

# Dual Channel RF Generator Interface

## Instruction Manual

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For assistance, contact:

Integrated Time Systems, Inc.  
PO Box 700699  
San Jose, CA 95170-0699  
[www.intyme.com](http://www.intyme.com)  
Phone: 408-996-3822  
Fax: 408-996-3834

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## 1. DESCRIPTION

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### 1.1. Overview

The Dual Channel RF Generator Interface, alternately referred to as Model 841 or “RF Pulser”, is designed to connect one or two RF generators to a process sequencer or to a Personal Computer with serial communications capability.

The interface receives commands and queries from the process sequencer via a serial port and generates the appropriate digital and analog I/O signals required by the specific RF Generators. Conversely, the RF Pulser monitors the analog and digital status signals from the generators and transfers the information to the process sequencer when queried.

Since the RF Pulser connects to the control device using a serial protocol, it can provide galvanic isolation between the generators and the process sequencer.

### 1.2. Features

- *Powered by an external 24 VDC Power Supply from the process sequencer or from either of the RF Generators.*
- *Supports various serial connections such as EIA-232 or EIA-422, isolated or non-isolated with plug-in communications adapters.*
- *Uses a 2-channel, 12-Bit D/A converter to generate the 0 to 10 volt analog setpoint signals.*
- *Uses a 4-channel, 10 Bit A/D converter (internal to the microprocessor) to monitor the RF Generator’s Forward Power and Reflected Power analog status signals.*
- *Includes (2) solid-state relay outputs to provide the RF Generator’s “Enable” commands.*
- *Includes (2) opto-isolators to monitor the RF Generator’s “Plasma OK” status outputs.*



## 2. INSTALLATION

### 2.1. RF Generator Connectors, J101 & J201

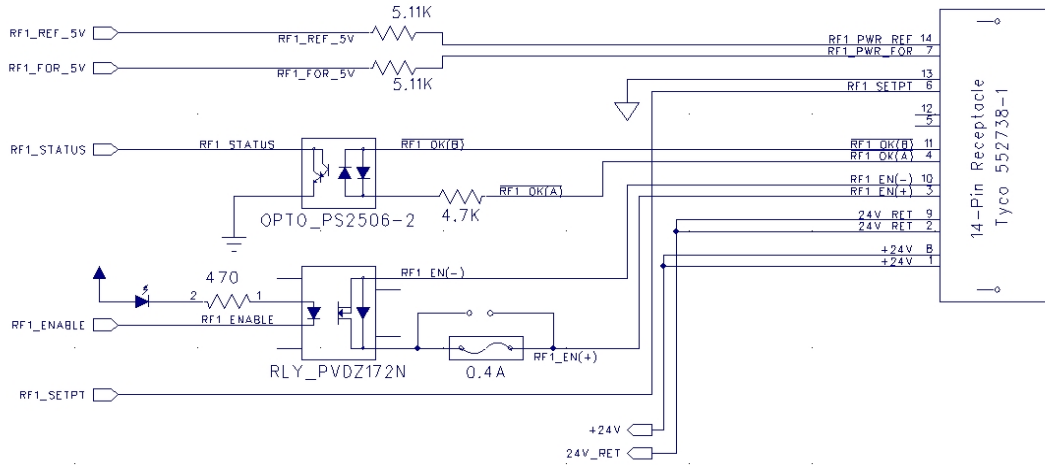
The RF Pulser includes two identical 14-pin interface connectors for use with the RF Generators. The female, board-mounted connectors are manufactured by Tyco as part number 5552738-1. Most Tyco or Amphenol male 14-Pin Communications Connectors may be used as mating connectors.

Either, but not both, of the RF Generator connectors may be used to connect to an external 24-volt power. The external supply may range from +18 Volts DC to +36 Volts DC.

