



# SYNRAD Technical Bulletin

# 0014

Technical Issue: Firestar f-Series Fault Indicators

Date: 14 December 2007

**Description:**

This Technical Bulletin describes fault indicators on Firestar f-Series lasers, specifically f100 / f200 version D lasers and f201 / f400 version C lasers.

This Bulletin covers the following topics:

- Rev D / Rev C fault indicators
- Troubleshooting Rev D / Rev C faults
- December 2007 changes to fault indicators
- Troubleshooting new fault indications

### Rev D / Rev C fault indicators

The introduction of Firestar f100 / f200 version D lasers and f201 / f400 version C lasers in December 2006 included changes that allowed the *Ready* LED to flash a specific sequence on certain fault conditions. This behavior provides the operator or technician with a visual indication of a fault, should one occur.

In the event of certain faults, the *Ready* LED on the laser's rear panel blinks an error code, pauses four seconds, and then repeats the error code. This sequence continues until the fault is corrected and the laser is reset by cycling DC power to the laser.

Fault indications from the *Ready* (RDY) LED are listed in Table 1 below:

**Table 1 Laser faults**

LED	# of Blinks	Fault Condition
RDY	1	Under Voltage Fault
RDY	2	Over Voltage Fault
RDY	3	RF Drive DC Fault / RF Oscillation Fault
RDY	4	PWM Drive Fault



## Troubleshooting Rev D / Rev C faults

### Under Voltage fault (RDY 1 blink) –

An under voltage fault occurs when the DC input voltage falls below a preset limit. This fault is indicated by the *Ready* indicator flashing one blink. To reset an under voltage fault, first fix the under voltage problem and ensure that 96 VDC is measured at the laser under full-load conditions. Next, cycle DC power off and then on again. On Keyswitch-equipped lasers, you must also cycle the *Keyswitch* from OFF to ON (or apply a  $\pm 5V-24$  VDC Remote Reset/Start Request signal with the *Keyswitch* 'ON').

### Over Voltage fault (RDY 2 blinks) –

An over voltage fault occurs when the DC input voltage rises above a preset limit. This fault is indicated by the *Ready* indicator flashing two blinks. To reset an over voltage fault, first fix the over voltage problem and ensure that 96 VDC is measured at the laser under full-load conditions. Next, cycle DC power off and then on again. On Keyswitch-equipped lasers, you must also cycle the *Keyswitch* from OFF to ON (or apply a  $\pm 5V-24$  VDC Remote Reset/Start Request signal with the *Keyswitch* 'ON').

### RF Drive DC fault / RF Oscillation fault (RDY 3 blinks) –

An RF Drive DC fault occurs on power-up when the tube fails to breakdown or a fault occurs in the RF Driver's 96-volt switching circuitry. This fault is indicated by the *Ready* indicator flashing three blinks. Reset the laser by removing DC power, wait 30 seconds, and then reapply DC power. On Keyswitch-equipped lasers, you must also cycle the *Keyswitch* from OFF to ON (or apply a  $\pm 5V-24$  VDC Remote Reset/Start Request signal with the *Keyswitch* 'ON'). If the RF Drive DC fault reappears, contact SYNRAD or a SYNRAD Authorized Distributor.

A RF Oscillation fault occurs when the RF Driver oscillates in the absence of a PWM signal. This fault is indicated by the *Ready* indicator flashing three blinks. Reset the laser by removing DC power, wait 30 seconds, and then reapply DC power. On Keyswitch-equipped lasers, you must also cycle the *Keyswitch* from OFF to ON (or apply a  $\pm 5V-24$  VDC Remote Reset/Start Request signal with the *Keyswitch* 'ON'). If the RF Oscillation fault reappears, contact SYNRAD or a SYNRAD Authorized Distributor.

### PWM Drive fault (RDY 4 blinks) –

A PWM Drive fault indicates a problem in the laser's internal RF circuitry. Reset the laser by removing DC power, wait 30 seconds, and then reapply DC power. On Keyswitch-equipped lasers, you must also cycle the *Keyswitch* from OFF to ON (or apply a  $\pm 5V-24$  VDC Remote Reset/Start Request signal with the *Keyswitch* 'ON'). If the PWM Drive DC fault reappears, contact SYNRAD or a SYNRAD Authorized Distributor.



