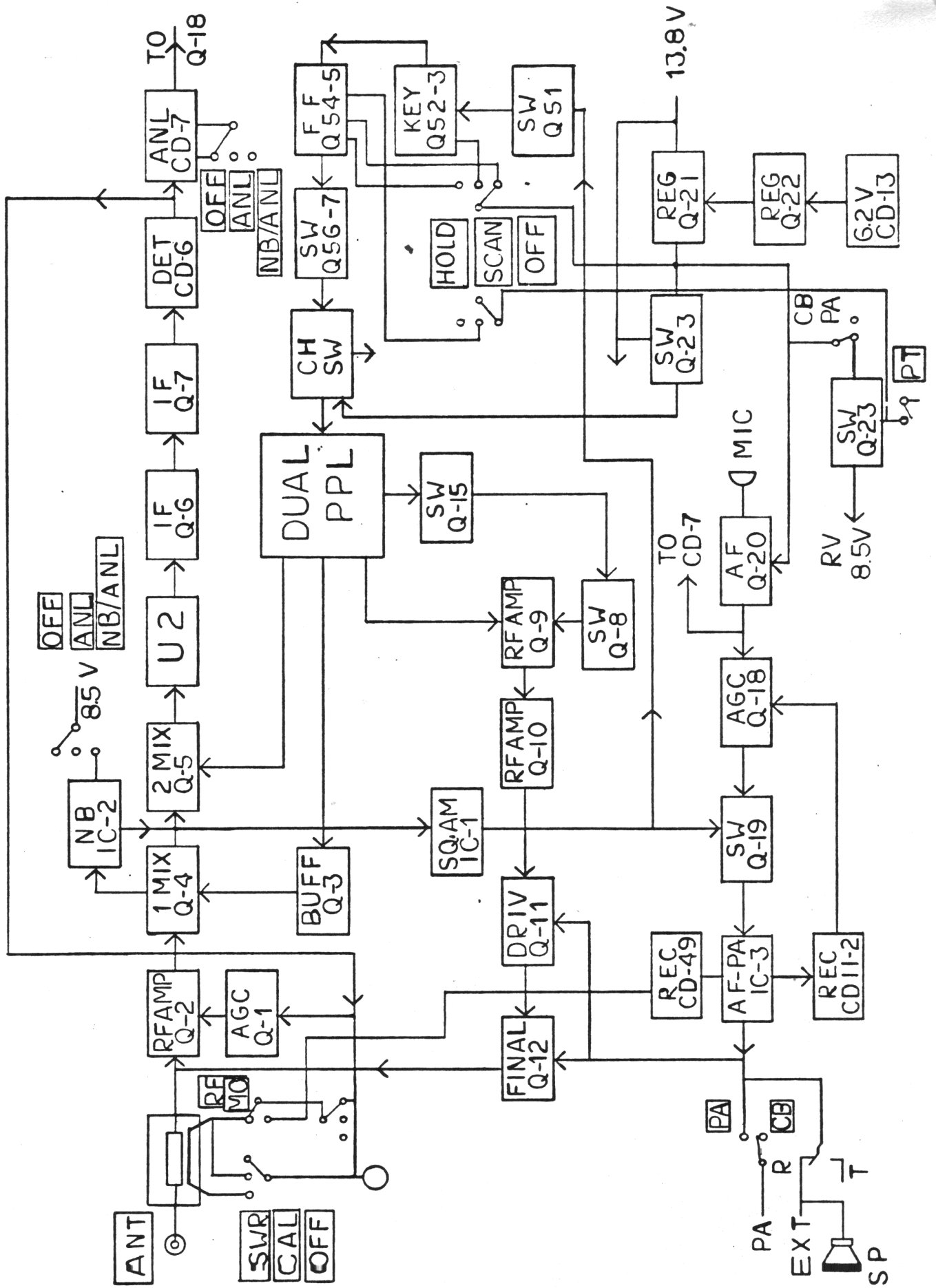
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Q-1	RF AGC	Q-21	Regulator
Q-2	RF Amp	Q-22	Regulator
Q-3	Buffer	Q-23	Switch
Q-5	2nd mixer	Q-31	Switch
Q-6	IF Amp-1	Q-32	VCO
Q-7	IF Amp-2	Q-34	Buffer
Q-8	Switch	Q-35	Mixer
Q-9	RF Amp Tx	Q-36	RF Amp
Q-10	RF Amp Tx	Q-37	Tx Osc
Q-11	Driver Tx	Q-38	Rv Osc
Q-12	RF Final	Q-39/42	Osc
Q-13	Switch	Q-43	RF Amp
Q-15	Switch	Q-51	Switch
Q-17	Switch	Q-52-53	Keying
Q-18	AGC	Q-54-55	Flip Flop
Q-19	Switch	Q-58	Channel Switch
Q-20	AF Amp	Q-56	Switch
		Q-57	Switch

Function of Fets

Q-4	1st Mixer	Q-33	Buffer
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## INPUT TO PROGRAMABLE DIVIDER IC-10

CHANNEL	1	2	3	4	5	6	PIN 7	8						
1	0	5.8	0	0	0	0	0	5.8						
2	0	0	5.8	0	0	0	0	5.8						
3	0	5.8	5.8	0	0	0	0	5.8						
4	0	5.8	0	5.8	0	0	0	5.8						
5	0	0	5.8	5.8	0	0	0	5.8						
6	0	5.8	5.8	5.8	0	0	0	5.8						
7	0	0	0	0	5.8	0	0	5.8						
8	0	0	5.8	0	5.8	0	0	5.8						
9	0	5.8	5.8	0	5.8	0	0	5.8						
10	0	0	0	5.8	5.8	0	0	5.8						
11	0	5.8	0	5.8	5.8	0	0	5.8						
12	0	5.8	5.8	5.8	5.8	0	0	5.8						
13	0	0	0	0	0	5.8	0	5.8						
14	0	5.8	0	0	0	5.8	0	5.8						
15	0	0	5.8	0	0	5.8	0	5.8						
16	0	0	0	5.8	0	5.8	0	5.8						
17	0	5.8	0	5.8	0	5.8	0	5.8						
18	0	0	5.8	5.8	0	5.8	0	5.8						
19	0	5.8	5.8	5.8	0	5.8	0	5.8						
20	0	5.8	0	0	5.8	5.8	0	5.8						
21	0	0	5.8	0	5.8	5.8	0	5.8						
22	0	5.8	5.8	0	5.8	5.8	0	5.8						
23	0	0	5.8	5.8	5.8	5.8	0	5.8						