The pinout of the (2) RF Generator connectors are as follows:

Pin	J101	Pin	J101
1	+24 VDC	8	+24 VDC
2	24 V RET	9	24 V RET
3	RF1 Enable (+)	10	RF1 Enable (-)
4	RF1 OK (A)	11	RF1 OK (B)
5	RF2 PWR FOR	12	RF2 PWR REF
6	RF1 Setpoint	13	Analog Common
7	RF1 PWR FOR	14	RF1 PWR REF

Pin	J201	Pin	J201
1	+24 VDC	8	+24 VDC
2	24 V RET	9	24 V RET
3	RF2 Enable (+)	10	RF2 Enable (-)
4	RF2 OK (A)	11	RF2 OK (B)
5	RF1 PWR FOR	12	RF1 PWR REF
6	RF2 Setpoint	13	Analog Common
7	RF2 PWR FOR	14	RF2 PWR REF



## 2.2. Communications Connector, J1

The RF Pulser includes a 6-pin RJ-12 connector for serial communications. The pinout of the connector depends on the type of Communications Adapter that is installed, Adapters are available for isolated and non-isolated versions of EIA-232, 2-wire EIA-485 and 4-wire EIA-422.

### 2.2.1. EIA-232

If the RF Pulser is to be controlled by a PC, a 6-conductor/6-pin modular cable and an RJ-12 to 9-Pin Female 'D' adapter are required. The modular cable should be wired 'straight-through' with Pin 1 through Pin 6 at one end connected to Pin 1 through Pin 6 respectively at the other end. Pinout of the 'D' adapter is as follows.

RJ-12 to 9-pin female 'D' adapter			
RJ-12 on RF Pulser	Wire Color (inside adapter)	9-Pin 'D' Connector To PC	Signal
1	Blue	5	SG
2	Yellow	3	TDX from PC to Tymkon
3	Green	2	RDX from Tymkon to PC
4	Red	7	RTS from PC to Tymkon
5	Black	8	CTS from Tymkon to PC
6	White		

### 2.2.2. EIA-422

If the RF Pulser is to be controlled by a Tymkon Process Sequencer, a special adapter cable is required. Since both the Tymkon and the RF Pulser have the same pinout, the transmit lines and the receive lines must be swapped to avoid signal conflicts.

Modular Cable		
RJ-12 on RF Pulser		RJ-12 on Tymkon
1		1
2		3
3		2
4		5
5		4
6		6





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## 3. THEORY OF OPERATION

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### 3.1. General Behavior

Under control of a microprocessor, a dual, 12-bit D/A converter generates an analog setpoint signal for each of two RF control channels. After amplification, the analog setpoints are routed through analog switches before exiting via two 14-pin interface connectors. In the pulsed modes, the analog switches alternatively connect the RF setpoint to analog ground and, then, to the 0 to 10 volt DC setpoint signals. The on and off times of these setpoint pulses, and their amplitudes, can be programmed via an asynchronous serial port. The serial port may be configured for EIA-232 if the unit is being controlled from a PC or for EIA-422 or EIA-485 if a process controller is controlling it.

### 3.2. Glossary

- **Peak Power** – The amplitude of the analog setpoint signal regardless of whether the setpoint is constant or pulsed. This value varies from 0.0% to 100.0% (10 volts) and can be set in 0.1% increments (0.01 volt resolution).
- **Average Power** – In some modes of operation, this value determines the duty cycle of the analog setpoint pulse.
- **Forward Power** – These values originate at the RF Generators and are digitized by a 10-bit A/D converter in the microprocessor. The signals range from 0 to 10 volts DC and, depending on the RF Generator, may represent Total Power or just the power delivered to the load.
- **Reflected Power** – These values originate at the RF Generators and are digitized by a 10-bit A/D converter in the microprocessor. The signals range from 0 to 10 volts DC and represent the wasted power.
- **RF Enable** – The RF Generator Interface generates a digital enable command for each generator. This signal generally energizes a relay in the generator.
- **Plasma OK** – Most RF Generators output a digital status signal that confirms that plasma has formed.
- **ON Time** – In some modes of operation, this value indicates the time interval for the ON portion of the control waveform. This value is programmed in tens of microseconds and may range from 10 to 99990 microseconds (99.99 milliseconds).
- **OFF Time** – This value indicates the time interval for the OFF portion of the control waveform. This value, typically calculated by the microprocessor, is set in microseconds and may range from 0 to 99999 microseconds (99.999 milliseconds).
- **Pulse Width** – This value indicates the total time interval for both the ON and the OFF portion of the waveform and ranges from 10 to 99990 microseconds (99.99 milliseconds).