## December 2007 changes to fault indicators

Beginning in December 2007, several revisions were made to fault detection and indication circuitry in Firestar f100 / f200 version D lasers and f201 / f400 version C lasers. In addition to the *Ready* LED, these new changes include a flashing *Shutter* indicator on certain faults. This improved annunciation provides the operator or technician with a more specific fault indication.

In the event of a fault annunciated by the *Ready* indicator, the *Ready* LED blinks an error code, pauses four seconds, and then repeats the error code. This sequence continues until the fault is corrected and the laser is reset by cycling DC power to the laser. If a VSWR fault occurs, the *Shutter* LED blinks continuously until the fault clears.

Note that RF Oscillation and PWM Drive faults have been eliminated and no longer exist, while VSWR fault detection and indication has been added.

Revised fault indications for *Ready* (RDY) and *Shutter* (SHT) LED's are listed in Table 2 below:

**Table 2 Current laser fault indications**

LED	# of Blinks	Fault Condition
RDY	1	Under Voltage Fault
RDY	2	Over Voltage Fault
RDY	3	RF Drive DC Fault
SHT	Continuous	VSWR Fault

## Troubleshooting new fault indications

Under Voltage fault (RDY 1 blink) –

An under voltage fault occurs when the DC input voltage falls below a preset limit. This fault is indicated by the *Ready* indicator flashing one blink. To reset an under voltage fault, first fix the under voltage problem and ensure that 96 VDC is measured at the laser under full-load conditions. Next, cycle DC power off and then on again. On Keyswitch-equipped lasers, you must also cycle the *Keyswitch* from OFF to ON (or apply a  $\pm 5V-24$  VDC Remote Reset/Start Request signal with the *Keyswitch* 'ON').

Over Voltage fault (RDY 2 blinks) –

An over voltage fault occurs when the DC input voltage rises above a preset limit. This fault is indicated by the *Ready* indicator flashing two blinks. To reset an over voltage fault, first fix the over voltage problem and ensure that 96 VDC is measured at the laser under full-load conditions. Next, cycle DC power off and then on again. On Keyswitch-equipped lasers, you must also cycle the *Keyswitch* from OFF to ON (or apply a  $\pm 5V-24$  VDC Remote Reset/Start Request signal with the *Keyswitch* 'ON').



RF Drive DC fault (RDY 3 blinks) –

An RF Drive DC fault occurs on power-up when the tube fails to breakdown or a fault occurs in the RF Driver's 96-volt switching circuitry. This fault is indicated by the *Ready* indicator flashing three blinks. Reset the laser by removing DC power, wait 30 seconds, and then reapply DC power. On Keyswitch-equipped lasers, you must also cycle the *Keyswitch* from OFF to ON (or apply a  $\pm 5V-24$  VDC Remote Reset/Start Request signal with the *Keyswitch* 'ON'). If the RF Drive DC fault reappears, contact SYNRAD or a SYNRAD Authorized Distributor.

RF Oscillation fault –

New circuitry on the f-Series RF board has eliminated the RF Oscillation fault; the fault indication no longer exists.

VSWR fault (SHT continuous blinking) –

A VSWR fault indicates an impedance mismatch between the tube and RF driver and occurs when a PWM Command signal is first applied. This fault is indicated by the *Shutter* (SHT) indicator flashing continuously until the fault disappears. If a VSWR fault occurs, the VSWR circuit limits maximum PWM pulse length to 12 milliseconds (ms). This equates to an 8% maximum duty cycle at a 5 kHz PWM frequency or a 25% maximum duty cycle at 20 kHz PWM frequency. When the VSWR fault disappears, the laser recovers automatically without cycling DC power. The leading causes of VSWR failures are environmental conditions, like cold overnight temperatures while the laser is off. In cases like this, it may take as long as 60 seconds for the tube to breakdown and begin normal daily operation. If the VSWR fault fails to clear or reappears, contact SYNRAD or a SYNRAD Authorized Distributor.

PWM Drive fault –

New circuitry on the f-Series RF board has eliminated the PWM Drive fault; the fault indication no longer exists.

For further information contact SYNRAD at 1.800.796.7231; outside the U.S., dial +1.425.349.3500 or fax us at +1.425.349.3667.