Application Note 110: Pulse Amplifier Terms & Definitions

Definitions of Pulse Amplifier Terms

RISE/FALL TIME

The Rise/Fall time is the time defined for the leading or trailing edge of a pulse measured from the 10% to 90% points of the pulse.

PULSE WIDTH

The maximum pulse width specification is based on the TWTs maximum allowable pulse width but typically most Pulse TWTs for instrumentation/EMC testing are specified at 100uses for a maximum pulse width.

PULSE RATE

The Pulse Repetition Rate known as the “PRF specification” is typically 100 kHz maximum for EMC applications. Some other applications require higher PRF rates as dictated by the requirement. The PRF rate is the pulse train applied as a TTL level that is applied to the pulse input connector for modulating/switching the TWT on and off at the rate applied.

RF DELAY

The RF Pulse delay is the difference in time from when the TTL Pulse trigger is applied to the Pulse input connector to when the RF pulse is present. This is the time for the propagation through the system to activate the TWT Modulator as well as the time for the RF pulse to transmit through the TWT.

PULSE ON/OFF RATIO

The RF Pulse On/Off ratio is typically specified at 80dB. This is because when the TWT Grid Modulator switches off the beam current normally flowing in the TWT is pinched/switched off so the noise is reduced with the beam being biased off.

PULSE to PULSE JITTER

The deviation/variation from the leading edge of each repeating pulse.

PULSE WIDTH JITTER

The deviation/variation in the Pulse Width for each repeating Pulse.

PULSE to PULSE STABILITY

The amplitude deviation/variation from Pulse to Pulse.

DUTY CYCLE

The typical maximum duty cycle specification for pulse amplifiers used in EMC applications is 6%. The desired PRF rate is setup externally on the test equipment but can be viewed on the IFI front panel display. This is a feature exclusive in IFI amplifiers where we show the Duty cycle/Pulse Rep Rate and the Pulse Width for the user.

Instruments For Industry
903 South Second Street • Ronkonkoma, NY 11779 • 631-467-8400 • 631-467-8558 • sales@ifi.com • www.ifi.com

DUTY CYCLE CORRECTION FACTOR

Knowing the Duty Factor or duty cycle allows simple multiplication or division to arrive at a peak power level given an average level or vice versa. For example, a pulse signal with a duty cycle of 10% and an average power indication of 50 watts would be multiplied by 10 to arrive at a 500 watts peak power. The same 10% duty pulse train is 1/10th or the total time period so the average power level would be 10 times less than the peak or -10 dB. The same process would hold true for a 1% duty cycle signal, but the average power would be multiplied or divided by a factor of 100 or 20 dB.

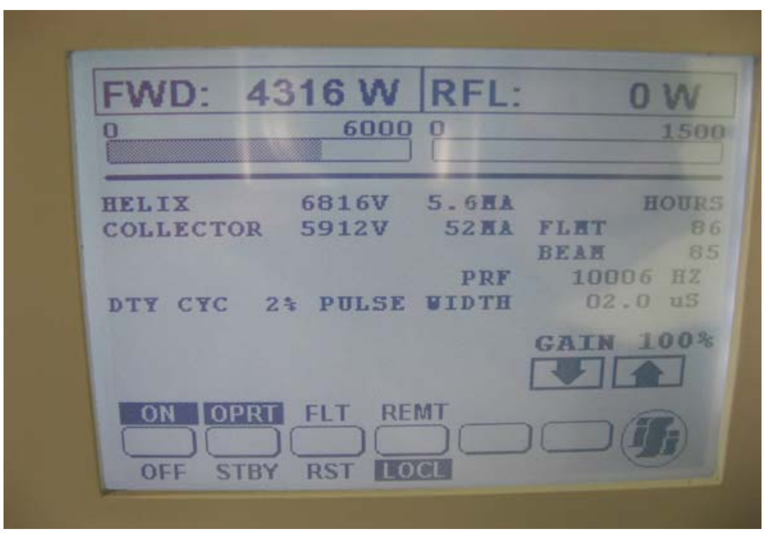
Figure 1 shows a list of duty percentages and multipliers.