### 3.3. Operating Modes

	Analog Mode		PWS Mode		PWM Mode		Test Mode	
RF Enable (Forward)	X	Avg	X	Avg	X	Avg	X	(Avg)
RF Pulse			X	Peak	X	Peak	X	Peak
RF PWS			X	On Time			X	On Time
RF PWM					X	Total Time	X	Off Time
RF Reflected (Optional)		Upper Limit		Upper Limit		Upper Limit		Upper Limit

#### 3.3.1. Off Mode

Each channel can be deactivated individually via the communications port. In addition, both channels can be deactivated with a toggle switch located on the enclosure. Once the toggle switch has been turned OFF, neither channel will turn ON until the toggle switch is turned back ON and an appropriate command is received over the serial port. While the toggle switch is OFF, the microprocessor will continue to respond to queries from the host.

#### 3.3.2. Analog Mode

Either or both channels may be commanded to control in an Analog Mode. In Analog Mode, the value commanded for the Peak Power (0 to 10 volts) is output as an analog setpoint and the analog switch is turned on at 100% duty cycle.

#### 3.3.3. PWS Mode

Either or both channels may be commanded to pulse in a **Frequency Modulation** mode with a fixed (but programmable) **ON Time**, a programmable **Peak Power** and a programmable **Average Power**. In this mode, the microprocessor calculates the **OFF Time** and, consequently, the **Pulse Width** based on the other parameters.

#### 3.3.4. PWM Mode

Either or both channels may be commanded to pulse in a **Pulse Width Modulation Mode** with a fixed (but programmable) **Frequency**, a programmable **Peak Power** and a programmable **Average Power**. In this mode, the microprocessor calculates the **ON Time** and the **OFF Time** based on the other parameters.

### 3.3.5. Test Mode

Either or both channels may be commanded to pulse in a **Test Mode** that is similar to the **Pulse Width Modulation Mode**. In this mode, the **Peak Power**, the **ON Time** and the **OFF Time** are programmable.

### 3.3.6. Timing Constraints

All pulse-time parameters are specified in microseconds, but the RF Interface has minimum and maximum constraints on all timing parameters. Generally, the minimum ON time or OFF time in any pulse mode is 75 microseconds. The maximum ON time or OFF time in any pulse mode is 12,000 microseconds (12 milliseconds).

## 3.4. Front Panel Displays

Each channel includes two LEDs on the front panel, one Green and one Yellow. The Green LEDs indicate which channels are active (not in the OFF state). The Yellow LEDs indicate which channels are in the Analog Mode of operation.

## 3.5. Tymkon Parameters

The following parameters are used in the Tymkon firmware to configure the Tymkon for use with the RF Interface:

### RFCOMM

- TRUE/FALSE – Enables communications on Port 1

### RF<sub>x</sub>\_ENAB

- Ranges from 0 to 31 (OFFH disables this feature)
- Assigns a Tymkon Output Function to control the RF Enable Digital Output relay
- Assigns a Tymkon Output Function for setting the Average Power in Pulse Modes, in Analog Mode, PWS Mode and PWM Mode.
- Assigns a Tymkon Output Function for reading the Forward Power in all modes.

### RF<sub>x</sub>\_PULS

- Ranges from 0 to 31 (OFFH disables this feature)
- Assigns a Tymkon Output Function to enable any of the Pulse Modes.
- Assigns a Tymkon Output Function for setting the Peak Power in any of the Pulse Modes.
- No Read-back Parameter

### RF<sub>x</sub>\_PWS

- Ranges from 0 to 31 (OFFH disables this feature)
- Assigns a Tymkon Output Function to enable the PWS Mode (when RF<sub>x</sub>\_PULS is also on).
- Assigns a Tymkon Output Function for setting the ON Time in the PWS Mode and in the Test Mode.
- No Read-back Parameter

**RF<sub>x</sub>\_PWM**

- Ranges from 0 to 31 (OFFH disables this feature)
- Assigns a Tymkon Output Function to enable the PWM Mode (when RF<sub>x</sub>\_PULS is also on).
- Assigns a Tymkon Output Function for setting the Total Time in the PWM Mode and the OFF Time in the Test Mode.
- No Read-back Parameter

**RF<sub>x</sub>\_REFL**

- Ranges from 0 to 31 (OFFH disables this feature)
- Assigns a Tymkon Output Function for reading the Reflected Power in all modes.

## Time Setpoints (RF1\_PWS &amp; RF1\_PWM functions)

- 00 = Defaults to 1 millisecond
- 01 to 10 = 0 to 10 milliseconds
- 11 = 110 microseconds
- 20 = 200 microseconds
- 99 = 990 microseconds (0.99 milliseconds)

## 3.6. Serial Communications

### 3.6.1. Communications Port

The RF Interface may be supplied with an EIA-232, EIA-485 or EIA 422 communications adapter. When the RF Interface is to be controlled from a PC, EIA-232 is used. When the RF Interface is to be controlled from a Tymkon Process Sequencer, EIA-422 is used.

### 3.6.2. Communications Parameters

- Baud Rate = 57,600
- Parity = N
- Stop Bits = 1
- Data Bits = 8
- No Flow Control

### 3.6.3. Communications Protocol

Command	Mode	Avg Pwr %	Peak Pwr %	ON Time $\mu$ Sec	OFF Time $\mu$ Sec	Total Pulse Width $\mu$ Sec
<b>X x</b>	Off					
<b>A a</b>	Analog	XXX.X				
<b>F/f</b>	PWS	XXX.X	PPP.P	NNNNN		
<b>P/p</b>	PWM	XXX.X	PPP.P			TTTTT
<b>T/t</b>	Test Mode		PPP.P	NNNNN	FFFFFF	
<b>W</b>	Disable Watchdog					

Any command or query to the RF Interface must begin with the ASCII character <@>. Messages to the RF Interface may be terminated with a Carriage Return <CR>, a Linefeed <LF> or both.

The first character of any such message from the RF Interface is the ASCII character <#>. Messages from the RF Interface are terminated with a Carriage Return <CR> followed by a Linefeed <LF>.

While some of the parameters in the table above have decimal points in their values, no decimal points are included in any of the messages. Since the exact format of all messages is predetermined, there is no need to slow the communications with unneeded characters.

There are currently no timing requirements in this protocol. As long as the character bit timing matches the specified baud rate, inter-character delays, though undesirable, will not cause a message to be aborted.

In all messages, the four characters following the start character identify the particular device being addressed. The first two characters must range from “00” to “99” and identify the product category. In particular, the RF Interface products are identified as Product ID = “07”. The next two characters after the Product ID are the Device ID. In most applications, there will be only one RF Pulser on the communications link and it will be identified as Device “01”.

The sixth character of any message to or from the RF Interface indicates the type of command, query or response. See the “Command and Query Summary” below for a list of available commands.

Some messages must include a Channel Identifier following the Command character. Since the RF Interface supports two independent RF Generators, this character determines which of the channels will react to the command. A Channel Identifier of “1” commands Channel A whereas a Channel Identifier of “2” commands Channel B. Any other character, including “0”, commands both channels.

Following the header information detailed above, most messages contain one, two or three numeric parameters. See the “Command and Query Summary” below for further details.







## 4. COMMAND AND QUERY SUMMARY

Message Format	Type	Message to Pulser	Reply from Slave
@ggddXc[<CR> <LF>]	6 Command	Go to Off Mode	#ggddQ: 111: 222: 333: 444: AaBb<CR>
@ggddAc: PPPP[<CR> <LF>]	11 Command	Go to Analog Mode	#ggddQ: 111: 222: 333: 444: AaBb<CR>
@ggddFc: PPPP: VVVV: NNNNN[<CR> <LF>]	22 Command	Go to PWS Mode	#ggddQ: 111: 222: 333: 444: AaBb<CR>
@ggddPc: PPPP: VVVV: TTTTT[<CR> <LF>]	22 Command	Go to PWM Mode	#ggddQ: 111: 222: 333: 444: AaBb<CR>
@ggddTc: PPPP: NNNNN: FFFFF[<CR> <LF>]	23 Command	Go to Test Mode	#ggddQ: 111: 222: 333: 444: AaBb<CR>
@ggddW0[<CR> <LF>]	6 Command	Disable Watchdog	#ggddQ: 111: 222: 333: 444: AaBb<CR>
@ggddW1[<CR> <LF>]	6 Command	Enable watchdog	#ggddQ: 111: 222: 333: 444: AaBb<CR>
		Error Reply	#ggdd_: ERROR: _<CR>
@ggddQ[<CR> <LF>]	5 Query	Data Request	#ggddQ: 111: 222: 333: 444: AaBb<CR>
@ggddV[<CR> <LF>]	5 Query	Version Request	#ggddV: ??????????<CR>