Duty Cycle Percentage	Correction factor in dB to correlate average power to peak power	Examples			
		Avg Power in dBm/watts	+ correction factor in dB	Peak Power (dBm)	Peak Power (watts)
1%	20	40dBm/10 W	20	60dBm	1000 watts
2%	17	43dBm/20 W	17	60dBm	1000 watts
4%	14	46dBm/40 W	14	60dBm	1000 watts
6%	12.2	47.8dBm/60 W	12.2	60dBm	1000 watts
10%	10	50dBm/100 W	10	60dBm	1000 watts

FORWARD AND REFLECTED PEAK POWER

IFI's Pulse TWTAs include a power indication function that shows both forward and reflected peak power on the front panel display. Not all labs are outfitted with peak power analyzers so power verification can be done in an average mode converting to peak power with the standard formula.

Duty Cycle Correction + Average Power = Peak Power
Example:
Duty Cycle 1%=Correction factor = 20dB
Average Power measured = 40dBm
Peak Power= 60dBm
20dB (Duty cycle correction) + 40dB (Average power) = 60dBm (Peak Power)



Below are common standard features incorporated into Pulse Amplifiers.

IFI Pulse Series of TWT Amplifiers

Complete TWT Protection

Safety Requirement of IEC-348
VSWR Reflected Power Protection (reverse power monitor)
Cathode Over/under voltage Protection
Collector over-voltage protection
Helix Overcurrent Protection
TWT Overtemperature
Power Supply Overtemperature
Input energy protection
Air Flow Fault Protection
Excess Duty Cycle Protection
Filament over/under voltage Protection
+/-Grid Undervoltage Protection
Solid State Power Supply for Increased Reliability
Modulation, AM, FM & PULSE
DC TWT Filaments

High Stability For:

Very Low Phase Ripple
Very Low Amplitude Ripple
Very Low Pulse/Phase Droop

Additional Standard Features

Front Panel Controls and Indicators
Power On/Off
Standby/Operate
Local/Remote
Fault Reset
Air-cooled (Integrated Forced Air – self-contained)
IEEE GPIB 488 & RS232 Remote Control
Self-Diagnostic Circuitry
EMI Filter built-in

Front Panel Back-Lit Display

Collector Current	Forward RF Power Indication	Reflected RF Power Indication
Cathode Voltage	*Duty Cycle/PW and PRF Rate	Beam Hours
Collector Voltage	Helix Current	Filament Hours

GPIB Address Front Panel Settable

The TWT Amplifier monitors and transfers the power supply operating voltages and currents to a LCD multi-character Front Panel Display. This aids the user in troubleshooting in the event of a failure. This amplifier model indicates on the display where the fault has occurred.

AMPLIFIER OPERATION DESCRIPTION TWT TURN ON/OFF

Pulse Amplifiers amplify RF signals applied to the RF input. Amplifiers have a Pulse input connection that accepts a TTL pulse level from an external pulse generator or signal source for modulation of the TWT. The TWT is modulated from the pulse input connector via the internal TWT pulse modulator. The Modulator is floating at Cathode voltage and switches the TWT on and off at very fast rates. This method of pulse modulation turns the beam off via the modulator when the pulse input connector is at a TTL low. This means there will be no noise power being created by the TWT. The RF rise/fall times are based on the speed that the modulator switches. Typically rise/fall times are 10-15 nsecs for Pulse amps. RF pulse bursts can be applied to the RF input while the pulse input is modulating the TWT. Various combinations can be applied to fulfill whatever your test requirement specifies.

Pulse TWTA's can work from very low duty cycles up to very wide duty cycles in excess of 10% if required for some frequency bands (Subject to TWT availability for this wider duty cycle applications). However, six percent (6%) is a typical duty cycle for most of the pulse amplifier EMC applications. Pulse amplifiers are used for EMC susceptibility testing as well as many other applications including radar.