Off @ggddXc<LF> or @ggddxc<LF>  
 ANALOG @ggddAc: PPPP<LF>  
 FM @ggddFc: PPPP: VVVV: NNNNN<LF>  
 PWM @ggddPc: PPPP: VVVV: TTTTT<LF>  
 TEST @ggddTc: PPPP: NNNNN: FFFFF<LF>  
 QUERY @ggddQ<LF>

When C=0, the particular command is applied to both channels. When C=1, the command is applied only to Channel A and, when C=2, the command is applied only to Channel B.

REPLY #ggddQ: 111: 222: 333: 444: XY<CR>  
 111 = Ch 1 Forward 00.0 to 99.9%, AAA=100%, ^^>=Overrange  
 222 = Ch 1 Reflected 00.0 to 99.9%, AAA=100%, ^^>=Overrange  
 333 = Ch 2 Forward 00.0 to 99.9%, AAA=100%, ^^>=Overrange  
 444 = Ch 2 Reflected 00.0 to 99.9%, AAA=100%, ^^>=Overrange  
 A = Ch 1 Mode  
 a = Ch 1 Fl ags  
 B = Ch 2 Mode  
 b = Ch 2 Fl ags  
 Fl ags = 010xmspe, x = unused, m = mode override, s = enabled, d = Plasma OK, e = error

The terminator character on incoming messages is either <CR> or <LF> or both.  
The terminator on outgoing replies is <CR>.

## 5. SPECIFICATIONS

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### 5.1. Physical

Dimensions: 6 in. wide x 5.75 in. deep x 2.25 in. high  
Weight: 1 lb. maximum  
Finish: Cardinal, high bake, water-based paint, medium texture.

### 5.2. Electrical

Supply Voltage: 18 to 36 VDC  
Current: 0.5 Amp maximum, 0.1 Amp typical  
Timing Resolution: 1 microsecond

## 6. CALIBRATION

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### 6.1. Equipment

6.1.1. To perform the calibration, the RF Pulser must be connected to a serial port of a PC or to an appropriate Tymkon. If a PC is used, an RS232 communications adapter (810-0381) must be installed in the RF Pulser. If the Pulser is connected to a Tymkon, an RS-422 communications adapter (810-0383) must be installed in the Pulser. The following procedure assumes that a PC will be used for calibration purposes.

6.1.2. A test cable is required for the following procedure. The adapter cable contains two 14-pin communications connector male plugs and connects to J101 and J201 on the RF Pulser and to a 24 Volt DC Power Supply. The adapter is constructed as follows:

Connector.Pin		Description
J101.1	+24V DC	To power supply
J101.2	24V RET	To power supply
J101.3	J201.4	RF1 Digital Output to RF2 Digital Input
J101.4	J201.3	RF2 Digital Output to RF1 Digital Input
J101.6/7	J201.14	RF1 Setpoint to RF1 Forward & RF2 Reflected
J101.8	J101.11	+24 to RF1 Digital Input
J101.9	J101.10	24V RET to RF1 Enable Relay
J201.6/7	J101.14	RF2 Setpoint to RF2 Forward & RF1 Reflected
J201.8	J201.11	+24 to RF2 Digital Input
J201.9	J201.10	24V RET to RF2 Enable Relay

## 6.2. Procedure

6.2.1. Set SW2 to the leftmost position (as viewed from front).

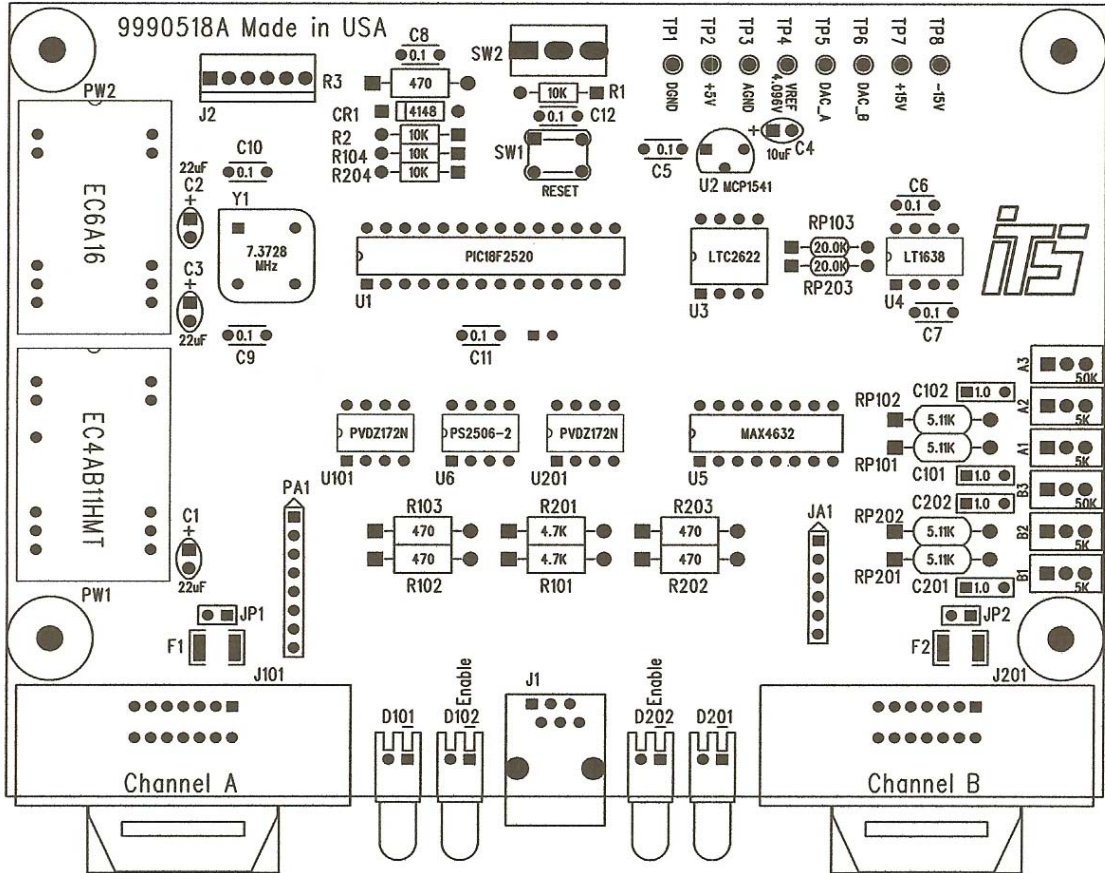
6.2.2. Pretest the power supply voltages as follows:

<b>Black Lead</b>	<b>Red Lead</b>	<b>Acceptable Range</b>
TP1, DGND	TP2, +5V	4.85 VDC to 5.15 VDC
TP3, AGND	TP4, VREF	4.087 VDC to 4.150 VDC
TP3, AGND	TP7, +15V	14.85 VDC to 15.15 VDC
TP3, AGND	TP8, -15V	-14.85 VDC to -15.15 VDC

6.2.3. Check the D/A Converters by confirming the following setpoints:

Black Lead	Red Lead	Command	Acceptable Range
		Get Version @0701V	#0701V:HILOPULS 25SEP2008: #0701Q:000:000:000:000:X@X@
		Kill Output A & B	Check Yellow LEDS. Both should flash once. Then, after 15 seconds, both should alternately flash
		Disable Watchdog	(Same as above)
		Channel A = 10V	Channel A; Green ON, Yellow OFF Channel B; Green OFF, Yellow OFF
TP3, AGND	TP5, DAC_A		3.98 VDC to 4.02 VDC
TP3, AGND	TP6, DAC_B		-0.01 VDC to 0.01 VDC
		Kill Output A	Channel A; Green OFF, Yellow OFF Channel B; Green OFF, Yellow OFF
		Channel B = 10V	Channel A; Green OFF, Yellow OFF Channel B; Green ON, Yellow OFF
TP3, AGND	TP5, DAC_B		3.98 VDC to 4.02 VDC
TP3, AGND	TP6, DAC_A		-0.01 VDC to 0.01 VDC
		Channel A & B = 10V	Channel A; Green ON, Yellow OFF Channel B; Green ON, Yellow OFF
TP3, AGND	J101.6		Adjust Pot A3 for 9.99 to 10.01
TP3, AGND	J201.6		Adjust Pot B3 for 9.99 to 10.01
		Channel A & B = 9.95V	Send Query Commands and Adjust A1, A2, B1, B2 for readings on the PC screen of 995:995:995:995 (+/-1)
		Channel A & B = 1V	#0701Q:100:100:100:100:AFAF (+/-1)
		Channel A & B = 5V	#0701Q:500:500:500:500:AFAF (+/-1)
TP3, AGND	J101.6	Pulse A = 1.5/0.5mS @5V	View Oscilloscope
TP3, AGND	J201.6	Pulse B = 0.2/1.8mS @10V	
		Kill Output A & B	#0701Q:000:000:000:000:X@X@ (+/-1)

# 7. APPENDIX - PC BOARD LAYOUT





## 8. APPENDIX – TYMKON APPLICATION NOTES

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THE FOLLOWING SECTION DESCRIBES THE OPERATION OF THE RF PULSER WHEN USED WITH TYMKON PROCESS SEQUENCERS.

**RF Enable** – This function enables the RF Interface and the RF Generator. When this function is turned ON with no other RF functions, the generator is operated in the conventional analog mode with no pulsing. The set-point entered for this function has a set-point resolution of 1% and ranges from 0 to 99%. This value determines the average power requested from the generator and represents a percentage of the total wattage that the generator is capable of producing. The analog input reported for this function is the value returned from the generator as “Forward Power”.

**RF Pulse** – This function enables the RF Pulse Modes. This function has no effect unless the RF Enable function is also on. The set-point entered for this function has a set-point resolution of 1% and ranges from 0 to 99%. This value determines the peak power requested from the generator and represents a percentage of the total wattage that the generator is capable of producing. For example, a setting of 35% sends pulses of 3.5 Volts amplitude to the generator. There is no analog input assigned to this function.

**RF PWS** – This function enables an RF Pulse Mode in which the user sets the ON Time of the pulses and the RF Pulser calculates the OFF Time based on the Average Power and the Peak Power requested. This function has no effect unless the RF Enable function and the RF Pulse functions are also on. The set-point entered for this function determines the ON Time of the pulse as determined by the table following this section.

**RF PWM** – This function enables an RF Pulse Mode in which the user sets the Total Pulse Width of the pulses and the RF Pulser calculates the ON and OFF Times based on the Average Power and the Peak Power requested. This function has no effect unless the RF Enable function and the RF Pulse functions are also on. The set-point entered for this function determines the Total Pulse Time as determined by the table following this section.

**RF Reflected** – This function has no purpose other than to log and display the “Reflected Power” data returned from the generator. The data will be recorded in the database and displayed on the graph whether the function is ON or OFF. In a future version, this function will also be used to set an upper limit on the Reflected Power so the Tymkon can alarm or abort as required.

**Test Mode** – Another pulse mode is provided to allow the user to explicitly set both the ON Time and the OFF Time of the pulses. To enable this mode, The RF Enable, RF Pulse, RF PWS and RF PWM functions must all be programmed on. In this mode, the RF PWS function determines the ON Time and the RF PWM determines the OFF Time.

<b>Analog Mode</b>			
	<b>Digital Output</b>	<b>Setpoint</b>	<b>Actual</b>
<b>RF Enable</b>	RF Enable Relay	Average Power Setpoint	Forward Power
<b>RF Pulse</b>			
<b>RF PWS</b>			
<b>RF PWM</b>			
<b>RF Reflected</b>	* Enable Alarm	* Upper Limit	Reflected Power

<b>PWS Mode</b>			
	<b>Digital Output</b>	<b>Setpoint</b>	<b>Actual</b>
<b>RF Enable</b>	RF Enable Relay	Average Power Setpoint	Forward Power
<b>RF Pulse</b>	Enables Pulses	Peak Power Setpoint	
<b>RF PWS</b>	Enables PWS Mode	On Time	
<b>RF PWM</b>			
<b>RF Reflected</b>	* Enable Alarm	* Upper Limit	Reflected Power

<b>PWM Mode</b>			
	<b>Digital Output</b>	<b>Setpoint</b>	<b>Actual</b>
<b>RF Enable</b>	RF Enable Relay	Average Power Setpoint	Forward Power
<b>RF Pulse</b>	Enables Pulses	Peak Power Setpoint	
<b>RF PWS</b>			
<b>RF PWM</b>	Enables PWM Mode	Total Time	
<b>RF Reflected</b>	* Enable Alarm	* Upper Limit	Reflected Power

<b>Test Mode</b>			
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	<b>Digital Output</b>	<b>Setpoint</b>	<b>Actual</b>
<b>RF Enable</b>	RF Enable Relay	Average Power Setpoint	Forward Power
<b>RF Pulse</b>	Enables Pulses	Peak Power Setpoint	
<b>RF PWS</b>	Enables Test Mode	On Time	
<b>RF PWM</b>	Enables Test Mode	Off Time	
<b>RF Reflected</b>	* Enable Alarm	* Upper Limit	Reflected Power

\*Future feature

<b>Setting</b>	<b>Interval</b>
0	1 Millisecond
1	1 Millisecond
2	2 Milliseconds
3	3 Milliseconds
4	4 Milliseconds
5	5 Milliseconds
6	6 Milliseconds
7	7 Milliseconds
8	8 Milliseconds
9	9 Milliseconds
10	10 Milliseconds
11	110 Microseconds
20	200 Microseconds
90	900 Microseconds
99	990 Microseconds

On 4 MAY 2009, the range of the pulse times that the RF Pulser is able to produce was extended from 10 milliseconds to 110 milliseconds. However, the programming functions on the Tymkon are still only capable of programming times up to 10 milliseconds.

When both the RF PWS function and the RF PWM function are energized on the Tymkon, the maximum ON time and the maximum OFF time are still 10 milliseconds. This mode of operation was only included in the Tymkon to provide a test mode and was never intended to be used in operation.

The preferred mode of operation is to:

- Turn **ON** the **RF Enable** function and set the RF Enable setpoint to the **Average** power desired (0 to 99%).
- Turn **ON** the **RF Pulse** function and set the RF Pulse setpoint to the **Maximum** power desired (0 to 99%). The maximum power setpoint determines the power level of the generator during the ON times. The maximum power must be greater than the average power or the generator will not be able to achieve the average power level even at 100% duty cycle. The primary reason for not setting this value to 99% might be to protect sensitive devices wafers or boats that cannot tolerate the high energy levels.
- Turn **ON** the **RF PWS** function and set the PWS function for the desired ON time. The technique for programming the ON time has not changed: settings of 1 to 10 set the ON in units of milliseconds and settings of 11 to 99 set the ON time in increments of 10 microseconds.
- Leave the **RF PWM** function turned **OFF** - the pulser will calculate the required OFF time. This mode of operation allows the pulser to set the OFF time to a value larger than maximum 10 milliseconds that can be programmed from the Tymkon.
  
- Example 1: if the average power is set at 10% in the RF Enable function and the peak power is set at 99% in the RF Pulse function and the ON time is set at 4 milliseconds in the RF PWS function, the pulser will calculate an OFF time of 36 milliseconds.
- Example 2: if the average power is set at 4% in the RF Enable function and the peak power is set at 99% in the RF Pulse function and the ON time is set at 4 milliseconds in the RF PWS function, the pulser will calculate an OFF time of 96 milliseconds.
- Example 3: if the average power is set at 1% in the RF Enable function and the peak power is set at 99% in the RF Pulse function and the ON time is set at 4 milliseconds in the RF PWS function, the pulser will calculate an OFF time of 396 milliseconds. This unlikely combination exceeds the maximum time range of 110 milliseconds that the pulser will produce and will not function properly.